ISBN 978-602-97809-0-1

ICIEBM

Proceedings

The International Conference on Industrial Engineering and Business Management 2010

editor :
Arya Wirabhuana, Muchammad Abrori, Kifayah Amar

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Proceedings

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PROOCEEDINGS

The International Conference on Industrial Engineeering and Business Management (ICIEBM) 2010

Editor :

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Published by :

DEPARTMENT OF INDUSTRIAL ENGINEERING
FACULTY OF SCIEMCE AND TECHNOLOGY
THE SUNAN KALIJAGA STATE ISLAMIC UNIVERISTY OF YOGYAKARTA INDONESIA

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First Edition, First Printing on 2010

ISBN : ***978-602-97809-0-1***

Preface

بِسۡمِ ٱللَّهِ ٱلرَّحۡمَـٰنِ ٱلرَّحِيمِ

Assalamu'alaikum. Wr.Wb.

Firstty, let us express gratitude for the presence of Allah SWT for the implementation of the ICiEBM 2010 (**International Conference on Industrial Engineering and Business Management)** which is on having the theme: ***"Sustainable Industry and Business Challenges toward the Future***." The event was held by the Department of Industrial Engineering UIN Sunan Kalijaga in collaboration with the Institute of Industrial Engineering and Management Indonesia (ISTMI), Journal of IEEE Indonesian Section, and Universiti Malaysia Perlis.

Furthermore, this book is published as a dissemination and publication form of the International Seminar results. Proceedings of International Conference on Industrial Engineering and Business Management 2010, contains 106 papers that have presented in this event and also have been selected through a selection process by the reviewer from many trusted institutions. The papers were written by academicians and practitioners from 12 countries namely: Australia, New Zealand, India, Malaysia, Philippines, Thailand, Pakistan, Bangladesh, Iran, Germany, South Korea and Indomesia.

Moreover, as realized, there are still many shortcomings in this book, however we hope this book can be beneficial to several various parties: academicians, practitioners, observers, and students and even the general public to enrich their knowledge and experience in the field of Industrial Engineering and Businesses Management, especially in the aspects of the Sustainable Industries and Businesses in facing the up coming challenges.

Finally, allow us to express its deepest gratitude - to the authors, reviewers, editors, sponsors and donors, organizers, partner, the leader of UIN Sunan Kalijaga and all those who have dedicate so that the book and the seminar can be held properly. Hopefully the seminar and this book can bring good for us.

Wassalamu'alaikum. Wr.Wb

Yogyakarta, September 26th 2010
Rector of UIN Sunan Kalijaga

Prof. Dr. H.M. Amin Abdullah
NIP. 19530728 198303 1 002

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ISBN : 978-602-97809-0-1

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CHAPTER 1 : Economy and Business System (EBS)

editor :
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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

E-commerce Adoption Barrier in Indonesian Micro, Small and Medium Enterprises (SMEs)

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Abstract - **Nowadays SMEs have been proven as important economic supporters in developing countries. Therefore empowerment of SMEs by improvement of e-commerce adoption can contribute significantly to the national economic development process. In the adoption process many barriers exist. If the barriers could be understood by e-commerce adopters, the adoption process is expected to be rapid and planned. This paper reports a study on barriers of e-commerce adoption by Indonesian SMEs in the non-oil-and-gas processing and the trading, hotels, and restaurants sectors, using Business Environment framework. This study found that there are 11 factors of e-commerce adoption barriers. Moreover the Business Environment framework was able to explain e-commerce adoption by SMEs.**

***Keywords* - Adoption, E-commerce, SMEs**

I. Introduction

Nowadays micro, small, and medium scale enterprises (hereinafter referred as SMEs) proved to be important economic supporters in developing countries, such as indonesia. Contributions of SMEs are especially recognized through the provision of employment and poverty reduction. Today, one form of SMEs empowerment is the adoption of electronic commerce (hereinafter referred as e-commerce).

Reference [27] revealed that competitive advantages could be gained by all types of firms, large-scale companies as well as SMEs, by implementing ICT (information and communication technology), which includes e-commerce and internet access. Moreover, Sesan (2000) and Wood (2003) as in [17] stated some benefits of e-commerce for enterprises are broader access to potential markets, reduction in transaction costs, increase in transaction speed, improvement in economies of scale, minimization of human involvement in business process, and unlimited consumers access to products information. As mentioned in [15], many studies found positive signs of e-commerce, as one particular type of ICT, adoption benefit for SMEs to develop the business.

Although there are many advantages that can be obtained from e-commerce adoption by SMEs, SMEs in developing countries are slower in conducting e-commerce adoption in comparison to SMEs in developed countries, as stated in [8]. In the purpose of SMEs empowerment to enhance the national economy of developing countries, the low-speed e-commerce adoption by SMEs must be resolved.

Researches on barriers of e-commerce adoption process are important because barriers are determinants of decisions and speed of the SMEs adoption process. If the barriers could be understood by the e-commerce adopters, the adoption process is expected to be rapid and planned.

Literatures study was done in the field of definitions of e-commerce and mobile commerce (hereinafter referred as m-commerce), as e-commerce development. Some of e-commerce definitions are: (1) "the use of electronic equipment in the process of exchanging information and in the execution of transactions" [14], (2) "the process of buying and selling products and services by business players and consumers over the Internet that involves financial transactions directly through internet technology, consisting of business to business or B2B, business to consumer (B2C) and Consumer to consumer (C2C)" [16], (3) "commerce accelerated and enhanced by information technology" [17], and (4) "transactions for products and services through electronic communication device" [28]. Some of m-commerce definitions are: (1) “electronic commerce conducted over a wireless device such as a cell phone or PDA” [17] (2) “the process of buying, selling, or exchanging products and services wirelessly over mobile communication networks” [2].

Based on the definitions mentioned, there are some similarities and differences that complement each other. The definition of e-commerce in this study accommodates the definition of m-commerce. The definition is: "process of exchanging information and transactions involving products and services through information technology such as networking, software, and electronic equipment, non-wireless as well as wireless ones".

In Indonesia, there is an enterprises classification method that is suggested by Indonesian government as in [4]. The classification method differentiates enterprises into nine economic sectors. Sectors with high employment level, high gross domestic product value, and high export value are trading, hotels, and restaurants sector, and processing industry sector. More specifically, the processing industry sector is divided into oil-and-gas industry and non-oil-and-gas industry. Oil-and-gas industry sector contains only large scale companies, while non-oil-and-gas sector has a large number of SMEs. In addition, in trade, hotels, and restaurants sector, the number of SMEs is much larger than the processing sector. Therefore, SMEs in non-oil-and-gas processing sector and trading, hotels, and restaurants SMEs are chosen as the focus of analysis in this study.

Based on the background mentioned above, the main questions to be answered in this study are: What are the factors of e-commerce adoption barriers for SMEs in Indonesia?

II. METHODOLOGY

A. Framework And Model

This study used a Business Environment framework developed by Jain (2009) to identify barriers affecting the adoption of e-commerce. The framework is presented in Fig. 1. The theory views SMEs as dynamic systems. The theory was chosen because it provides a comprehensive approach to identify and analyse different aspects of an enterprise and its environment. Using the approach, most factors that affect the company's business operation could be identified.

Based on previous studies, various measured variables influencing e-commerce adoption by SMEs were identified. Those variables were grouped around the components of the Business Environment framework. Selection processes of the variables were based on the real situation in Indonesia. In purpose to get the right understanding of Indonesia real situation, a pilot study were done by involving 3 (three) SMEs.

In the initial model at Table II, four Business Environment components are eliminated from the initial model. The elimination process was done based on its effect to e-commerce business operation by SMEs. They are "machine" and "material" component in the internal environment and "natural" and "demography" component in the macro external environment.

B. Data Collection And Sample

TABLE I
SMES CHARACTERISTICS (DEPKOP, 2009)

Scale	Assets (excluding land and buildings)	Gross Income
Micro	≤ Rp. 50,000,000.00	≤ Rp. 300,000,000.00
Small	> Rp. 50,000,000.00 - Rp. 500,000,000.00	> Rp. 300,000,000.00 - Rp. 2,500,000,000.01
Medium	> Rp. 500,000,000.00 - Rp. 10,000,000,000.00	> Rp. 2,500,000,000.00 - Rp. 50,000,000,000.01

Questionnaire was made using 4 point Likert like scaling, from strongly agree to strongly disagree. Questionnaires were given to 400 SMEs by using email and direct meeting. Follow-up emails and phone calls were made to encourage respondents to participate in the research. The response rate was 21.75% with 87 returned questionnaires.

There was no sample from hotel business. The majority were from the trading business. Majority of the sample were the micro scale enterprises. The SMEs' age ranged between below 1 year until 61 years and their e-commerce experience ranged between below 1 year until 7 years.

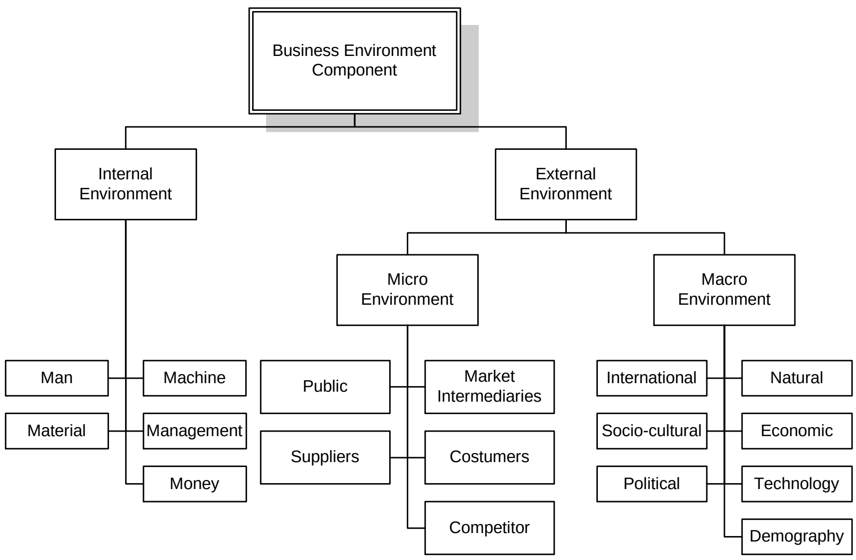

Fig. 1. Business Environment Component (Jain, 2009)

TABLE II
COMPONENT AND MEASURED VARIABLES

Component		Measured Variabel	Code
Internal Environment	Man	The lack of educated human resources	M1
		Lack of resources with IT skills	M2
		Employee resistance	M3
		Lack of knowledge about the benefits of e-commerce	M4
		Lack of knowledge about the implementation of e-commerce	M5
		Lack of experience using information technology / electronic marketing media	M6
		Lack of time to learn about e-commerce	M7
		Lack of time to operate e-commerce	M8
	Financial	Financial investment for the implementation of e-commerce is too high	F1
		The term of return on investment and capital is too long	F2
		Lack of financial resources	F3
	Management	This discordance with the characteristics of e-commerce products	ME1
		Incompatibility of e-commerce with the way organizations conduct business process	ME2
		The absence of standards of quality between sellers and buyers	ME3
		Do not support corporate strategic objectives	ME4
		Lack of support from management	ME5
		The high level of risk decision to use e-commerce	ME6
Micro External Environment	Consumers	Incompatibility with consumer e-commerce	K1
		Distrust buyers about the quality	K2
		Mistrust between the buyer regarding the time	K3
		Distrust buyers about the value-added products	K4
		Few consumers who use the internet	K5
	Partners	Partners have not implemented e-commerce	P1
		The high cost of internet access	P2
		Bad service from internet providers	P3
		Low internet speed	P4
		Lack of the vendor application maker	P5
		The low quality of service delivery	P6
	Publics	The absence of the threat of competitors who are using e-commerce	PU1
		Lack of support and input from SME associations	PU2
		Lack of support and input of import export companies association	PU3
		Lack of examples of organizations that have used e-commerce	PU4
		Lack of the media information about e-commerce	PU5
Macro External Environment	Political	The ambiguity of government regulation	PO1
		The unclear rules of international trade cooperation	PO2
		The high intensity of changes in government regulations	PO3
		Lack of support from the government	PO4
	Technology	Lack of online payment system is feasible and effective	T1
		Potential security risks in internet network	T2
		Information privacy issues	T3
		The low on-line payment security	T4
	Socio-economy	Less popular on-line sales and marketing	SE1
		National economic climate is less stable	SE2
		The poor condition of transportation infrastructure in Indonesia	SE3

III. RESULT

A. Assessment Of Validity And Reliability

Content validity was established by expert judgement. From 87 questionnaires, two questionnaires were not filled completely by respondents. Therefore only the other 85 questionnaires were used for further analysis. The construct validity of each variable was assessed by calculating the correlation between each variable and the sum of each respondent answer using software SPSS 17.0. Variables with insignificant correlation were deleted from the model. Reliability was assessed by calculating the Cronbach alpha coefficient. Calculation showed that the Cronbach alpha coefficient is above 0.7. From the normality test by calculating z score of data skewness and curtosis, we found 7 variables with non-normality distribution. By transforming them using LISREL 8.7, we only deleted 2 variables. Then, sample size and multicolinearity were calculated using KMO and Bartlett's Test in SPSS 17.00. KMO value was 0.780. It meant the sample size was enough for further statistical analysis. Based on on the value of each variable's MSA, we had to delete 1 variable as the value was unacceptable.

TABLE III
DELETED AND TRANSFORMED VARIABLES

Stage	Deleted	Transformed	Deleted
Construct Validity	PO3		
	PO4		
	T2		
	SE2		
Reliability	-		
Normality		ME2	-
		ME4	ME4
		ME5	-
		P5	-
		PU2	PU2
		PU3	-
		PO2	-
Multicolinearity	SE3		

B. *Factor Analysis*

Exploratory factor analysis (EFA) was conducted to validate the initial model. From the EFA, there were 10 factors extracted from 37 measured variables. In the initial model, there were 9 components and 44 measured variables. Difference of measured variable number was caused by the deletion of 7 measured variables in the data preparation process.

Although the number of components and factors were different, there were 2 factors from EFA that were exactly the same with components defined in the initial model. They were financial and political. The other factors in general had similarities with the components in the initial model.

TABLE IV
IDENTICAL FACTORS

Initial Model		EFA	
Latent Variabel	Code	Factor	Code
Financial	F1	3	F1
	F2		F2
	F3		F3
Political	PO1	6	PO1
	PO2		PO2

TABLE V
OTHER FACTORS

Initial Model		EFA	
Latent Variabel	Code	Factor	Code
Man	M1	1	M1
	M2		M2
	M3		M3
	M4		M4
	M5		M5
	M6		M6
	M7		M7
	M8		M8
Management	ME1		ME2
	ME2		K5
	ME3		P1
	ME5	2	ME1
	ME6		ME3
Consumers	K1		K1
	K2		K2
	K3		K3
	K4		K4
	K5		P6
Partner	P1	4	P2
	P2		P3
	P3		P4
	P4	5	ME6
	P5		T1
	P6		T3
Publics	PU1		T4
	PU3	7	ME5
	PU4		PU1
	PU5	8	P5
Technology	T1		PU5
	T3	9	PU3
	T4	10	PU4
Socio-economy	SE1		SE1

IV. DISCUSSION

The both of identical factors, factor 3 and factor 6, indicate that the Business Environment framework gave good definitions of "financial" or "money" and "political". It is proved to be fit to the real situation of Indonesian SMEs. The seven other components from the initial research model and eight other factors from the EFA are discussed below.

Factor 1 is a factor that has all the measurable variables of the "man" component in the initial model. It indicates that the usage of "man" component based on the Business Environment framework is able to describe the grouping of measured variables.

In addition to these measured variables of the "man", there is ME2 from the "management" component. One of possible causes of ME2 in this factor is the perception of respondents while filling the questionnaires. In conducting the assessment of "the way organizations conduct business processes", the manager or owner referred to the working way of employees. Thus, ME2 is possible to be included in the factor, which other measured variables related to "man" component.

Furthermore, there are also K5 and P1 in the factor 1. Conceptually, these two measured variables are very different from the others. The sources of P1 and K5 are external factors, which can be affected, but can not be controlled entirely by the SMEs. Therefore, P1 and K5 are separated from other internal environment measured variables in factor 1.

In performing the separation, it can be observed that both of the factors have a common concept. Both state the "use" of internet by consumers and "the use" of e-commerce by supplier. Internet is the basic information technology for e-commerce. Furthermore, consumers and suppliers are elements of SMEs supply chain. Thus, it can be stated that both of the measured variables represent the use of information technology in SMEs supply chain. The new component is expressed as "supply chain information technology".

Most of the measured variables in factor 2 are measured variables from "consumers". It indicates that the usage of "consumers" component based on the Business Environment framework is able to describe the grouping of measured variables.

Hereafter, in the factor 2 there are ME1 and ME3, which associate with the company's products. It indicates that the respondents consider characteristics and standards of products quality as uncontrollable things for SMEs. SMEs are seen as producers, sellers, or providers of products that have been established, not as systems that can perform products substantial changes to adapt with SMEs demand and environment.

In addition, there is also P6 which source is the delivery service providers who deal directly with consumers. It is very possible that P6 represents the same factors with other measurable variables related to the consumer. This was evident by considering that interarrival time is also influenced by the ability of delivery service providers.

To obtain an appropriate name for the factor 2, the process of generalization is done. It can be observed that there are

ISBN : 978-602-97809-0-1

three main sources of all variables measured, which are products, customers, and service delivery providers. They are the elements of a market. Therefore, factor 2 can be expressed as "market" component.

Factor 4 consists of three measured variables derived from the "partners". It indicates that the use of “partners” component based on the Business Environment framework is able to describe the grouping of measured variables. To perform the naming of the factor, it can be observed that the source of P2, P3, and P4 is the internet provider as a SMEs partner. Thus, the factor expresses "internet services".

All measured variables at the "technology" are grouped in the factor 5. It indicates that the use of “technology” component based on the Business Environment framework is able to describe the grouping of measured variables.

In addition to the variables, there is ME6. By obtaining the results, it is known that there is a high correlation between the risk considerations with the level of security. It indicates that SMEs reference to the security risks associated with the technology used. Therefore, all the measured variables in the factor 5 represent "security" component, which is defined as the security of information technology.

Factor 7 consists of two measurable variables, ME5 and PU1. Although the variables are derived from different sources, there is a relationship that can be observed from the two measured variables. ME5 is a variable measuring management support, while PU1 is a variable measuring the threat of competitors. Both of them become forces to push SMEs in conducting e-commerce adoption. Therefore, factor 7 can be expressed as a "push forces" which is an encouragement from the internal environment, as well as external environment.

Both measured variables in factor 8 are derived from the external environment. Although coming from different external environment, the formation of factor 8 can be explained by looking at the linkage between these variables. Vendor applications maker in the context of this research is a vendor that provides application development services for SMEs. In fact, the vendors generally can also provide consultation or input for a SMEs in the design process and usage of e-commerce applications. Therefore, the vendors are sources of information about e-commerce for SMEs. It can be stated that factor 8 is "source of information" component.

Factor 9 consists of PU3 that measures the support and input from companies associations. Therefore, factor 9 can be expressed as "associated companies" component.

Both measured variables in factor 10 associate with the popularity of e-commerce in general. One of the real popularity is the use of e-commerce by other organizations. Therefore, PU4 and SE1 measure "popularity" component, which is defined as the popularity of e-commerce in general.

V. CONCLUSION

From various comparative analyse between the initial research model and the result of EFA, there are two identical components and four components that have very high similarity. Identical components are financial and political resources. In addition, high similarity is indicated by factor 1 with "man", factor 2 with "consumers", factor 4 with "partners", and factor 5 with "technology".

TABLE VI
REVISED COMPONENT

Component		Code
Internal Environment	Man	M1
		M2
		M3
		M4
		M5
		M6
		M7
		M8
		ME2
	Financial	F1
		F2
		F3
	Push Forces	ME5
Micro External Environment		PU1
	Supply Chain Information Techology	K5
		P1
	Market	ME1
		ME3
		K1
		K2
		K3
		K4
		P6
	Internet Services	P2
		P3
		P4
	Source of Information	P5
		PU5
	Enterprises Association	PU3
Macro External Environment	E-commerce Popularity	PU4
		SE1
	Security	ME6
		T1
		T3
		T4
	Political	PO1
		PO2

In general, the Business Environment framework was able to be used in the process of identifying barriers of e-commerce adoption by SMEs in Indonesia. This is indicated by the level of similarity between the factors from EFA method with the components from the Business Environment framework. In addition, the framework is able to be used in conducting further analysis of the factors that formed from EFA.

By using the Business Environment framework and some adjustments that are made in accordance with the analysis of the factors, the initial research model is revised. The result is final components of e-commerce adoption barriers as in Table VI.

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ISBN : 978-602-97809-0-1

An Empirical Study on the Individuals' Online Purchase intention, An Islamic Perspective

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Abstract - **Despite the wide attention of scholars to adopt the Islamic line of thought in different management and business disciplines such as ethics, finance, economy and banking, no empirical study is available in the context of e-commerce from an Islamic perspective. To address this gap, this paper aims to adopt and empirically study some of the Islamic principles and values in the context of B2C e-commerce. After a literature review in Islamic sources, 4 concepts namely trusteeship, honesty, and promise keeping were identified and 4 variables were drawn out of them, namely security, competency fulfilment, and honesty to examine their influence on customers' purchase intention. To examine the hypotheses, the data were collected from 276 individuals, having the experience of online purchase from one of the airline service providers and after the tests of reliability and validity, structural equation modelling was executed to examine the hypotheses. The reults illustrated that all the identified variables have a direct or indirect significant influence on customers' online purchase intention. The results and implications are discussed briefly. The analysis and results presented in this paper reflect only the preliminary analysis and the main analysis will be conducted after the completion of data collection process.**

Keywords - **Islam, e-commerce, competency, online security, fulfilment, purchase intention**

I. INTRODUCTION

In the recent years, many researchers particularly those in the Muslim world, have recognized the ability of Islamic principles and Shariah to redesign many of the business processes and procedures, which led to the development of broad research areas in Islamic banking, economy, business ethics, law, finance and insurance. The motivation of the researchers conducting research in the areas related to Islamic business and management was enhanced by their novel findings using Islamic principles and also the interests of Muslim communities to conduct and manage their businesses based on Islamic values and principles. Although there are many studies available on the concepts of Islamic banking, business management and economics, researchers have disregarded the need to study e-commerce from the Islamic perspective. The only attempt done to explore e-commerce from an Islamic perspective was by Zainul et al. [1] who used an exploratory approach to discuss the legitimacy of the issues associated with e-commerce such as online payments through credit cards, contracts, and the rights of customers and merchants from an Islamic perspective. However, their paper lacked empirical analysis. Therefore, there is a research gap to adopt and empirically study some of the Islamic rules and thoughts in the context of e-commerce.

The main objective of this study is to adopt and empirically examine some of the values and principles recommended by Islam rooted in its principles of moralities or trade law. This study is the second attempt in the research world to adopt the principles and values recommended by the Islamic school of thought in the context of e-commerce and the first attempt to empirically examine those values and principles. It is hope that this study would enrich the theories available in the filed of e-commerce and information systems by proposing and adopting some of the principles in the Islamic school of thought and empirically examining those principles in this field. In addition, this study would contribute to the academic world by proposing and adopting the Islamic principles in the context of e-commerce and establishes a new research discipline based on Islamic school of thought to be investigated and explored by researchers. Furthermore, this research proposes new hypotheses to examine new relations between the variables of this study which improve our knowledge about the models exist in this field.

II. ISLAMIC SCHOOL OF THOUGHT

Islam is a lifestyle, and therefore, has its specific principles rooted in its moralities, and jurisprudence which are based on *Quran* and *hadith (Sunnah).* This paper does not intend to discuss the legitimacy of Quran and hadith in details, however since it refers to these two sources as the reference for the Islamic discussions of the literature, it needs to discuss their legitimacy and credibility in brief and therefore, it would be helpful to cast a glance at them.

Quran –as the holy book of Islam- is one of the religious sources widely accepted and recognized by all Muslims and

ISBN : 978-602-97809-0-1

therefore, this study starts its Islamic discussion with the statements of Quran. Quran states that "obey Allah, and obey the Messenger, and those charged with authority among you" [2]. According to this statement, there are three distinct entities to be obeyed: Allah, Messenger and "those charged with authority among you". The point in this phrase is that these three entities are to be obeyed with no limitations or conditions as clear in the verse. Therefore, it includes all the aspects of Muslims' life covering all the issues and dimensions related to their social and personal life. While this verse explicitly and clearly mentions Allah and Messenger, it does not clarify whom does it mean by "those charged with authority among you". The doubtless point in this verse is that since this verse does not put any limitation on the obedience of the three entities, it states that obeying Allah, or Messenger or "those charged with authority among you" are in the same line and there are no differences. In other words, obeying the prophet is equivalent with obeying Allah, obeying the third entities- "those charged with authority among you"- is equivalent with obeying Allah and his Messenger as well. Therefore, there are two main sources for Islamic jurisprudence and moralities: 1- *Quran* –as Allah's words and commandments; and 2- *hadith (Sunnah)*, which are the words and lifestyles of Messenger and "those charged with authority among you" [2].

To know whose words –other than the prophet- are hadith according to this verse, we have to identify the third entities. As mentioned above, there is no limitation in the obedience of Allah, Messenger and "those charged with authority among you" [2] which means that they should be obeyed in all aspects of life, and there is no difference between them in this sense as they are in the same line. In other words, it implies that whatever the Messenger commands is the same as Allah's commandments while it holds true for the commands of the third entities as well. This implies that their words are a part of the religion and has to be considered and obeyed as well. Therefore, there should not be any contradictions between the words and commands of these three entities. In other words, while there is no doubt that there are no contradictions between Allah's commandment and his Apostle's words, this should hold true as well for the words of the third entities introduced in the above verse. Therefore, they should be innocent and spotless so that their words and recommendations are not inconsistent or opposite to the words of Allah or his Messenger. In other words, an unconditioned and unlimited obedience from the third entities –similar to that of Allah and Apostle- will be possible only if the third entities are innocent and do not make any statements, recommendations and comments for their followers against those of Allah and the prophet. The only group ensured by Allah to have such a characteristic is the prophet's *Ahlul Bayt* (family) as stated in Quran: "and Allah only wishes to remove all abomination [evil deeds and sins, etc.] from you, ye members of the *Ahlul Baiyt* [the family of the Prophet], and to make you pure and spotless" [3]. Therefore, the third entities are the Apostle's true successors whose innocence has been ensured according to Quran and they have to be obeyed in the same line with Allah and the Messenger. Although the identity of Ahlul Bayt has not been explicitly mentioned in the above verse [3] but like the identity of the Messenger which has not been clarified in the verse 59 of Sourah Al- Nisa, their identity can be understood that who the Prophet's family members are.

Therefore, this research concludes that the bases for its Islamic discussion are Quran and hadith (Sunnah). As stated above, Quran is recognized and trusted by all the Muslims as the reference and base for Islamic discussions and values while there are differences among Muslims regarding the scope of hadith. This research argues that the scope of hadith (Sunnah) is based on the lifestyle, words and sayings of the Islam prophet and his true successors which has been narrated by many Muslim scholars [4], [5], [6], [7], [8], [9]- [10]. Therefore, this study establishes its discussions and arguments either based on Quran or based on hadith as the words of the prophet and his true successors.

A. Trusteeship

Dastgheib Shirazi [11, p. 430] cites from the Islam prophet that "trusteeship leads to the wealth while malversation leads to the poverty". Likewise, he cites from Imam Sadiqh that "honesty and trusteeship increase the sustenance" [11, p. 431]. Similarly, Esmaeeltabar and Hosseini [12] cite from Imam Sadigh that "you shall maintain honesty and trusteeship [...] since these two are the keys for sustenance" (p. 141). Therefore, due to the association of honesty and trusteeship with wealth and income according to Islam, studying the roles of these two factors in electronic commerce is necessary.

It seems that breaching of trust and malversation has been strongly criticized in the Islamic moralities and line of thinking. For instance, Quran has strongly recommended trusteeship [13]- [14] and has praised true trustees [15] while reproved those who betray the trust [15]. Trusteeship in Islam is not limited to physical and tangible properties, but also to non-physical and non-tangible properties as well. For instance, Dastgheib Shirazi [11] cites from the Islam prophet, Hazrat Mohammad that "if one participates in a party he shall keep whatever he hears secret; the believers are not permitted to reveal the secrets of his brother" (p. 450). He also cites from Imam Ali that "revealing the secret told to you is malversation and ruse" (p. 450). Dastgheib Shirazi states that:

"Sometimes, trusteeship is related to somebody's words or secret, stated to another person with the emphasis that the words or secrets shall not be revealed to others or even when someone unintentionally comes to know about the words, opinions or secrets of a person and knows that the person would not like his words or secrets to be revealed to others, in these cases, if the trustee reveals those secrets or words, he has betrayed the trust and it is malversation" [11, p. 449].

These secrets include individuals' sensitive personal and financial information in online environment and revealing this information to unauthorized parties can be interpreted as malversation. Furthermore, Islam has required trustees to practically ensure their trusteeship. For instance, it is speculated by Muslim top clergies that "those who holds some property in trust shall hold any responsibility for the property if they encroach on the property, i.e. [...they] fail in keeping the property such as putting the property in an unsafe place leading to its stealing" [16, p. 645]. The property in the above statements does not only refer to physical property in offline environment, but can be also interpreted as individuals' sensitive financial data and information in online environment as well. The phrase "failing in keeping the property such as putting it in an unsafe place which leads to its stealing" refers to the security of customers' information in which the online merchant should adopt and employ effective and efficient security measures and technologies to ensure that the information cannot be accessed by an unauthorized party. In other words, the statement clearly emphasizes that failing in providing robust measures to protect sensitive information against any unauthorized access and use is not allowed. Likewise, it is stated that those who hold a property in trust, shall provide a good situation for keeping it [16]- [17], which also implies the need for protecting the security of data and information in online environment. Therefore, it seems that individuals' online security have been strongly emphasized in Islam and as the dimensions of trusteeship, they have been associated with more wealth and income. Therefore, it is suggested that the roles of privacy and security issues are studied and included in the research model.

B. B. Honesty and Promise Keeping

According to Islam, being honest and avoiding lie is one of the keys to increase income. One of the most important and emphasized moral principles in Quran is honesty and according to the Quran, it has been one of the characteristics of the prophets and messengers [19], [18]- [20]. The Quran also prescribed lying [21], [22]- [23] and has explicitly mentioned that liars invoke God's curse [24]. The Islam messenger refers to lie as one of the characteristics of hypocrites [11] and Imam Sajjad suggests that "avoid telling a lie, whether small or big, as joking or serious" [11, p. 348].

Imam Sadiqh states that "honesty and trusteeship increase the sustenance" [11, p. 431]. Similarly, Esmaeeltabar and Hosseini [12] cite from Imam Sadigh that "you shall maintain honesty and trusteeship ... since these two are the keys for sustenance" (p. 141). Likewise, they cite from Imam Ali that avoiding lie leads to increasing sustenance while lying is a key to reduce it as Islam Prophet states that "lie leads to decrease of sustenance" [25] while according to the Islam prophet, telling lie leads to poverty [12]. Therefore, this research suggests that honesty as one of the key factors for the success of any business including online business and e-commerce.

Not only honesty –in its general broad meaning- but also keeping promise is one of the types of honesty as according to Dastgheib Shirazi [11] "some of the Muslim jurisprudents believe that breaking one's promise is one of the categories of lie specially when making the promise, he intends not to keep his word and break his promise and therefore, all the consequences of lie mentioned in Quran or in the prophet's words are applicable for that" (p. 424).

Considering the importance of promise keeping in Islam, it is needless to say that keeping promise and covenant refers to fulfilling an obligation or meeting an objective promised to someone as Quran states "O ye who believe! Why say ye that which ye do not?" [26]. Therefore, fulfillment and keeping promise are synonym and exchangeable terms and concepts. However, there are some differences between honesty and promise keeping as Imam Ali states that "keeping one's promise is accompanied by honesty" [11, p. 423]. While the term "honesty" conveys a more broad concept which includes honesty in both words and intention to fulfill the promises and obligations, the concept "promise keeping" concurrently refers to intention of fulfillment of the obligations and executing the tasks promised which conveys three considerations: (1) honesty in the intention of the one who makes the promise to fulfill the obligation; (2) technical capability and ability of him to execute the task and practically fulfilling it; and (3) actual fulfillment of the obligation. In other words, promise keeping reflects three dimensions: intention of keeping the covenant, practical capability and competency to fulfill the obligation and actual fulfillment of the obligation. Hence, honesty and promise keeping are different concepts though having strong links with each other. Therefore, this study suggests them as three different concepts and refers to them as honesty, capability and fulfillment as the merchants' required attributes in both the offline and online environments.

Following the above discussions, this research suggests security right, as customers' right in the e-commerce context. Moreover, this study suggests merchants' honesty, fulfillment, and competency as their critical attributes ensuring their success in an e-commerce business.

III. New Studies in E-commerce

This section provides the new literature on the variables discussed in the first section found by researchers in the recent studies.

A. Purchase Intention

Bigne´-Alcaniz et al. [27] refer to purchase intention as "a mental state that reflects the consumer's decision to acquire a product or service in the immediate future" (p 649).

There are two main approaches in measuring customers' purchase intention including objective and subjective measurements. Purchase intention can be assessed objectively by measuring the actual purchase. On the other hand, in subjective measurement approach, individuals are asked to evaluate and disclose their willingness to purchase from a vendor.

There are a wide variety of factors influencing individuals' online purchase intention. Among them, Website features such as confidentiality protection mechanisms and interface design features [28]- [29] and individuals' personality traits [30] are the main determinants. However, it seems that until and unless customers are not confident about the merchant, they do not involve any transaction with it. Although merchant's attributes such as competency, fulfillment and

ISBN : 978-602-97809-0-1

honesty are widely mentioned as the determinant factors of customers' trust in a merchant, customers need not necessarily trust a merchant to purchase from it [31]. This study examines the influence of merchant's attributes on determining customers' purchase intention.

B. Fulfillment

Gummerus et al. [32] defined need fulfillment as "the degree to which customer requirements are catered for" (p. 182). They found that fulfilling customers' needs is a strong predictor of trust and satisfaction. Customers are willing to purchase from a merchant when their expectations in the previous transactions are met and the promises are fulfilled. Customers' perception about the fulfillment of their orders by a merchant is the result of their perceptions about the merchant's integrity and benevolence which reflects its intention to fulfill the obligation along with the merchant's capability to fulfill the obligation. In oder words, customers are not willing to involve a transaction with a party who does not fulfill their orders. Hence, it is suggested that:

H1: *Customers' perceptions of the fulfillment of their orders have a positive significant influence on their purchase intention from the merchant.*

C. Competency

Kelton et al. [33] refer to competency as trustor's perception that the trustee possesses skills, expertise and know how, necessary to meet the needs of the trustor. According to them, competence is one of the results of cognitive dimensions of trust. Dealing with a competent merchant reduces customers' perceived uncertainty as they perceive that a competent merchant can fulfill the obligations and deliver the products/services with the required quality in the right time frame in the right place. Therefore, it can be suggested that:

H2: *Customers' perceptions of a merchant's competence influence customers' perceptions regarding the fulfilment of their orders.*

D. Honesty

Some scholars have used integrity and honesty as exchangeable terms and concepts [33]- [34] and maintain that integrity is the merchant's willingness to keep its honesty and promise [34].

Customers' perceptions about the extent of which a merchant adheres to ethical values and codes of ethics imply the extent of which a merchant is willing to have opportunistic behaviour in its transactions. Kim et al. [35] speculate that customers are interested to observe that a merchant can act in the interests of them, maintains its honesty and is capable of delivering the orders as promised.

H3: *Customers' perceptions about a merchant's honesty have a positive significant influence on their purchase intention from the merchant.*

E. Security

Mukherjee and Nath [36] define security as the safety of computer and financial information of customers and found that customers' security concerns are the top second determinant of their online trust. The first step to address customers' online trust is to ensure that their sensitive information will be safeguarded [37]. According to Mahmood [38], customers' level of perceived environmental uncertainty and risk is negatively influenced by their perceptions regarding the security mechanisms adopted and employed by a Website. Kim et al. [30] suggested that customer's perceived risk has a negative relation with their purchase intention. Therefore, since customers' perceived security has a reduces their perceived risk [38], therefore, it is hypothesized that:

H4: *Customers' perceptions of the security protection of a Website have a positive significant influence on purchase intention.*

Customers' belief in the competence of a merchant is expected to influence their perceptions regarding the merchant's technical capability to protect their information and guarantee the safety of their information [42]. Therefore, it can be suggested that:

H5: *Customers' perceptions of a merchant's competence influence their perceived online security.*

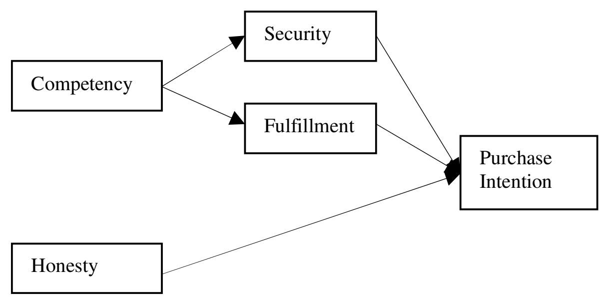

Figure 1- Research Model

IV. Research Methods, Reliability and Validity Tests

A quantitative data collection method was applied, using self-administered questionnaire while the questions were adopted and adapted from published sources with a high reported reliability and validity. The data was collected from 276 individuals who have had any experience of online purchase from the Website of one of the airline service providers in Malaysia.

As shown in Table 1, the reliability of the data was administered by Cronbach's alpha and the items negatively influencing the Cronbach's alpha were deleted to ensure the high reliability of the final scale used for the analysis.

ISBN : 978-602-97809-0-1

TABLE 1.

RELIABILITY RESULTS.

Variable	Source	No. of Items	Mean	Sd	Cronbach's Alpha
Fulfillment	[39]	4	3.84	0.73	0.72
Honesty	[40], [41]	5	3.53	0.54	0.79
Competency	[40], [41]	5	3.87	0.60	0.81
Security	[43]	4	3.43	0.64	0.84
Purchase intension	[30]	3	3.67	0.77	0.77

Moreover, the scale was tested for validity, using confirmatory factor analysis (CFA). As shown in Table 2, the goodness of fit for the measurement model was excellent. Moreover, all the factor loadings were above 0.5 while the correlations between the variables were found lower than 0.8. Furthermore, all the t values were greater than 2. The composite reliability (CR) of the variables were found greater than 0.7 and the average variance extracted (AVE) values were above 0.5, implying that the CR and AVE values are above the cut off values. These results indicate that the model has convergent and discriminant validity.

The demographic analysis of the data showed that 61.2 percent of the respondents were females while 78.2 percent were Malaysians, 14.3 percent were Indonesians and the remaining were from other nations. Moreover, the analysis showed that 25 percent of the respondents had one time online experience, while 57 percent of them had experienced online purchase for 2 to 5 times and the remaining had more than 5 times of online experience. Furthermore, 70 percent of them had evaluated their online skills as moderately good and good. These results imply that the samples had an adequate online experience and knowledge to understand the questions of the survey.

V. ANALYSIS AND RESULTS

In order to examine the hypotheses, structural equation modelling (SEM) was applied and as illustrated in Table 2, the goodness of fit for structural model was acceptable.

TABLE 2.

MODEL GOODNESS OF FIT

Indices	P	$\chi 2$/d.f	NNFI	NFI	CFI	RMSEA
CFA	0.000	1.959	0.904	0.847	0.918	0.059
SEM	0.000	2.327	0.883	0.836	0.898	0.069

The path analysis results with SEM showed that the influence of perceived merchant's competency on fulfillment (t-value > 2.5, p= value < 0.001) and security (t-value > 2.5, p-value < 0.001) was significant, supporting the hypotheses H2 and H5. Moreover, the analysis illustrated that the variables security (t-value > 2.5, p-value < 0.01), fulfillment (t-value > 2.5, p-value< 0.01) and honesty (t-value >2.5, p-value < 0.01) have a positive significant influence on individuals' purchase intention. Therefore, the hypotheses H1, H3 and H4 are empirically supported.

TABLE 3.

HYPOTHESES RESULTS

Hypotheses	Result
Fulfillment → Purchase intention	Supported
Competency → Fulfillment	Supported
Honesty → Purchase intention	Supported
Security → Purchase intention	Supported
Competency → Security	Supported

VI. DISCUSSION AND FUTURE RESEARCH SUGGESTIONS

The results suggest that customers positive perceptions about the security mechanism implemented by a Website, as well as their perceptions about the merchant's honesty and fulfillment of their orders enhance their purchase intention from the merchant in online environment. These findings are in line with the previous studies [29]- [44].

Moreover, it was found that customers perceptions about the merchant's competency influences both their perceived security and perceived fulfillment of their orders. These findings were new contributions in this context and no any other attempts had been made to examine the influence of merchants' competency on perceived security and fulfillment.

The findings of this paper, proved and validated the principles and values of Islam in business and trade, since all the dependent variables identified in the Islamic school of thought were found as the significant determinants of individuals' purchase intention from an online merchant as the variables reflecting profitability of a commercial relationship.

This research makes different contributions. From the academic perspective, this paper is the second attempt to adopt the Islamic school of thought in the context of e-commerce, after the study conducted by Zainul et al. [1]. However, this paper makes original contributions compared to the previous work. First, the orientation and content of this paper differs with that of Zainul et al. [1] and this paper concentrates mainly on the merchant characteristics and the security issues associated with transactions in online environment, based on the Islamic principles and values. Second, it is the first attempt to empirically examine these principles using the Islamic perspective. Moreover, this paper improves the models exist in the context of B2C e-commerce by empirically testing the new relations suggested in this paper.

The findings also have some implications for the business world. The results suggest that in order to enhance customers' purchase intention in online environment, they should be ensured about the security measures and protections of the Website. Moreover, merchant's competency, honesty and order fulfillment should be communicated to its customers. This process can be done through advertisement, customers' testimony and brand image improvement programs.

This research is however not free from limitations. The first limitation refers to the convenient sampling technique applied by this study, which eliminates the generalization of the findings. Moreover, this study did not examine the influence of the independent variables on customers' online trust, loyalty and satisfaction. Another limitation is related to the antecedents of the dependent variable. It is suggested that researchers find more variables rooted in Islamic values and morals and empirically examine their relations with trust, loyalty, satisfaction and purchase intention.

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ISBN : 978-602-97809-0-1

New M-Marketing Strategy for Natural Coloured Indonesian Batik Trading

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Abstract - **This paper propose a new m-marketing strategy for natural coloured Indonesian Batik trading. Batik is one of Indonesia's heritages that popular worldwide. Now, Indonesian batik lovers from abroad are more interesting in batik which is coloured with natural dyes because the usage of synthetic dyes has been prohibited in some countries. We did a case study in Batik Bixa and Pram in Yogyakarta, as one of the pioneers of natural coloured batik in Indonesia. In this paper, we will analyze the mobile device user in some countries that become destination of natural colored Indonesian Batik export. Then, we create m-marketing models that suitable for natural colored Indonesian Batik marketing. We proposed two strategies to improve natural coloured Indonesian Batik marketing. There are by taking the advantages of existing web community and making new web community portal. By implementing the right m-marketing strategy so natural colored Indonesian Batik trading will be increase rapidly and became one of the reliable export commodities.**

Keywords — **m-marketing, marketing strategy, natural coloured Indonesian Batik,**

I. INTRODUCTION

Today's communications market is moving quickly toward the promise of communications, commerce, and content available anytime, anywhere, and on any device [1]. Mobile phone opens up a new dimension for the marketer to build strong customer relationship by providing the customers with their desired information through mobile phones at any place any time [2]. In European, mobile communications and internet are expected to be the main drivers of the telecommunications industry. In this place around 1/3 of internet users (aged 16-74) produce some online contents and a similar or greater percentage of consumers did the same both in USA and in Asian Countries such as Japan, Korea, China [3]. In fact, especially young population (the 60% of surfers has from 15 to 24 years old) participates actively in online discussions. Moreover, young people say to use the Internet to find information before buying online or offline [4].

Mobile marketing has probably been one of the most discussed and hyped mobile phenomena during the past ten years [5]. Tiwari [6] says mobile marketing (m-marketing) refers to services based on mobile communication technologies that provide firms with new, innovative instruments, e.g. to increase sales, win and retain customers, improve after-sales services, build and sustain a positive and modern image/brand and carry out market research. The Mobile Marketing Association (MMA) defines mobile marketing as "any form of marketing advertising or sales promotion activity aimed at consumers" [7] .

Batik is one of Indonesia's heritages that popular worldwide. Now, Indonesian batik lovers from abroad are more interesting in batik which is colored with natural fibers because the usage of synthetic dyes has been prohibited in some countries. We did a case study in Batik Bixa and Pram in Yogyakarta, as one of the pioneers of natural colored batik in Indonesia. Until now, marketing of natural colored batik products are still based on relationships. They already have a website to deliver information about their products. But, the next transaction conducted via telephone. Countries that become natural colored batik export destination are Japan, Australia, Germany and United States.

In this paper we propose a new m-marketing strategy for natural colored Indonesian Batik trading. We will analyze the mobile device user in some countries that become destination of natural colored Indonesian Batik export. Then, we create m-marketing models that suitable for natural colored Indonesian Batik marketing. We hope that by implementing the right m-marketing strategy so colored Indonesian Batik trading will be increase rapidly and became one of the reliable export commodities. In addition, by colored Indonesian Batik marketing growth, income of the Batik craftsmen in Indonesia will be increased so that the Indonesian batik industry will also rise again and become one of the potential sources of foreign exchange. Also, the existence of colored Indonesian Batik will become stronger in the world as one of the original Indonesian culture.

II. MOBILE TRENDS AND ITS FUTURE

Based on the mobiThinking compendium of mobile statistics and research on June 2010 (www.mobithinking.com) and press release from International Telecommunication Union on **15 February 2010** (www.itu.int), mobile

ISBN : 978-602-97809-0-1

subscribers will surpass 5 billion in 2010 that is over 70 percent of the world population and growing rapidly, led by China and India. It spurred by demand of collaborative web applications known as 'web 2.0,' and greater 2.5/3G penetration. China has 747.4 million mobile subscribers in 2009 and it is will be grow to 1,311.7 million in 2014 and India has 525.2 million subscribers in 2009 and it is will be grow to 853.0 million in 2014 based survey from e-marketer (www.emarketer.com). Based on survey from CTIA, USA 285.6 has million subscribers in 2009 (www.ctia.org)

The International Telecommunication Union (ITU) says expects mobile Web access via laptops and smart mobile devices can overtake desktop Web within the next five years (www.itu.int). Strategy Analytics estimates that at the end of 2009 almost 530 million users browse the mobile web on their mobile device and **predicts combined consumer and advertiser spend on mobile media, which includes handset browsing, mobile applications, mobile games, mobile music, mobile video, mobile TV, ringtones, wallpapers and alerts, and associated data, will rise from just under $75 billion at the end of 2010 to just over $138.7 billion by 2015, at a 13.1% CAGR. This datasheet includes forecasts for users, usage, end user and advertiser spend across each mobile media application for Western Europe, North America, Asia Pacific, Central & Eastern Europe, Central & Latin America, Middle East & Africa, and major countries within each region** (www.strategyanalytics.com).

Morgan Stanley states that 3G is keys to success of mobile internet. Nowadays, the number of 3G handsets is growing fast. 3G means faster access the mobile Web by assuming a 3G network is available. Mobile devices sales fell slightly in 2009, while smart phones sales grown rapidly. Estimates for mobile advertising and marketing expenditure worldwide ranged from US$1.4 billion to $7.5 billion in 2009. In Japan, all analysts forecast that mobile advertising grow into US$1.14 billion in 2010 and that is predicted to reach US$119 billion in 2015 and In the United States, mobile online shopping rose from $396 million in 2008 to $1.2 billion in 2009. Globally in 2015, shoppers around the world are expected to spend about $119 billion on goods and services purchased via mobile phones. That number represents about 8% of the total e-commerce market. (www.abiresearch.com)

Gartner on March 2010 predicts that by 2011, over 85 percent of mobile device shipped globally (www.gartner.com). In mature markets, such as Western Europe and Japan, approximately 60 percent of mobile device will be smart phones with sophisticated browsing capabilities. Table I shows top five mobile phones manufactures in 2009.

TABLE I
TOP 5 MOBILE PHONES MANUFACTURES IN 2009 (GARTNER, 2010)

Rank	Vendor	Market share
1	Nokia	36.4%
2	Samsung	19.5%
3	LG	10.1%
4	Motorola	4.8 %
5	Sony Ericsson	4.5%
6	Others	24.7%

From Table I, we knew that Nokia still remains the king of mobile phones in the world. Table II shows top five smart phones operating system in 2009. From Table II, we knew that almost smart phones in the world still use Symbian as their operating system.

TABLE II
TOP 5 SMART PHONES OS IN 2009 (GARTNER, 2010)

Rank	Vendor	Market share
1	Symbian	46.9%
2	Research InMotion	19.9%
3	iPhone OS	14.4%
4	Microsoft Windows Mobile	8.7%
5	Linux	4.7%
6	Others	19.0%

Strategy Analytics on March 2010 estimates that global expenditure on mobile advertising at US$3.6 billion in 2009 will be growing to US$3.8 billion in 2015 (www.strategyanalytics.com) ABI Research on May 2009 estimates that global expenditure on mobile marketing and advertising in 2009 was $7.5 billion, and will b increased to $11.5 billion in 2010, $16.3 billion in 2011 and $21.2 billion in 2012 (www.abiresearch.com). Juniper Research on August 2009 predicts that total advertising expenditure on mobile was expected to rise from just over US$1.4 billion in 2009 to US$6 billion n in 2014 (www.smartbrief.com)

Mobile marketing and advertising expenditures in Japan in 2009 was 103.1 billion Yen, that's US$1.14 billion (Hayzlett, 2009; www.mobithinking.com). Year-on-year growth was 12.9 percent. Besides that, the European officials argue that the regulatory regime for e-commerce is vital because the sector is forecast to generate €128 billion, or $174 billion, across the European Union in 2008. It could grow by 230 percent in five years (www.nytimes.com). Fig 1 shows that in United States has the same condition, the mobile marketing increased rapidly like shown below [8].

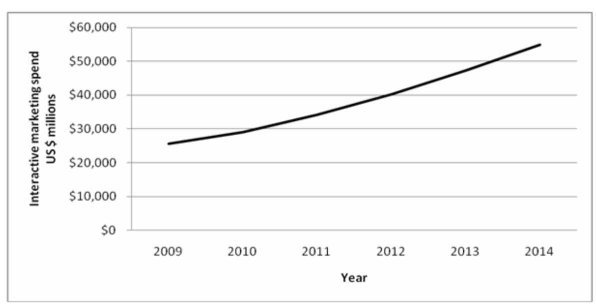

Fig. 1: Mobile marketing growth in United States

Table III shows the usage of internet marketing models in United States. From Table III, we knew that mobile marketing will grow rapidly from $391 in 2009 and will be $1274 in

2014. Besides that, from the data we know that mobile marketing is more used in United States than other internet marketing models.

TABLE III
INTERNET MARKETING GROWTH IN UNITED STATES (GARTNER, 2010)

	2009	2010	2011	2012	2013	2014	CAGR
Mobile marketing	$391	$561	$748	$950	$1,131	$1,274	27%
Social media	$716	$935	$1,217	$1,649	$2,254	$3,113	34%
Email marketing	$1,248	$1,355	$1,504	$1,676	$1,867	$2,081	11%
Display advertising	$7,829	$8,395	$9,846	$11,732	$14,339	$16,900	17%
Search marketing	$15,393	$17,765	$20,763	$24,299	$27,786	$31,588	15%
Total	$25,577	$29,011	$34,078	$40,306	$47,377	$54,956	17%
Percent off all ad spend	12%	13%	15%	17%	19%	21%	

Source : Forrester's Interactive Advertising Models, 4/09 and 10/08

III. NATURAL COLOURED INDONESIAN BATIK

In this paper we propose a new m-commerce strategy for natural colored batik trading. Organization of Education, Science and Culture of the United Nations (UNESCO) announce batik as a world heritage original from Indonesia. Batik assessed as a unique cultural icon that has a deep philosophical values that cover the life cycle of human beings as objects of cultural heritage [9].

Batik crafts have been developed from generation to generation as genuine clothing products of Indonesian heritage. From the era of pre-history, Hinduism, Islam, Colonial Time, the period of independent struggle, until the present time, batik has been continuously developed in various motives, design and technology. Indonesian batiks have its own characteristic that is associated with the making process that using blocking dyeing technique. The blocking material is waxing with particular ingredients. The motive has specific characteristic, arranged from ornaments that have beautiful nuance as well as symbolic meaning showing Indonesian personality [10]. Indonesian batiks divided into many different types based on their origin. There are Javanese Batik, Kalimantan Batik, Jambi Batik, etc.

Batik is one of Indonesia's heritages that popular worldwide. It has been exported to many countries. Now, Indonesian batik lovers from abroad are more interested in batik which is coloured with natural fibers. Countries such as Japan, Australia, Germany and United States have refused the entry of batik with synthetic dyes. Began on August 1st, 1996 the international community from Netherlands and Germany officially banned the entry of products that use synthetic dyes. They also prohibit wearing clothing that uses synthetic dyes. This makes Indonesian batik industry return to the natural colouring technique and no longer use synthetic materials.

Technique of synthesis colouring appeared since the year 1910. Type of indigosol such as procion, indanthrene and naphtol used for synthesis dyes to make the colors look sharp, bright and flashy. One of the side effects of synthetic dyes is the damage of 90% in the epidermal cells that cause skin cancer. Colours produced by natural processes tend to show the impression of supple and soft but it will not produce the exact same colour tone despite using the same recipe. Natural colours derived from bark, roots, fruits, seeds, leaves and flowers of plants. Each plant can be used as natural dyes because it has different colour pigment. Research and selection required to obtain strong colour of appropriate plants

Based on primary data by conducting interviews directly with the owner of the natural dye batik namely batik Batik Bixa and Prams, there are many plants that can be used for natural dyes such as trees leaf indigo (indofera), high soga bark (Ceriops candolleana arn), tegeran timber (Cudraina javanensis), roots of noni (Morinda citrifolia), skin of soga jambal (Pelthophorum ferruginum), etc. Type of plants that used as natural resources for making natural dyes shown in Table IV.

TABLE IV
NATURAL RESOURCES FOR NATURAL COLOUR DYES

Type of plants	Colour result
Temulawak	Brown
Morinda root	Red
Indigofera	Blue
Turmeric (curcuma)	Yellow
Kesumba (Bixa orelana)	Orange
Combination of secang tree roots with water	Purple Lotus
Combination of outside skin timber, jambal, tengeran, tinggi, and guava leaves	Glossy soga color

Utilization of plants as natural dyes for batik that made from natural fibers can contribute to the cultivation of plants. This can also be used to encourage conservation of biodiversity. Textile materials which are coloured with natural dye materials derived from natural fibers such as silk, wool and cotton (cotton). Combination silk and natural dyes produce better results than the combination of cotton and natural dyes.

There are several types to produce Batik with natural dye that are Mordanting process, Making a fixer solution (color lock), Dyeing process with natural dyes. There are some differences between Batik that made from natural dyes and synthetic dyes. Batik that coloured with natural dyes looks not really bright than batik that coloured with synthetic dyes. Besides that, natural dyes always produce unique colour although we used same resource composition. Although natural dyes can not produce flat colour as good as synthetic dyes. Batik that coloured with natural dyes batik is odourless whereas batik that coloured with synthetic dyes has unique strong smell. The examples of natural coloured Indonesian Batik shown in Fig.2.

Fig. 2: The examples of Natural Coloured Indonesian Batik

For the price of batik cloth with natural dyes themselves ranged up from IDR 100.000 until IDR 600.000 depend on the type of batik. There are three types of batik categories:

1) Batik purely done by batik tools with a particular stamp.
2) Handmade traditional batik.
3) Batik combination (combination of printed batik and handmade traditional batik)

The most expensive price is handmade traditional batik that done done purely by hand because the process of batik production is very long and detail.

We did a case study in Batik Bixa and Pram in Yogyakarta, as one of the pioneers of natural dye batik in Indonesia. Until now, marketing of natural dye batik products are still based on relationships. They already have a website to deliver information about their products. But, the next transaction conducted via telephone. Countries that become natural dye batik export destination are Japan, Australia, Germany and the United States. Export market share of natural colored Indonesian Batik in Batik Bixa and Pram shown in Fig.3

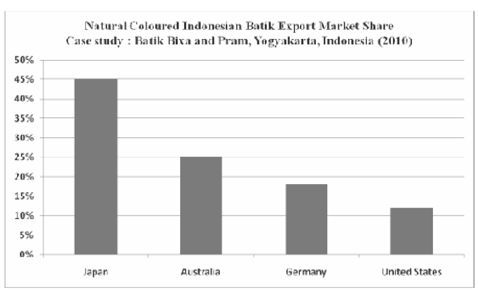

Fig. 3: Natural Coloured Indonesian Batik Export Market Share in Batik Bixa and Pram, Yogyakarta, Indonesia (2010)

IV. M-MARKETING

Internet has transformed our lifestyle in many ways [11]. The continuous evolution of information technology has been changing the way people lead their lives over the last century [12]. Today's communications market is moving quickly toward the promise of communications, commerce, and content available anytime, anywhere, and on any device [1]. Technology has become central to company operations as well as strategy [13]. Mobile communication technology and internet are probably among the most influential one [12].

M-Business is defined as the exchange of goods, services, information and knowledge with the aid of mobile technology [14]. Ling says that mobile business has potential to grow and to be one of the most important industries in the world [15]. Successful companies today recognize electronic technologies and the Internet as mainstream to business success [13]. Success in the mobile business requires co-operation among various business actors, e.g. technology providers, device manufacturers, content providers, service developers etc. to provide value to end customers [15].

Mobile commerce is defined in a variety of ways [16]. M-commerce is closely related to e-commerce, since the services offered in both variations are handled electronically by computer-mediated networks and accessible via telecommunication networks. The only difference is that in m-commerce the telecommunication networks are accessed through mobile electronic devices [6]. According to Dhindsa [17], mobile commerce is defined as the use of information technologies and communication technologies for the purpose of mobile integration of different value chains and business processes, and for the purpose of management of business relationships. Else, mobile e-commerce is defined as all activities related to a commercial transaction conducted through communications networks that interface with mobile devices [18]. Besides that, Kini [16] defined mobile commerce as commerce that done by using a wireless handheld device using cellular or Wi-Fi or any other type of wireless network. McCarthy [19] said that mobile commerce is commercial activity that occurs when consumers use their mobile devices to make purchases, just as they use credit or debit cards. Tiwari [6] defines m-commerce as "any transaction, involving the transfer of ownership or rights to use goods and services, which is initiated and/or completed by using mobile access to computer-mediated networks with the help of an electronic device".

Mobile services are reported in the fields of content, entertainment, travel, banking and marketing [6]. Mobile marketing and advertising are on the rise [20]. Mobile marketing is refers to services based on mobile communication technologies that provide firms with new, innovative instruments, e.g. to increase sales, win and retain customers, improve after-sales services, build and sustain a positive and modern image/brand and carry out market research [6]. Mobile marketing has the potential to fundamentally change the way consumer marketing occurs [21]. Mobile marketing enables distribution to the consumer at the most effective time, place and in the right context [22]. Marketing communications mix elements include advertising, sales promotion, public relations, direct marketing and personal selling [23]. According to Marshall [24], mobile marketing subdivision consists of SMS/MMS, Mobile Web, Application, Mobile Advertising and other (Video, Games, Music, Ringtones, etc).

According to Vrechopoulos *et al* [25], improving mobile devices, designing more user-friendly shopping interfaces, developing effective applications and services, reducing prices, influencing opinion leaders and solving security, bandwidth and coverage problems, constitute the critical success factors for accelerating mobile commerce diffusion in Europe [24]. Europe and Asia (Japan) have advanced in wireless

ISBN : 978-602-97809-0-1

technology faster than the US and other parts of the world. In Europe, short message system (SMS) was the driver for wireless devices. In Japan, entertainment, ring tones, and wireless icons pushed mobile consumer commerce forward. In the United States market, consumers are still waiting for the killer application [13]. Therefore, examining the emerging businesses around new mobile services in Europe is extremely important and topical [15].

Target marketing is all about developing highly focused messages that are more likely to motivate consumers, and then sending those messages at times when consumers are most likely to take action. It's not so much about reaching as many people as possible as it is about increasing response rates and, in doing so, lowering the cost of a customer response or acquisition. Mobile devices provide two-way communications. Mobile marketing enables marketers to develop sustained relationships and direct dialogues with their customers in ways and at depths previously unavailable [19].

One of the most important issues in e-marketing that has emerged is the need to get enough traffic to web sites to make them viable and then to further develop their potential to customize the interaction between the customer and the information [22]. Juniper Research (2009) pointed out that where fixed internet access is limited; mobile becomes dominant to access the internet (www.smartbrief.com). From previous research [25], it was found that the most important reason for utilizing mobile services is the "good price/service ratio" (68%). Therefore, most important reason for not using mobile services was found to be the "high price of mobile access" (61%). The majority of respondents (61%) reported that "lower prices" is very important [25]. Mobile devices not only do their transmit account information at the point of sale during a transaction, but these devices can also receive information. This information can be personal account information, and it can also be personalized advertising [19]. MMA or Mobile Marketing Association, along with major US carriers, has established the rules of conduct about mobile marketing. They said that mobile marketing will be achieving it's goals if it is not spam, engaging, context-relevant, simple, has good interfaces, measured, converged in multi channel, perzonalized and interactive [20]. According to McCarthy [19], there are two absolute certainties in mobile marketing: (1) There must be an opt-in mechanism for consumers to choose participation, and (2) If consumers do not like the messaging they receive, or if they become irritated by it, they will turn off the messages.

V. M-Marketing Strategy for Natural Coloured Indonesian Batik

Target of natural coloured Indonesian Batik consumers are from abroad. From research above, we found that many aspects that must be considered in arranging new strategy that appropriate to increase natural coloured Indonesian Batik marketing. In this paper, we will adopt m-marketing as base marketing strategy for natural coloured Indonesian Batik. Nowadays, M-marketing is already proven as the marketing strategy that enables distribution to the consumer at the most effective time, place and in the right context [22]. We review two important aspects that will be used for our new strategy in natural coloured Indonesian Batik, there are:

A. *Technical Aspect*

According to Marshall [24], mobile marketing subdivision consists of SMS/MMS, Mobile Web, Application, Mobile Advertising and other. We will use mobile web as marketing tools to distribute information about natural colour Indonesian Batik because mobile web is more efficient to deliver information that appropriate with consumer need. From research above, we also found that three top mobile phones that dominate in the world are Nokia, Blackberry (Research in Motion) and iPhone. They use their own operating system on their devices. We propose that mobile web that used for marketing tools build in Java. Java has become invaluable to web developers by enabling them to write software on one platform and run it on virtually any other platform (www.java.org). So, our mobile web can be accesed in many various operating systems on mobile device.

B. *Psychological Aspect*

We propose new m-marketing strategy that applied convenience to consumers. Our mobile web that using for natural colour Indonesian Batik marketing must has user friendly interface and interactive with users. We also recommended that our mobile web can be accessed with high speed using 3G network so consumers no need to spend lots of money to access the website. Most smart phones already used 3G as their internet network. Else, we also propose mobile web that can deliver services to the consumer personally. We assume to prepare customer service that can serve every customer personally. We also maintain the privacy of consumers by keeping the value of every advertisement that we offer where consumers can choose what information should we given to them on their mobile devices. So customers will not interfere with the information that they do not want.

Next, we develop two different strategies for natural coloured Indonesian Batik marketing:

A. *Take the advantages of existing web communit.*

Ordering products and services on the web are such common activity nowadays. Word-of-mouth not only happens offline but also in online. People communicate more seamlessly on mobile phones than on computer and there will be more opportunities for marketers to get their message disseminated at little cost to themselves and with higher credibility and readership – really tapping into word of mouth networks [22]. When buying products on the Internet, consumers read others opinion, reviews and experiences on them. In this process, many consumers automatically reveal themselves in eWOM. Compared to offline word-of-mouth, the range and speed of electronic word-of-mouth (eWOM) is extremely wide and rapid. It is because consumers actively generate and share opinions on products and services on the Internet [11].

Results show that Internet forum has a positive relationship in between brand attitude, brand switching, purchase acceleration and product trial [26]. There is further potential to segment the market by mobile device used and to deliver products and to use communication strategies that address the particular segments specifically [22]. From that result we know that community on web social are growing and make that aspect can be strategic for take the advantages of web community because natural coloured batik its self is a new comer in mobile marketing.

B. *Making new web community portal.*

Until now the Natural Color Batik doesn't have any community so it is need to create a community to natural Color batik to accommodate the demand of its product. Until now the demand is from relation and use offline marketing. This community needs to build a website and create a community in this website. The website must be up to date with any information that related to Natural Color Batik and support community inside. The marketing strategy is sharing information so this website can be the number one website to look for any information about it. This website should support mobile web and can be accessed with any mobile devices that support 3G. The weakness of this method is difficult to reach a market because this method should advertised about it mobile web first.

Those strategies will consider two aspects that have been discussed before. Every strategy will apply technical aspect and psychological aspect in its realization. By using mobile web marketing, we expect that we can obtain more customers from overseas so it can increase exports of natural coloured Indonesian Batik. Also, by using mobile web marketing, the relationship between natural coloured Indonesian Batik owners with consumers in foreign countries may also well preserved. Consumers from abroad can obtain updated information about natural coloured Indonesian Batik and the owner can respond to customer complaints through the mobile web. By implementing the right m-marketing strategy so colored Indonesian Batik trading will be increase rapidly and became one of the reliable export commodities. In addition, by colored Indonesian Batik marketing growth, income of the Batik craftsmen in Indonesia will be increased so that the Indonesian batik industry will also rise again and become one of the potential sources of foreign exchange. Also, the existence of colored Indonesian Batik will become stronger in the world as one of the original Indonesian culture.

VI. Conclusions

Based on the experimental result, we offer two strategies to improve natural coloured Indonesia batik marketing. The first strategy is by taking advantages from existing community by using e-Word-of-mouth and web community. The second strategy is making new web community portal that opened to everyone who want to join. Every strategy has its own advantages and disadvantages. By implementing the right m-marketing strategy so natural colored Indonesian Batik trading will be increase rapidly and became one of the reliable export commodities. In addition, by natural colored Indonesian Batik marketing growth, income of the Batik craftsmen in Indonesia will be increased so that the Indonesian batik industry will also rise again and become one of the potential sources of foreign exchange. Also, the existence of natural colored Indonesian Batik will become stronger in the world as one of the original Indonesian culture.

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

Jogjakarta : E-tourism Guide with Online System

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Abstract — **Indonesia, which is the number of islands and countries with great cultural, diversity typical for a tourist destination. One is jogjakarta. Jogjakarta as a premier tourist destination of foreign tourists, must have a supporting infrastructure to various tourist destinations which can be known by the community owned tourism, especially foreign tourists. Hence the need for an online information system that can provide supporting information. This information system provides a variety of data as well as areas that may be visited by many supporters of the facility or the surrounding area. So that existing communities can be ameliorated by the promotion system that will indirectly have a positive impact for tourism especially in the areas of life jogjakarta.**

Keywords — **E-Tourism, Jogjakarta, Information System, Online System**

I. INTRODUCTION

Tourism and culture are one source of local revenue that must be nurtured and developed properly. We need a way to attract customers or tourists by providing information about culture and tourism, particularly in the area jogjakarta. One way is by providing easy access to tourist information on places that have characteristics of a culture or tourism in certain areas in Jogjakarta. With the rapid technological developments, it is necessary to develop a model that can be given information in a timely, appropriate and accurate. One technology that can be exploited in accelerating the process is by tenologi handphone via WAP system. Mobile phone usage has become commonplace in every line of community life. As communication devices, mobile phones have several advantages. Apart from mobile phones can be used as a medium of communication, mobile phones can also be used as a data communication media. Supported by a small and lightweight form handphone to a practical device so easy to carry anywhere. Mobile experiencing rapid development features available in mobile devices offer greater convenience for users of mobile phones have features such as MMS, WAP, Video Streaming and others. Mobile can be used to support the process of regional tourism promotion. Jogjakarta is known as the world of education also have the advantage as a tourist destination in Indonesia. Jogjakarta has the advantage of the region as a tourist destination, either in the form of nature tourism, cultural or educational attractions that can be done through formal education or non-formal education. Natural attractions which include the coastal environment with a variety of characteristics, have natural advantages compared with other regions. beautiful scenery including beaches, mountains, can be utilized as natural and tourist attractions, along with sports. Jogjakarta also has approximately 36 pieces of Hindu and Buddhist temples are scattered throughout the region. In addition Tourists can see the various handicrafts such as batik, silver, pottery, wooden masks, skin and others. More than that, Jogjakarta also has a strategic position because the center of the southern region located between Java and transportation routes from Jakarta to Bali to make it easier for tourists to stop in Jogjakarta. To attract tourists in the country or abroad, it is necessary to develop a system that can provide information about tourism places in Jogjakarta quickly, precisely and accurately without having to search for guides or tourists should come directly to the Tourist Information Center (TIC) for information places of their destination and also do not have to come to local governments to ask.

II. ANALISA SYSTEM

For a user, simplicity and speed in getting much-needed information. Various facilities offered in the mobile communication-based digital cellular technology such as sms gateway, access web pages using GPRS and 3G technology, users will be very spoiled because it can provide facilities in a variety of things. From some of the above explanation will be made a system utilization of the GPRS service. With the GPRS service via mobile phones will be easier to gather information and make hotel reservations, allowing users to easily obtain unbiased information wherever they are without having to go somewhere that provides Internet services. The software is installed on the server machine and can be accessed by all users of the application in the mobile browser. With this system users can access the system to find information about places of tourism or other information required user and the user can make hotel reservations directly. With this system, will be given the advantage because the system can be used as supporting media for promotion. The hotel is acting as administrator, will be eased in managing reservation data or update data in the hotel. Arsitur system needs to map existing information on the system. In this system, the information needed by the user is obtained from admin. Users running the system mobile media. Documents

ISBN : 978-602-97809-0-1

within a web server and PHP can be a document (WML Wireless Markup language). Special WML document is displayed through a browser of WAP devices. While PHP document that should be displayed via a web browser, before reading through the WAP browser first translated by the gateway in order to adjust to the WAP device. We would like to request a cell phone information in the server, the phone must pass through WAP Gateway. And vice versa. The process of sending information from your phone to a WAP Gateway and vice versa using a wireless communications network (wireless). PHP documents for a super admin and admin will be stored into the server and when there is a request from the client (browser) in this case is a super admin and admin, the server will send an answer in the form of html web pages to client computer requesting the request through the HTTP protocol . HTTP is a protocol that determines the legal requests and answers so that the client will be able to view the web pages requested through a browser from a computer device connected to the Internet.

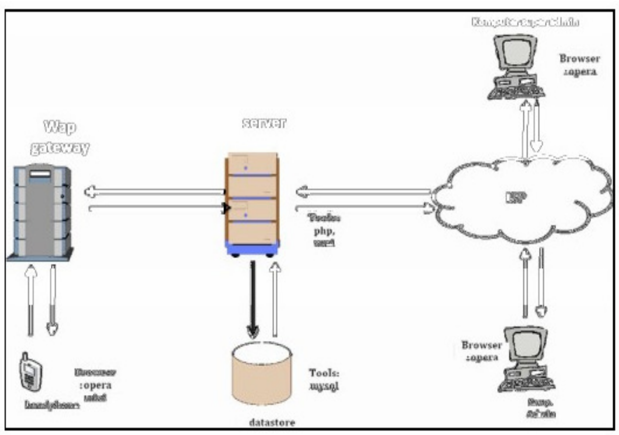

Figure. 1. Architecture for System Information e-Tourism Guide

The image seen some component to interconnected with system for make the connection to running well. Between user and te systems is connected through a server who manages all the request from any users.

By looking at the architecture of existing systems, it will be seen that the complexity of the existing components in the application of this system would be enormous. Various components will have a relationship for the system to run as desired.

Complexity of components involved in the tourism industry is extremely high. It can be seen from the involvement of the various components that are directly or indirectly have an important role.

There are two systems involved directly, business to bussniness (B2B) and business to consumer (B2C). Two of these systems are interconnected with one of another. Dependence that exist between both systems is very high. It can be seen from figure 2.

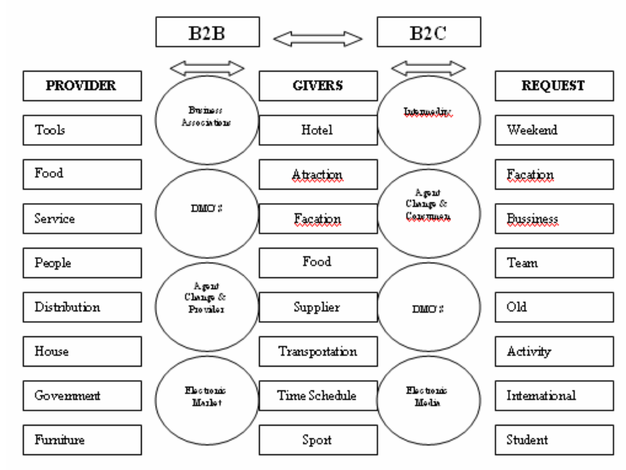

Figure 2. Complexity of Online Tourism Systems

(http://www.ar.itb.ac.id/wdp/archives/category/tourism-course/)

From the figure 2 shows that the business processs that occurs between providers and users of tourism actors in particular, require a media liaison to provide various facilities and the needs of the tourists.

Process that occurs on increasing the number of visitors tourist also have a structure that can be describe through a graph. It can be seen in figure 3, where the process of life that occurred on the perpetrators of tourist can be run in accordance with the condition and circumstances exist.

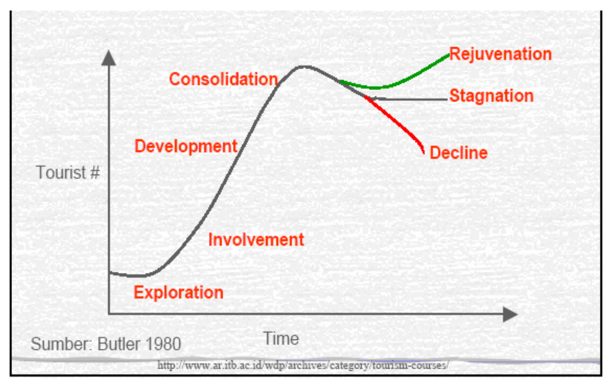

Figure 3. Tourism Life Cycle

(http://www.ar.itb.ac.id/wdp/archives/category/tourism-course/)

In accordance with the passage of time, the number of tourism players, particularly tourist who visit the area, having started from exploring the process of improving the existing tourism values in the area to conduct the promotion and developmentof existing values. Furthermore, the process will go through the statements to manage existing tourism. And from this consolidation process will be seen whether the existing process will experience rejection or improvement of tourism actors, especially tourist.

ISBN : 978-602-97809-0-1

III. System Design

In design, the system can be describe through several stages. Among others, by drawing on the table, Entity Relationship Diagram (E-R Diagram), and the relationship between tables that provide information on all process running on the system.

We can see from the table 1. where the system describe the items that will be excecuted on a process.

NO	FILE NAME	DESCRIPTION
1	24hoursoutlet.php	File used to manage 24-hours outlet
2	Atm.php	File used to manage atm
3	Bank.php	File used to manage bank
4	Bank_cabang.php	File used to manage bank_cabang
5	Etnic_store.php	File used to manage etnic_store
6	Fasilitas.php	File used to manage some facilities at system
7	Fasilitas_hotel.php	File used to manage fasilitas_hotel
8	Footer.php	File used to manage footer
9	Fungsi.php	File used to manage fungsi
10	Header.php	File used to manage header
11	Hotel.php	File used to manage hotel
12	Index_admin.php	File used to manage index_admin
13	Kamar.php	File used to manage kamar
14	Kamar_hotel.php	File used to manage kamar_hotel

Table 1. Information Table

This table provides information abouth the functions to be run on the systems. Every function has a role that links between table for the systems to run well. These functions are interconnected. Where the relations have a role to the information provide to users, especially tourism actors would be more appropriate to their needs.

In the ER-Diagram, we can see the relationship between tables that occur in the systems. The total number of the tables as much as 26 units. Each table has the characteristic and traits that distinguish between the table. We can see this diagram at figure 4 and figure 5.

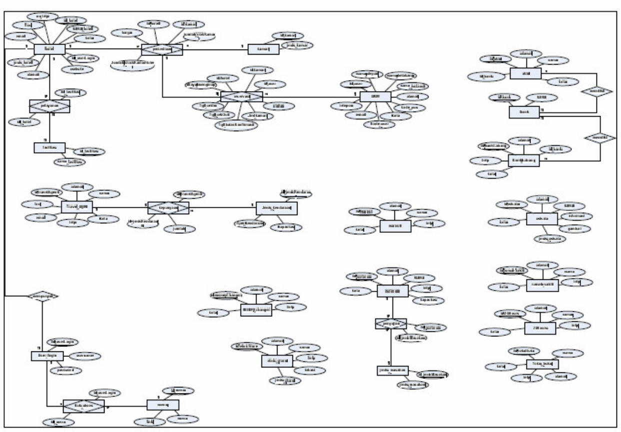

Figure 4. E-R Diagram

In the figure 4, we can see the existing design model looks at each table has a clear relationship. So that the systems is built can be seen through the design between this table.

For more details from the system relationship, the design of the relationship of the table can see at figure 5.

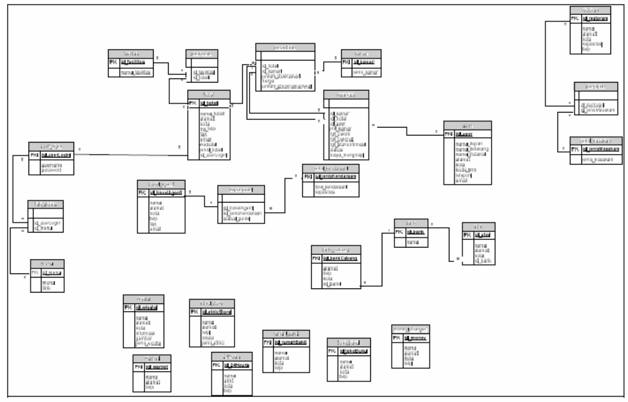

Figure 5. Relationship of the Table

Data modelling in designing a database is by using a model of the relationships among tables. Relationships between table consist of the components : tables, fields, and relationship.

IV. Implementation

Implementation is the stage where the systems can be ready to operate. At this stage we can known whether the systems made in accordance with the purpose to produce what is desired by the user.

In the implementation of this systems required a description of each function files used. Where the files are grouped into four major sections within the systems. The admin, user, java_scripts and images.

Each section has contacted each source file data within the system. So the system will be implemented in accordance with the needs of the user.

We can see in figure 6 below. There is a menu home page that indicades that someone has successfully entered into the system. System will provide information as needed from the users.

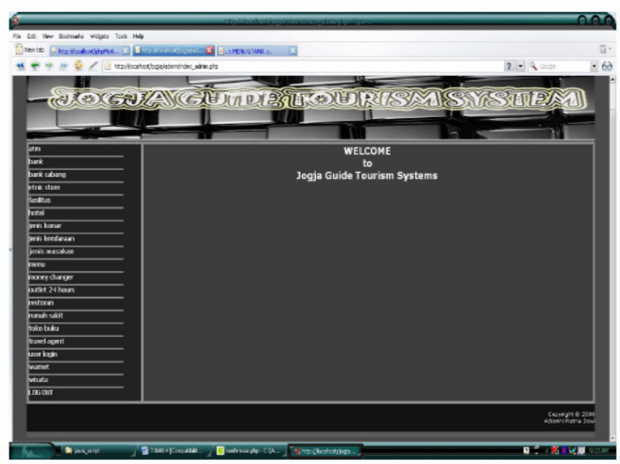

Figure 6. Home Menu

In the figure 6 seen from the system menu of the main page. This menu page provides information abouth the hotels, banks, tourist sites, as wll as various information abouth arts and craft or cultural activities held in the region Jogjakarta.

A variety of existing information and data can be seen in picture 7 below.

Figure 6. Home Men

In the figure 6 above the visible information provided by the systems to users is data about existence of the existing location in Jogjakarta crafts. The data for the location of this craft does not just provides information on addresses, but also information related product characteristic, the type that superior products, as well as information abouth owners and pieces of data of all product produced at such a craft center.

This system can be run by user or admin. If the systems is used by the admin, then the admin has a different function with the user. While the administrators may update or change data and information in accordance with the data already received. So that the data provide by the company owners or principals of tourism, particularly local governments, will be always update in accordance with exixting data. This could help tourism stakeholders, especially tourist who will visit the region can obtain the lates information from each existing the systems.

V. CONCLUSIONS

From the research conducted has created a tourism information system for WAP-based tourist. This system provides information on tourist places directly, simplify the management of the hotel reservation based on consumer desires, and update the data as well as hotel information, and can facilitate in making hotel reservations directly.

The information tourism system can help in the promoting of tourism especially in the jogjakarta area to be more recognize by the public, especially the tourism actors.

ACKNOWLEDGMENT

There are still many weakness in this Tourism Information System. So, to be able to produce a better system in the future then it can be done towards the development of new systems. This can be done by :

1. This system can be expanded by adding contact to the reservation travel agents.
2. This system can be developed by adding facilities for online payment.

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ISBN : 978-602-97809-0-1

Assessing Social Commerce Strategies for Indonesian Market Case Study : Kaskus.us

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Abstract – **Social Commerce is a combination of Social networking and E-commerce. Social commerce is becoming a growing trend in the internet world nowadays. Giant e-commerce websites such as Amazon and Ebay see social elements as a necessity to survive in the e-business competition. As Indonesia is entering e-commerce era, many retailers began to follow the srategy by utilizing social networking websites to gain competitive advantages. The purpose of this paper is to identify and analyze the key factors of successful social commerce strategy in Indonesian market; based on theories, survey and a case study. The case study will be based on the largest social networking website in Indonesia, kaskus.us.**

Keywords – ***Social Commerce, Kaskus, Indonesian Online Market behaviour, Social Commerce Strategy.***

I. INTRODUCTION

Electronic commerce has became a rising trend in the internet world in this modern era, and social elements are the key to some of successful e-commerce websites in the world such as Ebay and Yahoo!. Social Networking itself has been a phenomenal trend since the early 2000's with the emergence of social oriented websites such as Myspace and friendster. Social commerce combines both of these elements, electronic commerce and social networking.

Social media is crucial in e-commerce because it boosts consumer's trust to the shop, in a recent study conducted by Powerreviews.com in March 2010, 63% of shoppers consistently read reviews prior to making a purchase decision, and 72% of consumers consider customer ratings and reviews on retail sites as very/extremely important when it comes to selecting and purchasing a product [1]. Reviews is one of the elements of social media integration.

Social media integration also has proven to be an effective tool for improving company's competitive edge when applied effectively. One instance is DecisionStep.com, a purveyors of fine social shopping toolbars to brands such as Mattel and Charlotte Russe. They released ROI data for their "ShopTogether" toolbar. Working with German cosmetics brand, Hautbalance Naturkosmetik, specialist in natural and organic cosmetics, DecisionStep implemented their ShopTogether toolbar on the brand's e-commerce site. The result was a 15% increase in sales and a 50% increase in average order value**.** [2]

Another indicator for a successful website is the *Traffic* which reflects the number of visitors to a Web site[17]. The *Financial Times* reported that the Internet traffic to social commerce and social shopping websites grew by more than 500% from early 2007 to early 2008 [19].

In Indonesia the birth of e-commerce was marked by kaskus.us (short for *kasak kusuk*, which means "to gossip" in English) the biggest Indonesian social networking website. Social networking itself has already been enjoying a successful time in Indonesia. Indonesia ranks third so far among the 10 largest facebook-user countries with 26,277,000 users [12]. This is one of the positive supporting factors for social commerce prospect in this country.

However, social aspect is also related to the culture of the buyers. Differing characteristics of local environments, both infrastructural and socio-economic, have created a significant level of variations in the acceptance and growth of e-commerce in different regions of the world[3]. This paper will analyze which factors are suitable to create a strategy for Indonesian market.

II. RESEARCH METHODOLOGY

An online survey is conducted by online survey creator Google Form. The survey consists of 26 questions dicsussing Indonesian consumers' perception towards online social shopping. The survey is spread on the largest social network in Indonesia, kaskus.us, by employing simple random sampling. The resulting data is then being analyzed with SPSS software to ensure its validility and reliability.

The second step is benchmarking, benchmarking is a process of comparing two or more products, services or organizational practices [4]. In this case the subjects being benchmarked are the social toolsets or dimensions applied on the successful e-commerce websites, and the local social commerce website kaskus.us. This falls into Functional benchmarking category, which is comparing methods across organizations executing the same basic functions outside the industry. [10]. More specifically, this benchmark belongs to Strategic Benchmarking, which involves comparing different market strategies and correlating those market strategies with success in the marketplace[11]. The benchmarking process is based on the methods of social marketing, in order to identify the strategies used by various external websites and kaskus.us. According to Alexa.com, a site that measures websites traffic, kaskus ranks sixth among Indonesian websites, and 261 in the world, by August 2010. Kaskus also has a high new members growth rate, on a daily basis, of about 100-200[18]. Kaskus.us can be considered as a successful website based on these facts.

The third step is to compare the survey result between the Indonesian and US markets, in order to see the consumer behaviour differences between the US and Indonesian markets. And finally all those elements are used to formulate a new strategy.

III. BASIC THEORY

A. *Social Commerce Overview*

Social commerce can be defined as subset of electronic commerce that involves the use of social media, online media that supports social interaction and user contributions, to assist in the online buying and selling of products and services. The term social commerce was introduced by Yahoo! in November 2005 to describe a set of online collaborative shopping tools such as shared pick lists, user ratings and other user-generated content-sharing of online product information and advice. [5].

Social commerce can deliver three key business benefits – social media monetization, e-commerce sales optimization, and business model innovation. For customers, social commerce can enhance the purchase cycle experience offering trust, utility and fun in three key areas : product discovery, product selection and product referral. When deployed to enhance product discovery, social commerce solutions act as Awareness Boosters. For product selection, social commerce acts primarily as a Decision Accelerator, and for product referral social commerce acts as an Advocacy Activator. [7]

Trust, Risk, Privacy and Security are 4 social commerce main elements. Trust plays a central role in helping consumers overcome perceptions of risk and insecurity. Trust makes consumers comfortable sharing personal information,making purchases, and acting on Web vendor advice—behaviors essential to widespread adoption of e-commerce.[16]

B. *Social Marketing Dimensions & Strategies*

Whilst there are many ways to categorize the social commerce aspect(s), most social commerce solutions can be organized into one of six distinct dimensions, each is based on a general toolset, Social Shopping, Ratings & Reviews, Recommendations & Referrals, Forums & Communities, Social Media Optimization, and Social Ads and Apps, these toolsets can be categorized further by using strategies based on Social Inteligence Heuristics, which is effective brand building with social commerce using the social psychology of social commerce to create differentiated choice-shaping associations in the mind of the customer [7].The Social Inteligence Heuristics or Strategies are :

1) *Popularity Strategy :*

To resolve uncertainty of what to do or buy, we often look at what others are doing or have done, and take our cue from them. When something stands out as particularly popular or dominant, we instinctively perceive this as social proof that it is the correct, most valid option of the classic peer power in action. The social commerce application includes :

Most popular, top rated, top reviewed lists

Most recommended, most referred lists, social bookmarking - aggregated pick lists, wish lists and gift-lists [7].

2) *Authority Strategy*

People have a natural tendency to defer to the conclusions of an expert or authority, regardless of what they say. With specialist's knowledge, experience and expertise, they save us time and energy thinking things through. The social commerce application includes:

- Expert Reviews
- Personal recommendations and referrals
- Forums and Communities [7].

3) *Scarcity Strategy*

Our minds are hardwired to value scarce resources; we instinctively assign higher value to opportunities as they become less available - part out of fear of potential loss (known as psychological reactance). The social commerce application includes :

- News feeds and deal feeds
- Social Shopping tools
- Recommendations & Referrals [7].

4) *Affinity Strategy*

We have a mutual inclination to emulate and agree with people we have affinity with - people we like, admire or find attractive. This is partly to build social bonds and trust (saying yes is a form of social grooming - the human equivalent to animals picking flea from each other), and partly as an impression management strategy, managing our image and identity by association. The social commerce application includes :

- Portable social graphs, co-browsing.
- Referral programs, Social Bookmarking tools
- Forums & Communities
- Feeds to follow, share and spread social media news about brands we like and admire[7].

ISBN : 978-602-97809-0-1

5) Consistency Strategy

When faced with uncertainty, we'll opt for the one that is consistent with our beliefs and past behaviour. When our beliefs and behaviours don't match up, we feel psychological discomfort, "cognitive dissonance", which is a big motivator for trying to be consistent; particularly with any active, public and voluntary commitments we've made.The social commerce application includes :

- The Ask-Your-Network social shopping tool
- Social Bookmarking (Pick Lists, Wish Lists)
- Ratings & Reviews:
- Forums & Communities
- Social Ads & Applications [7].

6) Reciprocity Strategy

We have a natural inclination to repay favours, whether those favours were invited or not. We feel good when we reciprocate favours, partly because of our innate sense of fairness and social contract, and partly because reciprocity is socially rewarded because it is the social glue that makes cooperation, relationships, community and society possible. Now you know why you feel bad when you receive a season's greeting card from someone to whom you haven't sent a card. Social Comemerce application that applies this theory include :

- News and/or deal feeds that allow people to do others a favour by passing on useful information and offers
- Group-buy tools
- Referral programs that allow friends to offer exclusive access or special deals to their friends
- Feedback and advisory communities [7].

IV. FINDINGS

A. *Social Shopping Survey*

1) Demographics

The survey is conducted on 524 participants whose monthly online expense is above 100,000 rupiahs. There are more males (61%) than females (39%). About 23% have 1-2 million rupiahs monthly income before tax and 19% have under 1 million. Age wise, the number of internet users in Indonesia is dominated by teenagers and young adults, aged 18-24 years old (52%), followed by adults aged 25-34 (45%) and thus most of them are in college (69%) and High School(11%). Family profile-wise, about half of them do not have siblings under 18 in their families (55%), or only 1 (25%).

2) Researching Online

Online research already plays a major role in online consumers' purchase decisions, 98% states that they use internet to look for information of a product before buying it, and 46% says that about 75% of their overall shopping experience involves researching product online.

But most only spend few hours to carry out online research (59%), although 66% claims that it saves alot more time to research online compared to traditional research. The result though, (online product information) only rated as satisfying (62%), most likely because half (50%) of them trust online and traditional research almost equally.

Search Engine like Google still dominates as the starting place to look for Information (68%). And when asked to name top 3 places where they tipically research product online, kaskus takes the highest rank (72%), followed closely by other retail websites (53%) and product's official website (48%)

3) Customer Reviews

Indonesian online consumers considers product image avaliability as the most important feature in a retail website (68%), followed by product ratings & review (57%), customer service (40%), expert opinion (38%), and 35% thinks physical store existence is also very important.

The lack of product information ranked as the main reason customer leaving a particular website while researching (59%), followed by media availability (52%), customer review availability (44%) and lack of expert opinion (33%)

Customer Reviews are rated as the most important social media tool (52%), followed by community forums (47%) and Q&A(Questions and Ask) section(35%). And about 31% read the reviews "Some of the time" before making a purchase decision. The time spent reading reviews varies, 24% respondent spend 5-9 minutes, 22% 30 minutes to 1 hour, 20% 10-29 minutes, another 20% more than 1 hour, and the rest less than 5 minutes. But most demands 2-7 reviews before buying a product (71%), only 5% says only 1 review is needed.

Customer reviews are trusted, but are only seen as part of the research source (74%), some do not trust them completely (21%), only 4% trust reviews more than other sources. Majority still doubt that reviews are written by a real buyers(29%), lack of reviews (24%) and information about reviewers (24%) also decrease consumers' trust. Some are bothered by lack of negative reviews (56%), while some others (41%) are not.

4) Social Networking Role

The majority (64%) rated friends in social networks (facebook, twitter etc) as a very important/important "online voice" for their purchase decision. It's also related to the fact that 66% have 200-999 friends in their facebook accounts. Facebook activities are also generally high, 38% updates their facebook status everyday, 25% update it a couple of times in a month, and only 4% do not use facebook or other social networking websites.

B. *Case Study : Kaskus.Us*

Kaskus is the largest Indonesian social networking website, originally it was intended as a forum dedicated to specific hobbies, not for commercial purpose, but as its member grew, Andrew Darwis, the founder of kaskus evolves kaskus into a B2B website providing opportunities for kaskus members to open up an online shop based on a thread in a subforum called "Forum Jual Beli". This, then became the center of Kaskus' B2B transaction activities.

This website is analyzed based on the six dimensions/tools of Social Commerce mentioned before, then the result are used to determine which strategies they are using, because

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from the toolsets used we can see which strategies are being implemented.

1) Social Shopping: Social Shopping Tools allow people to the act of online integrated shopping together.

a. Social Media Store : Kaskus only have Facebook pages for important announcement and
b. Portable Social Graph : Kaskus provides Facebook Connect as a login alternative, but not for supporting commercial activities.
c. Group Buying : Kaskus also implents “Group” feature where members can form a group together, however it hardly creates any commercial impacts.

2) ***Ratings & Reviews,*** allows people to exchange feedbacks and to inform each other’s choices with independent views and experience

a. Customer Rating & Reviews, kaskus implements this in a form of “thread rating” on the upper rightc corner of the thread, where user can rate the thread’s quality based on his opinion. (Consistency Strategy).

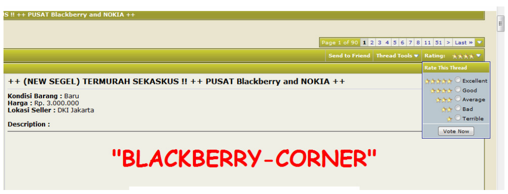

Fig. 1 Rate option in thread selling cellphone products

b. Expert Rating & Reviews, Expert reviews are usually presented by kaskus staffs or administrator, and are displayed on the first page of Forum Jual Beli. (Authority Strategy).

Fig. 2 a review about a Watch product

c. Customer Testimonials**,** usually presented their testimonials about separate thread, and is linked in the first post in order to improve sellers’ reputation. (Consistency Strategy).

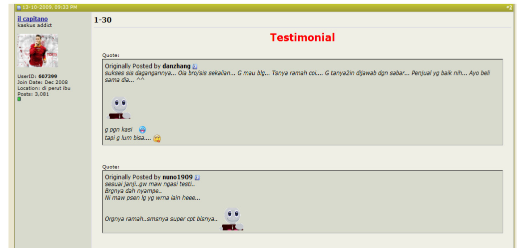

Fig. 3 A Testimonial page

3) *Recommendations & Referrals.* Kaskus’ form of recommendation comes together with the testimonials, usually buyers say “recommended seller” in their testimonials to present it. Another form of this is the Top 10 most popular item, based on the most searched items in Kaskus (Popularity Strategy).

Fig. 4 Top 10 most searched items on Kaskus

4) Forums & Communities

a. Discussion Forums
Kaskus benefits most in this area because it was originally a forum for discussions.Various subforums are available in kaskus. Which are divided into 4 major categories according to their functions, Kaskus corner, Casciscus, Loekeloe and Regional. (Affinity Strategy).

Fig. 5 Various Forums and Subforums in Kaskus

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b. *Q&A Forums*
Kaskus also provides this feature intensively, usually in each subforum as the main rules & guidance for users when using the forums. (Consistency Strategy).

Fig. 6 Q & A Thread in Kaskus

c. *Retail Blogs,* kaskus provides an option for user to create his own blogs, but this is rarely utilized by sellers to support their shop.

d. *Customer Communities*
As mentioned above, communities is the strong point of kaskus, and there are various communities that are related to the product sold in kaskus, one example is cellphone subforum . (Affinity Strategy)

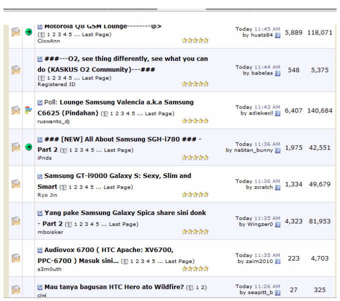

Fig. 7 Cell phone subforum in Kaskus

5) *Social Media Optimization*

a. *News Feeds,* offering syndicated news on Twitter, Facebook, Blogs (RSS) and other social media platforms, providing a resource for exclusive information. Kaskus already implement this in Kaskus Toolbar and Kaskus Menu to ease browsing process. (Consistency Strategy).

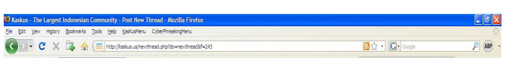

Fig. 8 Kaskus Toolbar

b. *Social Media Events,* kaskus has been involved in various social activities or popular events, such as "Kaskus Peduli" for charity purposes, various gathering events, Seasonal Contests, Design Contests, etc. (Affinity Strategy) :

c. *Kaspay,* Kaspay is an effort by kaskus to establish a safer and easier payment system by creating third party application between bank and the customer, similar to paypal. (Consistency Strategy)

Fig. 9 Kaspay Symbol

6) *Social Ads and Apps*, kaskus has social Ads in the form of"Share to Friends in Facebook", option. Unfortunately this feature is blocked in FJB / B2B subforums. (Consistency Strategy).

Fig. 10 Share to Facebook option in Kaskus

Another aspect is the "Wish List" in the form of Want to Buy"/ WTB list where kaskus member could post for items that they are looking for. (Popularity Strategy).

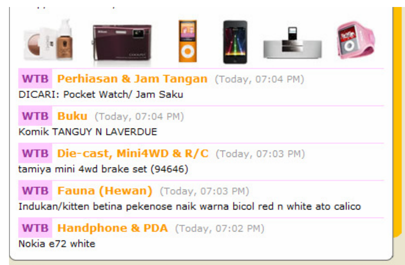

Fig. 11 "Want to Buy" thread list in Kaskus

V. CONCLUSIONS & STRATEGIES

A. Survey Comparison

Comparing the results of the survey, there are 4 main differences between Indonesian market and US market :

1) Indonesian consumers still trust offline/traditional research as well as online research (50%) whereas in US only 15% do so. US consumers trust online research more than offline (46%). This could come from many factors, but it is mostly caused by the fact that the use of the internet and e-commerce is still green in Indonesia, so most people still trust traditional shopping more, up to 2010, only 12% of Indonesian people are internet user, compared to US where 77% are internet user[15].
2) Indonesian consumers only rate the results they get from online research as "somewhat satisfying" (62%) whereas US consumers are very satisfied with the result (45%). The lack of e-commerce activity in Indonesia becomes the factor creating this situation.
3) Indonesian consumers think media availability is slightly more important (68%) than reviews (57%) while US consumers prioritize reviews (72%), customer service (69%), category buying guide (64%) and top item list (60%) over media (39%). Lack of reviews compared to media in Indonesian websites may cause this situation.

4) Indonesian consumers have more facebook friends, 66% have 200-999 friends, compared to US consumers; 50% of whom have 50 or fewer friends, 41% have 51-199 friends, and only 25% have 200 or more friends. And lastly Indonesians are more active in facebook, 38% of Indonesians update their facebook status everyday, while 25% do so several times a month. Compared to US where 32% never update facebook status at all, followed by 18% that update daily. This is related to the fact that Indonesian cultures emphasize more on social interaction [6] Therefore social networking websites like facebook gain a big success in Indonesia.

B. Kaskus' Strategies

Kaskus mainly uses Consistency strategy (Customer ratings & reviews, testimonials, Q&A, RSS feeds, Kaspay WTB items), followed by Affinity (Discussion Forums, Customer Communities, Social Media Events), Popularity (Top 10 items) and lastly Authority (Expert Review Product). Consistency has the most impact on puchase decision because it is related to consumer trust, one aspect that is very important in online business. Affinity also plays an important role in building communities and lowering risk, and subsequently, increasing security. These 3 elements are important to create a stable social commerce. And kaskus continues to improve its strategies by providing new tools such as Kaspay to increase security even further.

C. Strategies For Indonesian Market

Based on this findings, the appropriate strategies for Indonesian Market are:

1) Build Trust using Consistency,

Trust is the main pillar for any Social commerce website and should be the main priority. Consistency is one of the key to Kaskus' success A consistent environment will increase trust, especially in Indonesia where e-commerce is still fairly green. Example of applications : reviews and ratings must exist, and should be presented in balanced perspective to minimize distrust. Q&A section and complete description must also present because both of them could reduce 62% of Indonesian consumers' "somewhat satisfying online research." Rich media also must present because based on survey it attracts Indonesian Consumer more than reviews.

2) Use Social Media Optimization (SMO) and Social Ads/Apps to make content easier to find:

This is crucial because a good or cheap product is pointless when it is hard to find. This is also the reason why Indonesian Consumers can not find online products easily. One instance of such optimization is SEO, or Search engine optimization (SEO), it is the process of improving the visibility of a web site or a web page in search engines via the "natural" or un-paid ("organic" or "algorithmic") search results[13]. Google still ranks the most favorite site to look for information, so SEO on google is very important. Another example is advertisement on popular and high traffic websites.

3) Apply Affinity Strategies to boost Trust.

Affinity has a bigger impact in Indonesia because based on the survey, social networking is more popular in this country, as seen on the number of facebook members and activity in Indonesia. Websites should utilize facebook apps like Facebook Store and Facebook Connect to attract the huge number of facebook members in Indonesian. Online voice from friends and communities will boost trust even more greatly. Other important voices like brand experts and "People Like me" should also be implemented

4) Develop Niche / Blue Ocean Strategy

In the internet, being the first mover/innovator is important especially with the fastly growing number of competitors. Blue Ocean Strategy is a creative battle where the players of a particular segment do not compete with each other remaining in the same market space; instead explore, create and acquire new market spaces by dealing with new demand through the principle of ' value innovation' [14]. We need to differentiate strategies from our main competitors and look for a new one to avoid direct competition. In order to compete with Kaskus for example, we can use strategies which are not yet implemented, such as "Dell's Swarm" where a group of people purchase an item together in a batch so that the price can be cheaper. Other strategies for example :

- Allowing facebook widget to publish bought items on facebook page so that more people will be attracted to that store.
- Creating a separated status for Trusted Sellers in order to increase consumer trust even more.

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

The Framework for Technology Entrepreneur Development through Incubation Process in Universities in Indonesia

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Abstract **- University play an important role in motivating young graduates to become technology entrepreneur. The increasing number of graduate entrepreneurs will reduce the unemployment rate and even will increase the number of field work. However, it is seem that there are very limited theory and model on technology entrepreneur development, especially in universities in Indonesia. Thus, this paper focuses on discussing the key influencing factors on technology entrepreneur development (TED) through incubation process (IP), and to construct new framework that contribute to the knowledge on TED in universities in Indonesia. The results contribute to the new framework for TED through incubation process in universities in Indonesia. The developed framework consist of four key factors i.e., the person, the internal environment i.e. universities, the external environment i.e. government and industry; and the development process. The framework developed will hopefully benefit the student, Indonesian policy makers and universities to enhance the TED in the country.**

Keywords **- Techonolgy,Entrepreneurs,Incubator, Incubation Process**

I. INTRODUCTION

Nowadays, Indonesian government put high attention in developing technology entrepreneurs (TE) among young graduates from all universities in Indonesia. Therefore, every university in Indonesia were encouraged to have their own incubator that could provide entrepreneurial activities and to facilitate the development of invention and innovation among potential student to become real TE. Furthermore, it is a hope that incubation process could develop the entrepreneurial spirit among the student and encourage them to use technology as a medium in implementing their business.

II. THEORY AND MODEL USED IN THE STUDY

In this section, the researcher explores the existing theories and models that are relevent to the research subject, as well as those theories and models that form the body of knowledge of the research. The theoris and models which will be explored and used through out the study are discussed in the following sub section.

A. *Model Continuous Learning*

Albert Shapiro, Professor of Ohio State University, USA, said that entrepreneurs are not born but made his career through experience. Based on his statements, Entrepreneur Education Consortium (2004) has developed a business development model, called Model Continuous Learning (Lifelong Learning Model). The model is divided into two main categories of work related training / education and work experience.

The second category of work experience is broken down into two stages, namely the beginning of the work and career development. At this level, students in this category before making a business of their careers and strive to develop their career endeavor. Each prospective entrepreneurs/ businessmen who are on their level of need focuses on the set at every level and at the same time trying to establish relationships with prospective entrepreneurs / businessmen in the other. Fig.1 below shows clearly the model that describes the role played by each business according to a certain extent.

ISBN : 978-602-97809-0-1

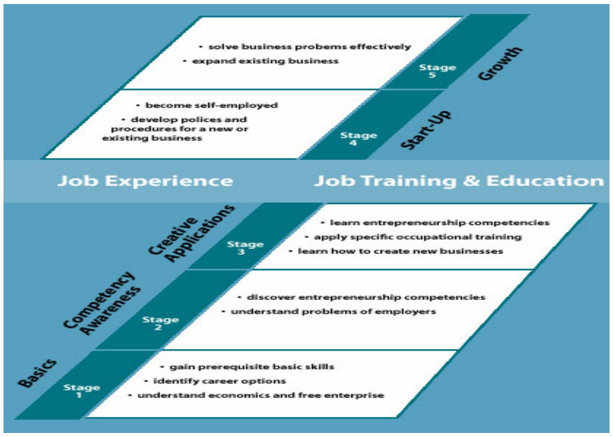
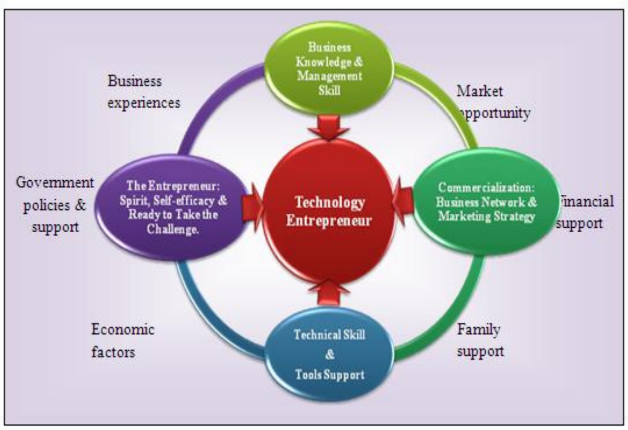


Fig. 1 Entrepreneur Lifelong Learning Model

According to Sahadah (2010), there are four main factors and six supporting factors, could encourage a person to *be* and to *survive* as a technology entrepreneur in the market place. The four key factors are the person, business knowledge and management, technical skills and tools support, and commercialization strategy. Sahadah also has noted that these four key factors are also need to be supported by another six factors i.e. government policies and support, financial support, business experiences, economic factors, market opportunities and family support. Sahadah's model on TE key success factors, which also known as S-TEK Model is shown in Fig.2



Fig,2 S-TEK Model (Adopted from Sahadah, 2010)

B. *Supporting Emerging Entrepreneurs Model (SEM)*

This model is based on the framework developed in business development Wharthon Business School, University of Pennsylvania, USA and Graduate School, University of Cape Town. He had to modify this framework to be used as a model business development at the University of Sharjah, Ajman, UAE. The model Shown In Fig.3 below.

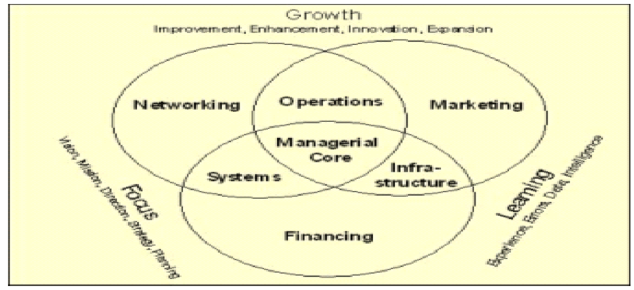


Fig. 3 Supporting Emerging Entrepreneurs Model (SEM)

This model involves a close relationship between mentor and student in which all aspects covered in this model is the relationship, operational, marketing, infrastructure, systems, and basic financial management. The model is constructed to produce three major outputs of learning and development focus. In the process of learning, some aspects such as courses taken, information, education, experience, intelligence produced to support the entrepreneurial activities of students. The result of this process will create a business plan (business plan) produced by the students and tailored to the student curriculum. The second output is the students through the counseling process in determining the vision, priorities, strategic role in determining their career in entrepreneurship. Finally, students will be exposed to real business chosen by the students as their careers. Mentor from the faculty play an important role in guiding the students.

III. III. RESEARCH METODOLOGY

A. *Research Approach and Data Collection Method*

According to Yin (1994) research strategy should be chosen as a function of the research situation. Yin pointed out that each strategy has its own specific approach to collect and analyze empirical data. Therefore each strategy has its own advantage and disadvantage.

For this research, the study employed qualitative methods research design. The sample was chosen based judgment sampling technique. Qualitative data were obtained through face-to-face in-depth interviews with the key informants from selected universities in Indonesia and Malaysia, industries, and Indonesian government. On top of that, the authors were also employed document review to strengthen and support the research finding.

B. *The Proposed The Framework*

Through the theoretical and empirical study, the authors have come out with the proposed a model framework for TED through incubation process in universities in Indonesia. Theframework is consist of four key elements that are interconnected in three phases as shown in Fig. 4 These four elements are:

1) The entrepreneur/person/Student/program participant as describe in Sahadah, 2010; Timmons and Spinelli, 2007; Wickham, 2004; Hisrich, Peters, and Shepherd,

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2005; Bhide, 2000; Baum and Locke, 2004; Samuelsson, 2001; and Robert, 1991;

2) The development process as discussed by Sahadah, 2010; Bruyat and Julien, 2001; Timmons and Spinelli, 2007; Gartner, 1985;
3) The internal environmental element inclusive institution environment and training environment factors as described by Sahadah, 2010; West and Bamford, 2005; Cruz et al., 2002; Antonic and Hisrich, 2003; Hynes, 1996; and Solomon, 2007;
4) The external environmental element i.e university-industry linkage and government support factors as discussed by Sahadah, 2010; Gnyawali and Fogel 1994; West and Bamford, 2005.

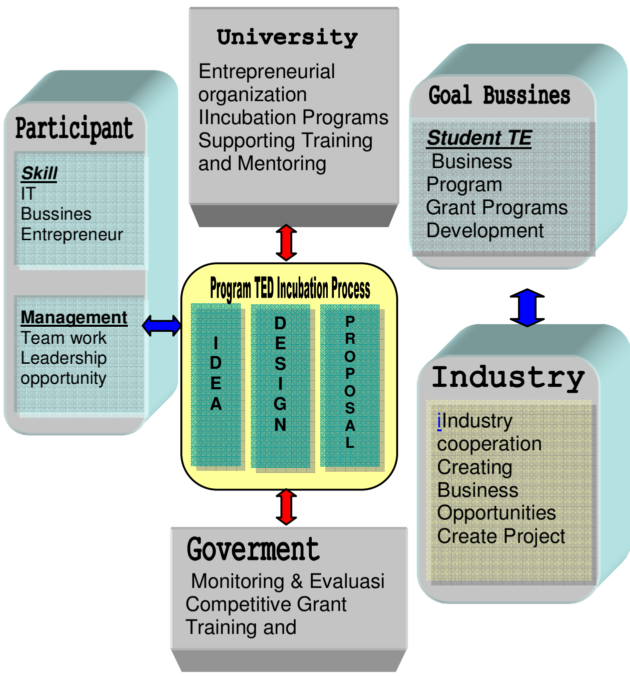

Fig 4: Proposed The framework for TED through Incubation Process in universities in Indonesia

The after collections the questionnaire to the participants of entrepreneurship and Mentor in project, the got a resume, that the capability is supported with outside parties, both government and universities and industry will get a students who qualified in made to entrepreneurship technology.and result fig 4.

Overall, this framework proposed systematic activities for developing technology entrepreneurs through incubation process in universities in Indonesia. The main activities are starting from searching and selecting potential business idea and business plan. To get to this level, all universities student are encourage to propose their business idea and business plan. Selected student with good business plan will be opened for incubator facilities and support for the development and commercialization of their business i.e. business facilities and training; business network, industrial attachment and also financial support from the government.

IV. CONCLUSIONS

This research is focusing on proposing a model framework for TED through incubation process in universities in Indonesia. Both theoretical and empirical studies have been employed through out of this research. Through this research approach, the authors have brought together the knowledge from latest theories and model on TED and also in-depth interview with the key informant. This qualitative study provide the researchers with thorough information which is very useful in developing the proposed model framework. With four key main factors i.e. the person, the internal environment, external environment, and the development process, this model framework is hoped to benefit the student, policy makers and universities to enhance the development of TE in Indonesia.

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

Management Strategy of Local Company in Competitive Market

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***Abstract* - Today, we see that market is more competitive than before, as many local products is faced with the challenges from global products. In Indonesia, Teh Botol Sosro has to compete withCoca Cola, Pepsi and Ades for winning customers' simpathy for beverage products, thus requiring the company to develop many strategies to survive. Internally, Sosro develops strategies to gain loyal customers by winning at the first moment of truth, promote the slogan good product-good quality, and launch Sosro Social Responsibility. Externally, they must survive in the battle against their competitors by promotions. Uniquely, the strategies that they use are the opposite to marketing strategy theory. There is no doubt, using their uniqueness, Sosro is still winning tea bottling market in this country. Now, the company expands its market by exporting the products in Tetra Pak to several countries, including Malaysia, Singapore, Brunei Darussalam, several Middle East countries, Africa, Australia, and USA.**

***Keywords*: management strategy, competitive, market, local**

I. Introduction

In today's global competitive market, companies recognize quality and customer as a critical factor in in their performance. One of the critical aspects of quality is how to maintain customers. The growth and the survival of the companies depend customers' loyalty and on the company's ability to minimize the production time and cost.

Dynamics market condition drives company to differentiate their strategy focuses and apply competitive advantages strategies such as quality reputation, service and product support, good company's image, good management, financial resource, market share, and uniqueness [1].

Every company must create strategies to winning the market. Porter in Prajogo suggests that a differentiation strategy aims to create a product that customers see as unique. A firm adopting this strategy selects one or more attributes or characteristics that customers perceive as important, and uniquely positions itself to excel in those attributes leading to a premium price [2]. Phillips in the same journal holds that among many sources of differentiation, quality is the approach that most often characterizes a differentiation strategy. This is because quality creates a competitive advantage through customer loyalty as well as minimizing customer sensitivity to price. They also note that the conventional wisdom suggests that achieving higher quality usually requires the use of more expensive components, and other manufacturing and management techniques incompatible with achieving low costs. However, in their accompanying empirical study, they conclude that product quality exerts a beneficial effect on cost position via market share [2].

Today, the issue of science and technology also has an important impact on customers' view and their decision to consume certain products. Many companies believe that technology can impact their ability to gain efficiencies. Uniquely, Sosro didn't do innovation on its brand "Teh Botol Sosro". More than 30 years this brand has been using the same bottle packaging. They have some standard for the product that showed on table I.

TABLE I
PHYSICAL STANDARD OF SOSRO BOTTLE TEA

Criteria	**Sosro Bottle Tea**
Volume	220 ml
Bottle Shape	Slim and unsmooth
Bottle printing color	Red, White
Crown	Red, White
Product Color (tea)	Yellow gold
Smell	Special Jasmine and Tea
Material	Green tea/jasmine tea

Source: PT. Sinar Sosro Ungaran [3]

Paper Framework

This paper aims to discuss the management strategies of a local product competing in the global market. This paper also aims to describe and analyze a number of of Sosro Management Strategy to gain new customers, create loyal customers and their efforts as local product in a competitive market with global product competitors.

A. *Company's Profile*

Company History

SOSRO is the pioneer of packaged ready-to-drink tea in Indonesia. The name SOSRO is derived from the name of the founding family, SOSRODJOJO.

In 1940, Sosrodjojo family started their business in a small city in Central Java called Slawi. At the time, the product sold was dried tea, sold with the brand name "Teh Cap Botol" and was distributed only around Central Java.

In 1953, Sosrodjojo family started to expand their business to enter the capital city Jakarta to introduce "Teh Cap Botol" products that was already very popular in Central Java. The journey to introduce the "Teh Cap Botol" was started by doing CICIP RASA (product tasting) promotions to several markets in Jakarta. The promotion was conducted by entering the markets and brewing the "Teh Cap Botol" tea product on the spot. Once the tea was ready, it was then distributed to people *in situ*. This promotion was not too successful as the distributed tea was too hot to drink whilst the brewing process took too long, making those who would like to taste it impatient to wait [4].

The second method was used: tea was not brewed on the spot, but carried already brewed in big pans to the markets using open trucks. Again, this was unsuccessful because some of the tea spilled on the way to the market, mostly due to the bad, pockmarked road condition in Jakarta at the time.

Then, an idea sprang up to carry the brewed tea in cleaned bottles. It turned out that this method was quite interesting for the customers because it was practical and the tea was ready to consume without the need to wait for the tea to be brewed.

Then, in 1969, the idea to sell ready to drink tea in bottles was formulated, and in 1970, a bottled tea plant of PT SINAR SOSRO was established, the first bottled ready-to-drink tea plant in Indonesia and the world. The bottle design for Teh Botol Sosro has changed three times: [4]

Fig 1. The change of bottle design

1. First Version

Released in 1970 using the brand name of TEH CAP BOTOL SOFT DRINK SOSRODJOJO

2. Second Version

Released in 1972 branded TEH CAP BOTOL (with smaller size for the word "CAP" so that people would see more of TEH BOTOL). The phrase 'SOFT DRINK' was taken out, while 'TEH BOTOL' was written in red and white to symbolize that it was a product of Indonesia. The name SOSRODJOJO was shortened into SOSRO within red circle logo.

3. Third Version

In 1974, the third change took place. The bottle design was not different from both the first and the second versions. The bottle design got a new shape and the brand name was changed into TEH BOTOL SOSRO. The third design was launched in the celebration of the establishment of PT. SINAR SOSRO's first plant in Cakung, Jakarta.

In its business expansion, PT. SINAR SOSRO has been distributing its products throughout Indonesian archipelago via its more than 150 sales branches and several Regional Sales Offices. In addition, PT. SINAR SOSRO has also penetrated international market by exporting its products in Tetra Pak and can packages to several countries, including Malaysia, Singapore, Brunei Darussalam, several Middle East countries, Africa, Australia, and USA [4].

B. *Production Process*

Teh Botol Sosro has 3 core materials: water, Jasmine tea and sugar. There are three units to produce sweet liquid tea before packaged in to the bottle. The first is water treatment unit processing ground "raw" water from deep well pump to become ready to drink water. The raw water must flow through ten tanks: cone-shaped tank, reservoir, Sand Filter tanks, Carbon Filter tanks (IA, IB), Cation Exchanger Tank, Anion Exchanger Tank, Softener Tank, Carbon Filter III tank, and Buffer tank. Final water product in the buffer tank should meet certain quality standards as previously determined by the company. Table II shows the quality standard quality for each tank [3].

TABLE II **WATER STANDARD QUALITY**

Unit	Quality Standard						
	Cl_2 (ppm)	TH (^{o}dH)	PH	Alk P (ppm)	Alk M (ppm)	Cl^- (ppm)	Fe^{3+} (ppm)
Cone Tank	1 – 5	≤ 30	7±1	0	≤ 800	≤ 130	≤ 8
Reservoir	1 – 5	≤ 30	7±1	0	≤ 800	≤ 130	≤ 8
Sand Filter I	≤ 5						≤ 2
Carbon Filter I	≤ 0,2	≤ 30	2-6,5	0	≤ 800	≤ 130	≤ 0,5
Kation Exchanger		≤ 2,5	2-6,5	0	≤ 800		
Anion Exchanger		≤ 2,5		0	≤ 800	≤ 130	
Softener IIA, IIB		≤ 1					
Softener III		<2,5					
Softener Cleaner		<1					
Carbon Filter II	0	0,9-1,6					
Buffer I, II	0		6-7,5	0	300±25	≤ 100	≤ 0,2

Source: PT. Sinar Sosro Ungaran [3]

The second unit is the Kitchen unit. This unit produces sugar syrup in dissolving sugar tank heated to the temperature of $100^0 \pm 5^0$ C. In addition, this unit produces extract tea in extract tea tank. Once both products are ready, this unit will mix the sugar syrup and tea extract in the mix tank, still in $100^0 \pm 5^0$ Celsius. The last process before bottling is pasteurization. This procedure is to ensure the elimination of any living organism in the product [3].

The final process is carried out in Bottling unit. Sweet liquid tea temperature is reserved at $100^0 \pm 5^0$ C. In this unit, sweet liquid tea is packaged into the bottle, and put into the crater. Finally, this end product is ready to be consumed. Table III shows quality standard of Sosro bottled tea [3].

TABLE III
QUALITY STANDARD OF SOSRO BOTTLE TEA

Criteria	**Sosro Bottle Tea**
Sugar (°Brix)	8,5 ± 0,1
pH *value*	7 ± 0,5
Colour	A-B-C
Smell	A (Jasmine-Tea)
Clarity	A-B-C
Tannin (ppm)	950 – 1150
Total hardness (°dH)	2 – 4
Bacteria	≤ 200 colony/ml
Total *yeast*	≤ 5 colony/ml
Total *mold*	≤ 5 colony/ml
Coli form /ml	negative
Acidity (%)	-

Source: PT. Sinar Sosro Ungaran [3]

II. MANAGEMENT STRATEGY

In the presence of fierce competition, manufacturing firms strive to stay in the forefront of today's marketplace by offering quality product and service. In his book, Kodrat [5] classifies strategy into three groups based on Perspective View: Design, Planning and Positioning. The oldest and Classic Strategy is based on design. The result of this thinking is SWOT analysis. The second model of strategy is based on Planning, that was further applied into Ansoff Matrix model. This model assumes that corporate goal is to maximize long term profit. The last model is based on Positioning. BCG Model and Generic Strategy are among the outcome of this model. The Generic Strategy is divided into three elements: overall cost leadership, differentiation, and focus [5].

Strategic or institutional management is the conduct of drafting, implementing and evaluating cross-functional decisions that will enable an organization to achieve its long-term objectives. It is the process of specifying the organization's mission, vision and objectives, developing policies and plans, often in terms of projects and programs, which are designed to achieve these objectives, and then allocating resources to implement the policies and plans, projects and programs [6].

Strategies implemented by managers will influence the selling target and central company, that become market leader who achieve biggest market share and become central of oriented (benchmark) their competitor [7].

A. *Constructing Loyal Customer*

Winning First Moment of Truth

Manufacturing companies are beginning to market as service providers, or as providers of solutions. Products contain both tangible elements (goods) and intangible elements (service). The consumption of physical goods and services cannot be separated. The same thing applies to did Teh Botol Sosro. Sosro offers a combination of goods and services. Yet, it is no longer enough. Companies should provide their customers with satisfactory experiences [8] thus making them loyal customers. Sosro, understood this thinking and try to reach new customers. They produce high quality products standardized with high quality process and inspection. Quality control process starts with the incoming material from suppliers, production process, and finally in packaging process. In addition, they always maintain their equipment daily and weekly to keep their product standardized to satisfy their consumers [3].

Beside inside control, Sosro also uses external control to reach certification and awards such as:

- Zero Accident Award from President of Republic of Indonesia, 1997
- ISO 9002 Quality System Certificated from Sucofindo, 1996.
- GMPs (Good Manufacturing Practices) from Governor of Central Java, 1997
- Halal certification from MUI (Majelis Ulama Indonesia), 1995
- Republic of Indonesia Government Standard, SNI 01-3143-1992 [3].

Sosro Social Responsibility

The past twenty years have seen a radical change in the relationship between business and society. Key drivers of this change have been the globalization of trade, the increased size and influence of companies, the repositioning of government and the rise in strategic importance of stakeholder relationships, knowledge and brand reputation. The relationship between companies and civil society organizations has moved on from paternalistic philanthropy to a re-examination of the roles, rights and responsibilities of business in society. Corporate Social Responsibility (CSR), defined in terms of the responsiveness of businesses to stakeholders' legal, ethical, social and environmental expectations, is one outcome of these developments [9].

PT. Sinar Sosro Ungaran realizes the important of CSR. This company establishes a number programmes to matching with their mission, for example: [3]

1. Construct their third deep well pump for the public use, especially those live surrounding the factory. They have three deep well pumps, two of which are used to support the production process. If the third pump are broken, they will halt the production process while the pump is being repaired, and let the first or second pump used by the people.

ISBN : 978-602-97809-0-1

2. Recruiting employees from nearby location, thus contributing to the increase of local citizens' income.
3. Treating their liquid waste before releasing it to to environment.
4. To minimize the impact of the polution to the surrounding community, Sosro built the factory far from the village.
5. Celebrating Indonesia Independence Day, *Idul Qurban* and *Idul Fitri* with the surrounding people by giving present, money or tournament sponsorship.

Good Product, Good Quality

Quality is an essential strategy for winning and retaining customers. Indeed, quality is more important than price in differentiating a manufacturing firm from its competitors and in fostering customer loyalty.

Sosro launched a number of programmes to educate their customer and gain new customers by the slogan "*Bebas 3P*: *Pengawet, Pewarna dan Pemanis Buatan*"-meaning No Preservatives, No Artificial Coloring, and No Artificial Sweeteners. To promote this programme to the stakeholders, Sosro has a apprenticeship programme for university students. This programme usually takes 1 to 2 months. From this programme, the company can obtain free market speaker to promote their product. On the other hand, the students obtain an experience of working in the company, which could be advantageous for their future career. This relationship has a mutual advantage for both sides involving in the programme, the company and the students. Not . many companies give such opportunity to students, which . I believe to be one of the weaknesses of education in Indonesia. There are few companies who are willing to to support education system by having students to learn in their companies through programmes .

Beside that programmes, Sosro also encourages stakeholders, especially from education institution such as senior high school or university to come and visit to see the production process in the factory directly.

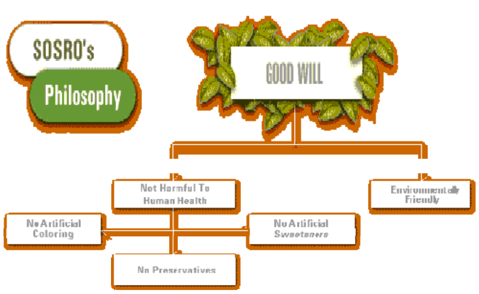

Fig 2. Sosro's Philosophy

Competitors

Coca Cola and Pepsi are Sosro competitors in beverage industries. They are global products that have been in the local market for long time and have big capital to promote their product. To survive harsh competition, companies would have to find new innovations. The characteristics of innovation were applied in two major areas, product innovation and process innovation [2].

Abernathy and Utterback (in Prajogo) assert that the competitive advantage of innovative companies over their competitors is based on superior functional performance rather than lower initial cost, and so these radical innovations tend to offer higher unit profit margins. In, addition, in respect to the differentiation strategy, innovative companies also tend to emphasize new product development [2]. Sosro embraces this idea. When Coca Cola and Pepsi produce similar product, *Frestea* and *Tekita*, they no doubt have some impacts on Teh Botol Sosro. But, Sosro did not change this product, neither did the production process. Instead, they innovate by creating counter branding by launching *S-Tee* in bigger volume [10]. For younger generations segment, Sosro launched *FruitTea*. This strategy was successful as Sosro still seems to be winner in this market [10].

Against Marketing Theory

Firstly, Sosro is the first product tea product packaged in bottles. The company decided on this without research. It was not common in marketing theory [11]. It was also uncommon to drink tea from a a bottle in cold condition. Usually, people drink tea from a glass in hot condition. In the beginning, it needed hard work to change this tradition. Slowly, they reach customers. Moreover, with the slogan "Apapun makanannya, minumnya teh botol sosro" appear. This slogan jiggles not only packged tea, but also other beverage products.

Secondly, their product robustness is a unique strategy. From the beginning (1974) until now, the taste, packaging, and color is same. In marketing theory, naturally customers will change over time. Along with changes in the product market, there should be certain changes in the product to adjust with the existing trends. The changing is caused by attribute life style, economy, or education [10].

Modern marketing theory states that key factors to organizations success depend on their ability to adapt to dynamically complex and changing condition. The change was indicated by fluctuation of product selling caused by external factors such as demography, financial condition, customer taste, and competitor, as well as internal factors such as distribution system, resource, technology and management motivation [11].

ISBN : 978-602-97809-0-1

Nationality

Nationality issues is newest strategy blown up by Sosro. Together with *Kacang Dua Kelinci* and *Jamu Tolak Angin*, a brand for grilled peanut and herbal medicine respectively, Sosro tries to growi nationalism spirit in Indonesia consumers. "Love Your Own National Product"; this issue brings a spectacular message for this country: If not us. who will be concerned to our country?

Similar strategies have been used in other areas such as marketing, religious fanaticism of religion, gender, and so on. For example, when there was a war between Palestine, an Islamic country and thus becoming Islamic symbol, with Israel, a Jewish symbol, many countries propagandize to boycott Israel products.

Indonesia government, as a developing country, tries to grow nationalism spirit in Indonesian people. By campaigning to love and use national product, Sosro as actively supports this programme. If this is successful, there are two advantages that can be gained, both for the company itself and for this country. In a long term, hopefully we can build our strength to develop our country with our own resources so that our local products can win the market not only locally, but also internationally.

III. CONCLUSION

Sosro, with the products *Teh Botol Sosro* is one of the local products created and produced in Indonesia. In the presence of globally competitive markets, Sosro strives to stay in the forefront of today's marketplace by offering its local products. The company struggles with global products like Coca Cola, Pepsi and Ades. Internally, they try to find the best management strategies to win the competition. The growth and the survival of companies depend on being customer oriented which will lead to customer loyalty and on the ability to produce fast and with low cost.

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

Innovation in Service Marketing / Service Marketing Innovation

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Abstract - **This paper is a literature review from the various thoughts of innovation, particularly the innovation in service marketing. This library research is not only based on the textbooks but also based on the empirical research about the innovation in service marketing. However, before the research is conducted, there will be a description about the global innovation index which describes the achievement in innovation in the private organization as well as the public in all of the countries, which Indonesia is on the 19th rank from the big 20 countries in the world.**

Innovation is an organized creative effort which is based on the science and technology in transforming the goods and services to the better one. In the empirical research, tested service innovation is the mediation variable between service marketing mix and customer satisfaction or customer loyalty. Service innovation has taken a part in the four phases of mature service management, they are product-centric manufacturer, as-needed service provider, full-line service expert, and integrated solutions provider.

There are two innovation terminologies in service that are often used, they are New Service Development (NSD) and service innovation. NSD refers to the effort of service innovation that is based on the information technology. The dimension of service innovation consists of finding the needs and new advantages for customers, the use of technology, the better business system plan, and timeliness. The successful service innovation is the innovation that is oriented to the customer values. For that reason, the companies of service provider should do regular measurement of successful service innovation using consumer perception of service innovativeness (CPSI). Therefore, we can find out the effectiveness, efficiency and economical values from the implementation of service innovation that has been conducted, including the higher education institutions in Indonesia.

Keywors: Iinnovation, service innovation, service marketing

I. BACKGROUND

There is no one can deny the importance of innovation in our life activities, including in the business world, especially service business companies. Without doing innovation continually, it can be sure that a business can not be surviving in competitiveness. The old competitors as well as the new ones will produce the innovation product creatively and continually.

Word "Innovation" refers to "process" and/or "result" of development and/or knowledge utilization/mobilization, skills (including technology skills) and the experience of creating and fixing product (goods and/or services), processing, and/or new system, that can give valuable or significant value, especially to the economy and social environment. (http://id.wikipedia.org/wiki/ Inovasi).

Innovation as an "object" also has the meaning as a product or a new practice that is available for application that is commonly used in commercial context. The various levels of the newness usually can be differentiated, depend on the contexts: an innovation can be a new thing for a company (or "agent/actor"), a new thing for a market, or country or area, or a new thing globally. On the other hand, innovation as an "activity" of a creating innovation process, is often identified as commercial invention.

The term "innovation" is often defined differently, even though it has the same meaning in general. The following are the meanings or definitions of innovation: (a) innovation is new creations (in the form of tangible and intangible materials) that have significant economical value and generally it is done by the companies or sometimes the individuals (Edquist, 2001); (b) innovation is the first commercial application of a new product or process (Clark dan Guy, 1997); (c) innovation is a creative and innovative process that involves the market and non market institutions (OECD, 1999); (d) innovation is the knowledge transformation to the new product, process and service; an action to do something new (Rosenfeld, 2002); (f) Innovation is a successful utilisation of new ideas (Mitra, 2001 and the British Council, 2000), or on the other words, knowledge mobilization, technological skills and the experience of creating new products, process and services; and (g) innovation is a research, development and/or manipulation activity that the goal is developing the application of the new value practices and science contexts or a new way to apply the available science and technology to the product or production process (UU No. 18 with the year 2002).

Therefore, innovation can be said as an effort of a creative person or a group of kind people that is organized and based on the science and technology in transforming the goods and services to the better products and services underlining the needs and wants of the consumers/customers.

II. THE PURPOSES OF INNOVATION

Innovation is done along with the goals or purposes of the company or organization, including the company business plan and increasing the advantages of company position. Innovation becomes the trigger or support in achieving the

ISBN : 978-602-97809-0-1

company goal development such as profits and market share. According to Davila *et al.* (2006) said that "Companies cannot grow through cost reduction and reengineering alone... Innovation is the key element in providing aggressive top-line growth and for increasing bottom-line results" (p.6)

In general, the company has the high expenses in doing the innovation, such as the changing of the old product, including the product and service process. The amount of investment is various starting from the low that is half of the percent until more than 20 percent of the company budget in order to get the high changing. The investment of the innovation in every company is about 4 percent on the average. The investment budget is spread to the various function including the marketing, product design, information system, manufacturing system and quality assurance.

In the number of manufacturing and innovation program service companies, innovation is usually forced by: (a) improving quality, (b) creating new market; (c) expanding product range, (d) declining the work labor cost, (e) increasing production process; (f) decreasing production raw materials; (g) decreasing environmental damage; (h) replacing product and service; (i) decreasing energy consumption and (j) obeying the rules and regulations.

The innovation, of course, will be various referring to the improvement of product, process and service. So, innovation is not only related to the new product development. Most of the purposes can be applied to every company or organization such as manufacture, marketing company, hospital or even the government service institutions.

III. INNOVATION ON THE GLOBAL RANK

Global Innovation Index is the global index that measures the innovation rank of a country. This index is published by The Boston Consulting Group (BCG), National Association of Manufacturers (NAM), and The Manufacturing Institute (MI), which are the biggest and the most comprehensive innovation measurement. Global innovation index is a research on the innovation effort that is done by the government as well as the private sector. This research is conducted with the survey of more than 1000 senior executives of companies from the various countries and cross industries. This research is also conducted with a deep interview with the 30 executives of 110 countries including the United States about the performance of innovation that is done by the countries and companies in each country and it is based on the effort to trigger the innovation. (http://en.wikipedia .org/wiki/global_Innovation_Index)

Table 1

Innovation Index of World Big Countries

Rank	*Country*	*Overall Innovation*	*Innovation Input*	*Innovation Performance*
20	Brazil	-0.59	-0.62	-0.51
19	Indonesia	-0.57	-0.63	-0.46
18	Turkey	-0.21	0.15	-0.55
17	Mexico	-0.16	0.11	-0.42
16	Russia	-0.09	-0.02	-0.16
15	India	0.06	0.14	-0.02
14	Italy	0.21	0.16	0.24
13	China	0.73	0.07	1.32
12	Belgium	0.86	0.85	0.79
11	Spain	0.93	0.83	0.95
10	Australia	1.02	0.89	1.05
9	France	1.12	1.17	0.96
8	Germany	1.12	1.05	1.09
7	Canada	1.42	1.39	1.32
6	United Kingdom	1.42	1.33	1.37
5	Netherlands	1.55	1.40	1.55
4	Sweden	1.64	1.25	1.88
3	Japan	1.79	1.16	2.25
2	United States	1.80	1.28	2.16
1	South Korea	2.26	1.75	2.55

Source: http://en.wikipedia.org/wiki/Global_Innovation _ Index

The current index which is published on March 2009, showed how poor the position of Indonesia as a big country that only has overall innovation index about 0,57, input index 0,63 and innovation performance index 0,46 and all of the index numbers showed negative value.

Input Innovation index includes the government and fiscal policy, education and environmental policy. Output innovation index includes the license, technology transfer and research and development results; business performance, such as work labor productivity and shareholder return and the effect of innovation to the business migration and economic growth. The following above are the list of the 20 big countries that are measured with PDB by International Innovation Index:

IV. THE INNOVATION ROLE IN SERVICE MRKETING

Agarwal *et al.* (2003) referred to the several experts such as Han *et al.* (1998), Deshpande *et al.* (1993) and Slater and Narver (1995) had the opinion that innovation successfulness in order to achieve the advantageous performance becoming important for service company because service product is difficult to be protected through the license. In order to keep the competitive advantages, service company needs to be innovative continually so it can always be on the front line in the business competition.

In the research Agarwal *et al.* (2003) did the hypothesis of the innovation role as the variable mediation, because commonly market orientation is related to the superior company performance. However, the empirical support for the proposition in the research study before is week. This study does the research about the correlation between market orientation and performance with the data from 201 international hotels and find out that market orientation positively correlated with the two judgemental performance (consists of: service quality, customer satisfaction and employee satisfaction), objective performance (consists of level of stay, gross operational profit and market share). Particularly, the study finds out that direct impact of market orientation is to trigger the innovation and furthermore it will increase the judgemental performance that is focused on the increasing company objective performance.

The margin of innovation role between product and service is actually very thin. For manufacturing industrial products are already united with the service dimension just like what was mentioned by Sheldon (2009) that product innovation is not enough or is not able to produce competitive advantages and grow continually. The well known brands are the examples, such as HP, Apple, Rolls-Royce, TomTom and GE that occupy the product offer with the innovative service in order to give solution that can give higher customer values, increase the brand preference and create the chance of bigger cross-selling.

Furthermore, Sheldon (2009) explained that there are four phases of mature service management: Product-Centric Manufacturer, As-Needed Service Provider, Full-Line Service Expert, and Integrated Solutions Provider. Every phase adds the higher level of service, give more sophisticated solution and create more interesting profit margin. However, we need to pay attention that the movement to the higher phase needs the readiness in expanding the product value proposition that is offered to the customer with the integrated solution covering the product and service. The company management itself needs to be able to combine the technology with the business model innovation by managing and utilizing the available sources. Finally, the company management needs to develop the strong partnership to support the renew product or service value proposition

Going into detail, Droege et. al (2009:123) mentioned that there are four principals or thoughts in the new service development (NSD) research and implementation, they are technologist, assimilation, demarcation and synthesis. Firstly, technology principle in doing the research and implementing the innovation is referred to the product life cycle concept that is very familiar, they are: introduction, growth, maturity and decline. The technology aspect becomes the key to increase the service quality in order to satisfy the customers. However, the principal is critized because the technology for every service industry can be very various, furthermore, in giving the service to the customer, technology aspect is not the top of all. Service industry is the industry with the very high human interaction level. (high involvement and high human interaction).

Next, for the second principal, assimilation is the thought outline in the service marketing, which the concept and the application of manufacturing industrial innovation are applied to the service industry. The point is the technology aspect becomes the trigger for innovation in service. The third, demarcation can give research contribution that focuses on the different features in service, but in the practice, it will not easy to transform the innovation in manufacturing to the service. It happens because of the characteristics of service, they are intangibility, co-production with customers, simultaneity, heterogeneity and perish ability (Fitzsimmons and Fitzsimmons, 2006) that influence the process of service development and it is also has its own unique (Nijssen *et al*., 2006, p. 242). The last or the fourth is synthesis that does the study of innovation and its implementation in the manufacturing industry together with the service but actually they are separated from one to another.

Table 2.

The Net Value Application and Service Development Process

Service development dimensions enhanced through application of network perspective:	Service features addressed through enhanced service development dimensions			
	Intangibility	Inseparability	Perishability	Heterogeneity
The firm's ability to understand customer needs	X			
Ability of customers to evaluate new service ideas	X	X		
Customer input into both core service and delivery system design	X	X	X	X
Ability of firms to move into new markets with increased speed and less cost via collaboration and resource exchange with suppliers/competitors	X	X		
Understanding and commitment of distributors to new service	X	X	X	X
Customer contact staff knowledge and understanding of compound mix of elements comprising new service	X	X	X	
Commitment of customer contact staff to effective delivery				X
Conformity to industry regulations, increasing customer confidence/reducing perceived risk	X			

Source: Syson *dan* Perks (2004): 264.

Syson and Parks (2004) described the net perspective in the new service development (NSD) with developing and integrating the two theme: new service development and innovation process in the net that is from the study of manufacturing industrial net. The two themes become the basic research of net case study based on the new service in financial service sector. Basically, every company has the creative capability in combining the activity with the sources to provide the unique service for the successfulness of NSD implementation, with paying the attention to the service features, such as intangibility, heterogeneity and inseparability (Table 2).

Gray et al. (2000) mentiond that the strong organizational culture in hotel industry will force the innovation in the web-based marketing to increase the hotel company performance in New Zealand. Furthermore, it is explained that innovation is the important source of competitive advantages in the market where the customer preferences will be changing quickly along with the very tight competition, the more shorter and more mature product life cycle and the limitation of product or service differentiation.

Gray *et al.* (2002) in the next research, tries to re hypothesize the company performance and its correlation to the innovation. Their hypothesis result that is based on the sample of multi big industrial companies in New Zealand suggests that to increase the business performance of information service company, the company should develop the system to find the profitable customers and products, develop the company culture that focuses on the needs of stakeholders and develop the policy to force the ethical behavior. In order to develop the marketing performance, the company should increase the market orientation, develop the company culture that focuses on the marketing and innovation concept, adopt the new product development and open the chance with e-commerce.

Droege *et al.* (2009: 131-132) that had conducted the library research on the innovation in service industry mentioned that if it is compared with the product, it will be left behind. In service industry, innovation term is used for two sufficient popular concept, they are new service development or NSD and service innovation. There are also some other experts in service marketing or management that use the terminology in service development to show that

ISBN : 978-602-97809-0-1

there is a change or innovation in the service given by a service company.

Service innovation, according to the meaning, is not far different with the other industry that is the company capability to survive in the competitive business world. The capability to survive gives the advantageous position and what has been offered by the company to the customers can be fulfilled. The other definition f service innovation is the service principal that can be used to increase the company performance to the customers in order to get the service with the newer benefit. If we compare with the definition in the healthcare service industry is the company activities based on the technology, the plan and the transformation of the half or the whole service to the customers. According to the all definition of service innovation, Lee *et al*., (2009) added that one important factor in service innovation is the timeliness that becomes one of the cores in service that can not be denied.

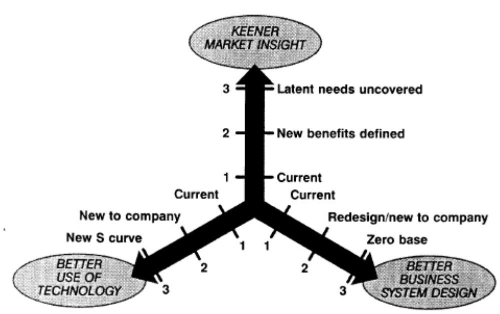
Service innovation, in term of timeliness, has been the attention for a long time, especially for banking service industry, domestically as well as internationally. Chryssochoidis and Wong (2000) in the case study of explorative research on service innovation that had been conducted in the Siprus financial institution in the three or more foreign markets showed that service innovation is really depending on: service innovation that is integrated with the available banking operational service system; the sufficient marketing sources; the use of organizational mechanism widely and integrated and the affordable service development process

The external environmental factor, including the market heterogeneity and wide competition has the lower impact to the timeliness when the service innovation is applied in that environment.

Innovation can be successful commercially in the competition with the major pattern is giving the customer value from the price, quality, service and so on. According to Parsons (1991: 9), there are three innovation dimension that should get more attention to give the customer value, they are finding the new needs and utilization for the customers, the better use of technology and the better business system plan (picture 1). Parson referred to the successfulness of CNN as the world famous news television that can redesign the business system successfully.

Picture 1

Innovation Focus to The Customer Value



Source: Parsons, 1991: 9.

How can the company be succeful in applying the innovation that is oriented to the customer value. Parson (1991: 12-14) explained that there are five steps that can be used, they are: firstly is evaluating the current position and capability of the company. Then, the second step is finding the all things that will be done in innovation that can give competitve advantages for the compay. The third until the fourth step are done together by the company, those are building the special skills of human resources, making the more dinamic cross functional organisation approach and the management process of innovation it self

If those five steps have been done and the company is still failed in the implementation of innovation to give the more value to the consumers or customers, Parson mentioned that there will be 3 possibilites of fails, they are failed stategy, failed procedure and failed organization. However, the effort to do the innovation to give the more value to the consumers or customers is done again by choosing the right innovation strategy, keeping build the special skills of human resources, focussing on the cross organisational fuctions to force the innovation and the innovation process management itself.

Lin *et al.* (2010) did the empirical hypothesis of the impacts from the various management dimension related to the customers (Customer Relationship Management – CRM) to the innovation capabilities of 107 companies, computer producer in Taiwan. Five dimension of CRM are information sharing, customer involvement, long-term partnership, joint problem-solving and CRM technology-based. The relationship and the influence of five dimension of innovation capability (product, process, administration, marketing and service innvation) are identified and veryfied. The empirical finding in the computer producers in Taiwan shows the all levels of CRM and the all levels of impact to the each of five capability of innovation. Generally, the company can increase their innovation capability with CRM partially; customer involvement and innovation process; customer incolvement and administration innovation and long-term relationship and non significant marketing innovation and only CRM technology-based that has positive impact to the all five types of innovation. The finding shows that not all of the CRM activities can give contribution to the innovation program, that clearly shows that it needs to apply other mechanism, such as supplier integrity, to make the complete innovation program. The managers need to put the supplier development, the management practice and CRM with the desirable innovation capability in a harmony.

Zolfagharian dan Paswan (2008: 339-345) said that goods innovation is done more easily by the company by integrating the changing in the real form from the new product that is produced. For the service providers, there will be much more difficulties in making intangible to the more tangible service innovation that will be more acceptable to the consumers or customers. Therefore, in service innovation, it is more correct if it is understood as how far the actions and the reactions of the customers on the service innovation that is given to them. They use the conceptual and operasional definition of service innovation that refer to the theory of consumer behaviour about the customer decision process in adopting the innovation, including the rejection aspect that is called exposure innovation to the acception

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level to the innovation. This concept is called as consumer perception of service innovativeness (CPSI). The CPSI dimension is related to the plan, creation and service delivery where the consumers are interacted from the tangible to the intangible services for core service as well as supplementary. Their empirical hypothesis gives the result of seven dimension of important CPSI in service industry, they are interior facility, service administration support, exterior facility, human resources, core service, technology and response.

Lin *et al*. (2007) tried to find the multi dimension perspective and the innovation practices for small and medium business in Taiwan in manufacturing and service industry, especially about the correlation between innovation and company or organization performance. The finding is 80% of the companies that have been surveyed do two kinds of innovation, they are technology innovation and marketing innovation. However, innovation has week correlation with the company sell. The administration innovation comes as the essential factor to explain the sales rather than the technology innovation. The practical impact is creating the successful innovation platform as the basic for innovation that is related to non technology, that is company management aspect that is proven to become the esential catalist in innovation.

Hurmelinna-Laukkanen and Ritala (2010) said that the profit that the company can get from the service innovation is really promising. Service innovation is not only about the price and the good service, but also about how to avoid the competitors copying our system. Basically, service innovation is different from technology/product innovation in protecting the license and the colaborative service innovation. In the research they showed that service innovation differentiate the characteristic of product innovation or license protection process. In contrast, service innovation is an activity from all colaboration so it will be little different from license protection: The company should protect "the service innovation" as the knowledge that can give competitive advantages, but on the other hand, service innovation needs development that needs to be shared. As the result, the investors from sevice sector can not olny count on the intellectual right strategy, just like people who work for manufacturing, but also the wider service needs wider knowledge and human resources utilization, timeliness and contract protection. However, one thing that can not be denied is that innovation colaboratively as well as competitvely become the business model where the service innovation becomes the core of product and service that are offred to the consumers or customers.

V. INNOVATION APPLICATION IN SERVICE INDUSTRY

Zeithaml *et al.* (2008: 15-21 and 278-279) had seen the innovation application in the service industry, especially in the service marketing program, they are usually technology-based such as computer-based office automation for service industry and Internet use. Service innovation is mainly applied for the new service development for the customers so the service performance will be better than before in order to satisfy the customers and of course it can keep the customer loyalty so they will be loyal to the service that is offered by the service provider.

The aspect of innovation in service industry that needs attention, according to Zeithaml and Bitner (2003: 70-71) was consumer will be longer accept the innovation compared with innovation in goods just like they said: "Consumers adopt innovations in services more slowly than they adopt innovations in goods." However, innovation application in service marketing will help to shorten the delivery time to the consumers or customers. One of the innovation applications is CRM (Customer Relationship Management) that is really related to the management application with the computer-based, especially for the inventory, editing and customer database management (O'Brien, 2004: 220). Innovation in service industry that is technology-based makes the interactive marketing between service provider and consumers (B2C – Business to Consumer become more dynamic. The service company that does not adopt this program, for sure will be loose in the competitiveness because in the interactive marketing development, there is service marketing with the transactional characteristic and the relationship between consumer and consumer (C2C – Consumer to Consumer)

VI. CLOSING

Innovation is an organized creative effort which is based on the science and technology in transforming the goods and services to be better than before. The previous purpose of innovation is limited to the technology and now becomes the cross industry and organization. In the empirical research, the tested service innovation becomes the variable mediation between service marketing mix and customer satisfaction or loyalty.

Service innovation has a role in the four phases of mature service management, they are product-centric manufacturer, as-needed service provider, full-line service expert, and integrated solutions provider.

There are two innovation terminologies in service that are often used, they are new service development (NSD) and service innovation. NSD refers to the four important principals, they are technologist, assimilation, demarcation and synthesis. Service innovation is a service development effort by creating the new service line for the customers.

There is not an agreement in service innovation dimension, but there are three innovation dimension, they are finding the new needs and benefits for the customers, using the better technology and business system plan. This dimension needs to be occupied with the timeliness. There are also five innovation capability dimension, they are product, process, administration, marketing, and service innovation itself

The successful service innovation is the innovation that is oriented to the customer value. The empirical evidence shows that there are three possibilities of failed service innovation, they are failed strategy, failed procedure and failed organization. Therefore, service provider company should do the measurement of the service innovation successfulness regularly using the Consumer Perception of Service Innovativeness (CPSI), so we will know the effectiveness, efficiency and economical value of the service innovation implementation that has been conducted.

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ISBN : 978-602-97809-0-1

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The International Conference on Industrial Engineering and Business Management 2010

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

An analysis of program management at the Universitas Khairun, Maluku Utara

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Abstract – **The vision to sustaining industry and business towards future challenge has been exploring the journey of uncertainty and complexity. These two elements have forced project management to uplift its scope in managing complex project into strategic level. The paper aims to provide a potential angle in achieving organization's goals by managing a number of small projects which are reaching similar objectives yet fight for limited resources. Program management is proposed to be implemented as methodological equipment, particularly in refining pathways of strengthening Universitas Khairun management. The analysis provides step-by-step solution to manage projects simultaneously.**

***Keywords* – change, stakeholders, and program management**

I. INTRODUCTION

Change is inevitable, and it leads the emerging of projects. The projects become more complex when an organisation has to interact with groups of external and internal stakeholders, limited budget and timeframe, and unforeseen future. Not to mention unskilled organisation's individuals who will be the agents of change and think tankers.

Project management by definition aims to manage project in efficient and effective manner within limited budget, duration, and specific objectives in order to yield a novel, unique result or process (PMBOK, 2004; Turner, 1999). By this definition, project management has moved from nice-to-have to strategic-and-important technique. There have been a number of years project management proves its powerful methodology and tools in managing projects (Harold Kerzner, 2006).

Program management in its nature is defined to as a series of projects, manage collectively, and for additional benefit. In other words program management is "the management of a coherent group of projects to deliver additional benefit" (Turner, 1999). This is similar to the definition provided by Project Management Institute (PMI). It defines program management as to the centralized management of a program to accomplish the program's strategic objectives and benefits (PMBOK, 2004). Cooke-Davies (2002) further explains that program management recognizes the interdependence of projects within a program, confining its focus to a singleprogram. PMI in its Standard for Program Management (PMI, 2006) outlines how projects are coherently managed into a singleprogram.

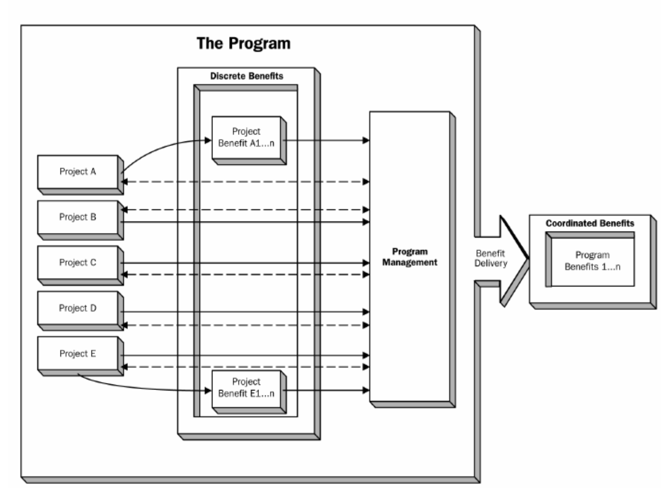

Figure 1: Program Benefit Management

The existence of program management assist an organisation to manage its projects which have similar goals yet fight for limited resources to achieve business strategy. Under this circumstances top management might heavily rely on program management to ensure the alignment of projects and business goals as whole (Cooke-Davies, 2002).

Moving from current state to ideal condition, Universitas Khairun is in the process to strengthening its management capacity. As a higher education institution, the university has to be able to balance public demands as agent of change, limited resources, and dynamic change in science and technology. This is why program management will be proposed.

II. EVOLUTION OF ORGANIZATION

Universitas Khairun was established in 1963 and has many contributions to the local community by developing and improving human resources quality. One of the biggest contributions was assisting the formation of our new province, the province of North Maluku, in 2000. The university is also expected to be an agent of change through balancing the impact of globalization and local needs.

The enactment of Government Regulation No. 12, 2003 formally enacted Universitas Khairun as the first state university in North Maluku. As a result, the university has to prepare itself to meet all required qualities. There are plenty

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of issues rises after changing the status, which are mainly concern with (Unkhair, 2005):

- Minimum infrastructure
- Low capability in prioritizing resources
- Low level of human resource competencies and capabilities
- Dated Curriculum
- High demand of new students

A consequence of being state university, Universitas Khairun is forced by Directorate General of Higher Education (DGHE) to have a certain level of organization health (DGHE, 2003). The university then gradually starts to equally place itself with other state universities by emerging as two main strategic plans (Unkhair, 2006):

1. Business re-engineering particularly in academic and quality assurance area
2. Plan master site (This is due to the integration of all campuses)

By defining the issues and main strategic plans, the program is to have an integrated process of strengthening institutional management.

III. PROGRAM MANAGEMENT ANALYSIS

Even though the program is informally legalized, the strategic and the spirit are obvious. The program will be decomposed into smaller "projects" which interrelate to one another and consume similar and limited budget. Program management analysis is then utilized to coherently manage the complexity. Program management encompasses stakeholder analysis, functional analysis, ideation and collaboration, program approach and organizational structure, and task oriented WBS (work breakdown structure).

Stakeholder Analysis

The objective in analysing stakeholders is to "identify and classify by sector, measure influence on action and its implementation, and determine needs and expectations" (Thiry, 2006). In analysing stakeholders, it is assumed that Universitas Khairun places DGHE as one of the key stakeholders. Other stakeholders, which have different needs and expectation of any programs within the university, are outlined below on Table 1. Moreover Figure 2 shows stakeholders' influence and impact to Khairun's program.

TABLE 1

STAKEHOLDER ANALYSIS

Key player	*Needs/Expectations*
Directorate General of Higher Education	Improve organisational health
Board of counselors	Recruit qualified staff
	Improve staff capabilites and competencies
	Improve the infrastructure
	Re-engineer the process
Academic staff	Gain opportunity to upgrade skills and qualifications
	Establish and broaden network
Administrative staff	Gain better work environment
	Be clear career path
Students	Increase university reputation
	Produce qualified graduates
	Provide better facilities
Public or community	Develop local human resources
	Be a change agent
Local governments	Improve their employees' skills and knowledge
	Save educational and training costs

The scattered pattern of stakeholders on Figure 2 describes the different level and power, even though the group of stakeholders are in the same grid. By analysing the stakeholders, it is expected that there is a clear picture of stakeholders' needs and expectations as well as the impacts to the program.

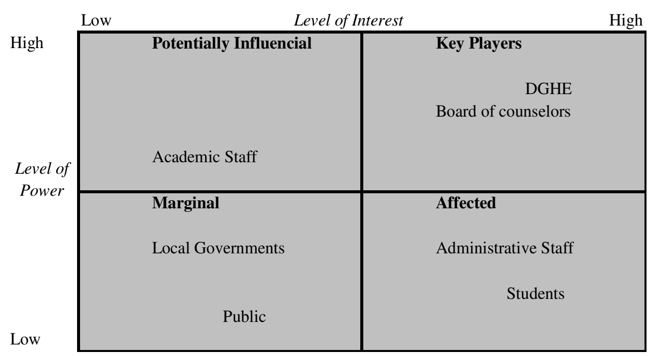

Figure 2 - Influence Grid

Functional Analysis

At higher level of an organisation, the expected benefits are seems too abstract such as in vision, mission, objectives, and goals. Those expected needs and benefits are needed to be cascaded down into more manageable tasks or concrete activities through a hierarchical structure. This hierarchical uses Functional Breakdown Structure (FBS) (Thiry, 1997) to create a model that represent needs and expectations of the stakeholders in more tangible actions and have agreed understanding of current situation. By using the FBS, the stakeholders at Universitas Khairun have common view of concrete tasks in order to achieve their expected benefits and needs (see Figure 3).

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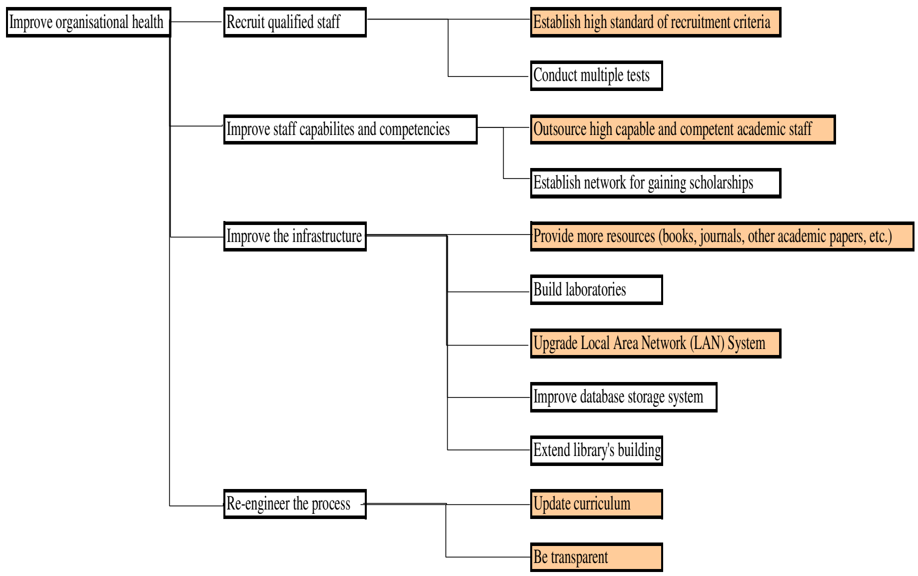

Figure 3 - Functional Breakdown Structure (FBS)

The Figure 3 illustrates the concrete actions from higher level needs and expectations into more manageable tasks. The most left-part of the hierarchal of need comes from DGHE which is applicable to all universities in Indonesia. Then, this expected need cascades according to situation in each university which may be different from one university to another. By reviewing the needs and expectations of Universitas Khairun, there are four actions to satisfy the requirement from DGHE. However, those actions are very broad and abstract. Therefore, the four needs are still decomposed into eleven concrete actions.

Having established FBS, the process continues to select Critical Success Factors (CFSs). The actions of the most right-part of the FBS are the CSFs. These factors are still high level and easy to be measured (Thiry & Willey, 2004), although they are still more qualitative statements. The highlighted actions are the CSFs for the university's program:

A. Establish high standard of recruitment criteria
B. Outsource high capable and competent academic staff
C. Provide more academic resources (text books, journals, and other types of academic papers)
D. Upgrade Local Area Network (LAN) System
E. Update curriculum
F. Transparency

TABLE 2

PAIRED COMPARISON

	A	B	C	D	E	F	Total	Weight
A		2	1	2	2	3	10	13%
B	3		2	4	3	3	15	20%
C	4	3		3	3	3	16	21%
D	3	1	2		2	2	10	13%
E	3	2	2	3		3	13	17%
F	2	2	2	3	2		11	15%
							75	100%

From the CSFs above there are two short term focuses: outsource high capable and competent academic, and provide more academic resources. The assumption behind this opinion is because the university really needs these qualified staff and supported by up-to-date academic resources in order to urgently strengthen management capacity, especially in academic and quality assurance.

After finishing this process, the CSFs are then prioritised by using paired comparison as shown on Table 2. Once the top three of CSFs – provide more academic resources; outsource high capable and competent academic staff; and update curriculum – has been identified, the process continues with setting up Key Performance Indicators (KPIs). The KPIs aims to measure the achievement of the CSFs. These indicators have four elements: criterion, level, flexibility, and measuring tools. The indicators are tabled on Table 3.

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TABLE 3

KEY PERFORMANCE INDICATORS (KPIS)

CSFs	*Criterion*	*Level*	*Flexibility*	*Measuring Tools*
Provide more academic resources	significance	types & ranges of academic resources within 6 months increase by 20%	± 10%	library's semester report
	years	20% of current resources (up to 5 years)	± 10%	library's semester report
	publisher	75% local & national publisher, and 25% international publisher	± 10%	library's semester report
Outsource high capable and competent academic staff	experienced practicioners	30% increase within 12 months	± 10%	HR department's annual report
	qualified researchers	30% increase within 12 months	± 10%	HR department's annual report
	doctoral degree	50% increase within 6 months	± 10%	HR department's annual report
Update curriculum	proportion	20% within 6 months	± 10%	benchmark againts best practice
	no. of offered subjects	20% within 12 months	± 10%	benchmark againts best practice
	legalization of DGHE	none	± 10%	DGHE legalization
	frequency	year	± 10%	University's annual report

Ideation and Elaboration

Ideation is a literal thinking process which aims to broadening the range of possible alternatives in implementing the top three of CSFs, whereas elaboration phase (vertical thinking process) is the process where those alternatives are assessed, developed and then grouped into the most viable and profitable options. These processes must be separated in order to achieve best result. The processes are outlined on Table 4.

Having elaborated the alternatives into the feasible and beneficial options, it is necessary to review the logical relationship between the option and the CSFs. This is because the options will then become projects that carry high level of expected needs and benefits of the stakeholders. Once the options have been identified, the next process is prioritised the option based on their achievability against the CSFs, as shown on Table 4.

TABLE 4

IDEATION AND ELABORATION

Critical Success Factors	*How to implement CSFs (ideation)*	*Option (Elaboration)*
Provide more academic resources	Buy license from providers	A. Benchmark against best practice from particular universities which is combined with the demand from the academic community
	Benchmark against best practice from other universities	
	Set up resources criteria	
	Co-operate with other universities	
	Establish the committee	
	Bid the materials from supplier	
	Provide regular report	
	Set up references list from lecturer	
	Offer exchange program	
	Run a academic-demand survey	
Outsource highly capable and competent academic staff	Offer professional development program	B. Offer professional development program which is based on setting the recruitment standard.
	Set up HR recruitment standard	
	Benchmark against best practice	
	Modify curriculum	
	Review strategic plan	
	Promote the university	
	Provide incentive program	
	Establish network with other universities	
Update curriculum	Benchmark against the best practice	C. Ensure the alignment of workforce demand and offered courses by carrying out a survey on business and industrial sector.
	Conduct a survey to business and industrial sector	
	Set up official committee	
	Build network with other universities	
	Provide mentoring and training program	
	Establish standard quality	
	Conduct curriculum seminar or workshop	
	Align workforce demand with offered program	
	Modify learning system	

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This matrix is aimed at measuring how an option can contribute benefits or CSFs. The exhibit shows that option 1 is the most achievable options, followed by option 3 and 2. From this point those three options are then assumed as projects: Project 1, 2, and 3. In order to choose which project is the most profitable, the process continues with the next stage by combining achievability/benefits scoring and using MESA© (Model for Evaluation of Strategic Alternatives) (Thiry, 2003) as shown on Figure 4 below. It is appeared from the exhibit that all projects are highly beneficial because those range from 500 – 700, and project A is higher in terms of its achievability compared to project C and B.

Achievability					
VHI 0.90 801 - 1000	0.05	0.09	0.18	0.36	0.72
HI 0.70 601 - 800	0.04	0.07	0.14	0.28 Option 1	0.56
MED 0.50 401 - 600	0.03	0.05	0.10	0.20 Option 3 & 2	0.40
LO 0.30 200 - 400	0.02	0.03	0.06	0.12	0.24
VLO 0.10 001 - 200	0.01	0.01	0.02	0.04	0.08
	0.05 001 - 100 VLO	0.1 101 - 250 LO	0.2 251 - 450 MED	0.4 451 - 700 HI	0.80 701 - 1000 VHI
	Benefit				

Set thresholds

> 0.15	0.05 - 0.15	< 0.05
High Priority	Moderate Priority	Low Priority
Implement	Improve & Re-assess	Reject

Figure 4 - MESA© Qualitative Prioritization

Program Approach and Organisational Structure

Having finished all the prioritisations, the process continues with establishing an organisational breakdown structure (OBS) by using program approach. This structure aims as a basis in appointing a responsible party to manage critical success factors in each project. For this case study, the OBS, that carries roles and responsibilities of each party, is shown on Figure 5.

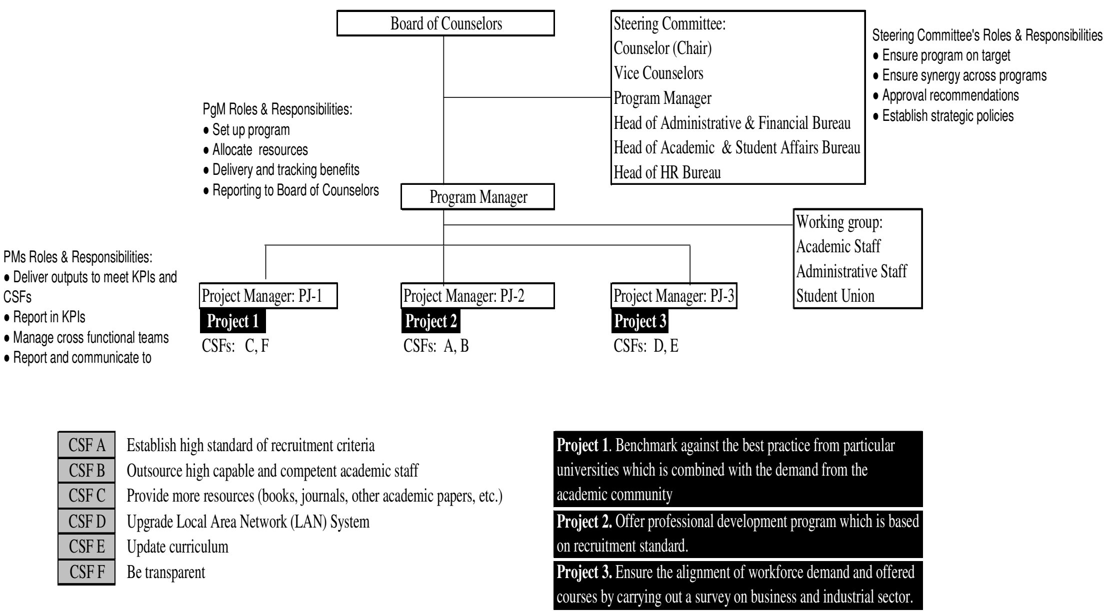

Figure 5 - Organizational Breakdown Structure (OBS)

In regards of Khairun's program, even though DGHE is one of key stakeholders according to the influence grid in stakeholder analysis, there are assumptions why DHGE is excluded in the OBS. This is because the institution is very high level of organisation and is aimed at ensuring the achievement of its main strategic plan and do not involve into lower level of every project in every university. The institution realises that every university has its uniqueness

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due to the difference of vision and mission in developing its competitive advantage, which is vary regionally.

Task Oriented WBS

Task oriented WBS offers better integration deliverables and the expected needs and benefits. Task oriented WBS uses verb-noun expression in order to explain project managers how to achieve the CSFs.

In terms of Khairun's program, the explanation about the WBS is only for Project 2 (see Figure 6). From the exhibit, project 2 has four main actions: Analyse situation, increase job satisfaction, develop academic personnel, enhance knowledge and experience exchange. These actions are then decomposed into several activities in every main action. The task of establishing task oriented WBS was challenging because it has to be re-reviewed in order to value its logical integration to the project, Critical Success Factors, Function Breakdown Structure, and stakeholders' needs and expectations.

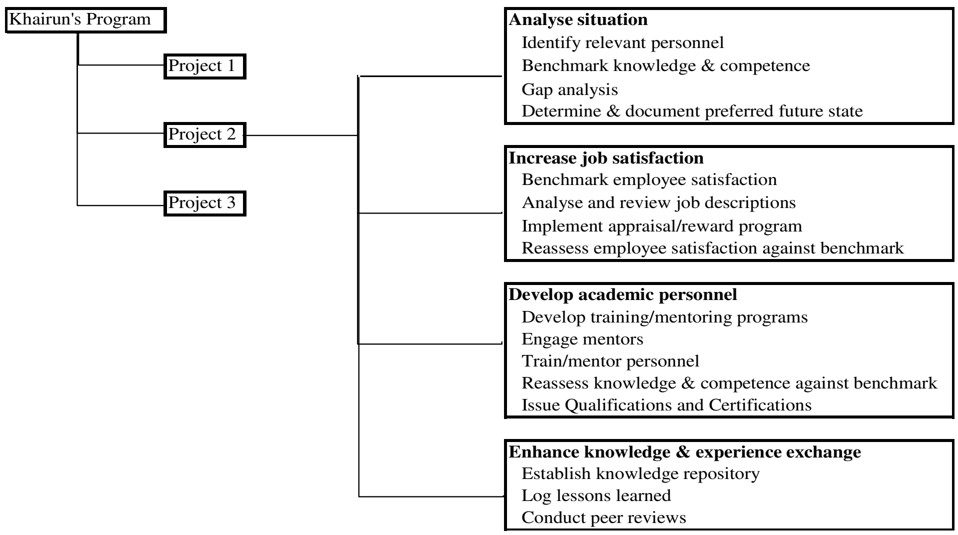

Figure 6 - Highe Level of Task Oriented WBS

IV. Conclusion

The prospect of formally implementing program management is open widely. The scarce resource within Universitas Khairun forces top management to strategically managing a number of project-based activities and tasks; because they aim to achieve similar objectives. The result depicts that only few projects are allowable to be executed. MESA© is implementable to assist managers and top management in prioritizing a number of potential ideas, but under limited resources. By managing collectively, program management might ensure the alignment between projects' and organization objectives.

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ISBN : 978-602-97809-0-1

Design an Effective Training Program by Using Spencer's Competency Model at Communication Division - PT Jasa Marga

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Abstract - **One method to improve human resources performance is conducting training. To create an effective training it is necessary to identify training need for employees. In this paper, identification of training needs is based on job descriptions, key activities and critical incident of key activities. The Spencer's Competency Based Model is used as a competency model to design the training program. Spencer divides competencies into two groups namely core competence and generic competence.**

***Keywords* - Effective Training Program, Spencer Competency Based Model**

I. INTRODUCTION

Sources of competitive advantage of the organization is always change. This changes is in line with the changes that occur in the world such as: changes in political structure, global free markets, and developments in information and communication technology. It greatly affects to the development of regional economy as well as world economy recently. To gain a continuous competitive advantage, a successful company depends not only on technology, patents, or strategic location but on how they manage their human resources too.

Each employee is required to improve their resources quality, especially that relate directly to the customer. For supporting it, there should be an assessment of work performance and an alternative that can be used to evaluating performance with competency approach. Assessment of competency-based work is an assessment based on the dimensions of attitudes and behaviors that be considered as a critical insident of completion of work by employees, but not by factors of race, gender or socio-economic.

The results of the assessment of work competence based can be used to design a training programs that will sustain progress and improve the quality of employees. .

Organizations require employees who have diverse knowledges and skills, and have positive attitudes and behavior to support their knowledges and skills. The concept of human resources competence based will crystallize the entire process of managing human resources including recruitment & selection process, performance appraisal, compensation & benefits, career development and training & development. To align the employee competencies, and in order to achieve a good work performance and fit, it is necessary to conduct training for employees.

Training is a part of human resource management, it should be in line with the concept of human resource management based on competency. Therefore, this paper will identify the training needs for employees based on competency using Training Needs Analysis Method in Communication Division – PT. Jasa Marga (Persero). This method is expected to analyze the training needs of employees in a comprehensive, objective, structured and precise.

Based on explanation above, the purposes of this paper are:

1. Identifying and determining the training needs for employees
2. Improving the process of determining training needs for employees to be more objective, systematic and well targeted
3. Designing a basic competency in human resources management, particularly basic competency training and its development, which is the company's strategy in human resource development.

II. BOOKS REVIEW

A. *Competency Based Human Resource Management* (CBHRM)

Competency is [1] defined as a combination of skill, knowledge, and personal qualities necessary to be able to carry out their job effectively. It should be understood that the essence of CBHRM is a value-driven strategies, so the aspect of personal qualities get special attention in its management in addition to the attention of the skills and knowledge. This is based on the premise that personal qualities are a critical component for a person to actualize / demonstrate the skill and knowledge possessed.

All employees may have received customer service training, but who are really able to satisfy customers is that they are demonstrating good patient, friendly, caring, sincere and responsible, or those who seek to develop qualities such properties. Therefore, in terms CBHRM known threshold competencies, ie the competence of the general competency of skill / knowledge and a minimum should be had by all who occupy the job / position.

Thus the importance of this aspect of personal qualities but people often get trapped by this thing just seems real. Like an iceberg, skill and knowledge is part of that look real and are relatively easy to develop.

By using CBHRM, not only the skills and knowledge that could be developed, the personal qualities can be identified, measured, and developed so that collectively become organizational qualities that reflect the behavior of the organization in carrying out business strategies and providing services to customers.

B. Criteria of CBHRM Development [1]

Realize how much work volume CBHRM development, the development and implementation CBHRM done by the following criteria:

1. Considering the Learning Process: The term of competence is not something new, however, talking about CBHRM, the emphasis of the competence varies. There is an emphasis on skill, some combination of skill, knowledge and attitude, there is also choosing an emphasis only on the attribute / personal qualities. Implementation of CBHRM at various companies also showed the emphasis diversity. Therefore, development of CBHRM must be gradual to provide learning opportunities in order to understand better about CBHRM and find the appropriate competency model company need.
2. Can be Maintained: Implementation of CBHRM will not be much benefit if the follow-up to cover the gap competency is ineffective or competency gap closure is not give a real impact, both for companies and employees..
3. Simplified: Assessment tool that developed is strived simple to maintain the expected level of accuracy. Both the method and language should be understood by all levels of employees, since all employees will be an assesor.
4. Acceptable All Parties: Using a general reference to the applicable national.
5. Flexible: Provides flexibility for organizational units (especially division) to add the characteristics of competence in line with the characteristics of division.

C. Competency Categoryzation Base on CBHRM

The CBHRM job assesment system that is used is formed from three main competencies directory, which is a combination of skills, knowledge and personal quality. All three competencies directories mentioned above, namely: core competencies, generic competencies and specific competencies. Core competencies are the competencies to be possessed by all employees; generic competencies are the competencies to be owned by a group / family / work streams that have similar characteristics; specific competencies are the competencies to be possessed by a particular job.

Based on the description of Spencer's competencies in the book At Work Competency, competencies that must be held are as follows:

1) Achievement and Action :
   1. Achievement Orientation,
   2. Concern for Order, Quality and Accurancy, CO.
   3. Initiative, INT,
   4. information Seeking, INF
2) Helping and Human Service
   5. Interpersonal Understanding, lU
   6. Customer Service Orientation,
3) impact & Influence:
   7. Impact and Influence,
   8. Organizational Awareness, OA
   9. Relationship Building, RB)
4) Manajerial:
   10. Developing Others, DEV
   11. Directiveness, DIR
   12. Team Work Cooperation, TW
   13. Team Leader, TL
5) Cognitive:
   14. Analytical Thinking, AT
   15. Conseptual Thinking, CT
   16. Expertise, EXP
6) Personal Effectiveness
   17. Self Control, SCT
   18. Self Confidence, SCF
   19. Flexibility, FLX
   20. Organizational Comitment, OC

D. Training Theory

Training is [2] an important thing in a human resource development. Training can not only increase knowledge but also improve the working skills that ultimately will improve work productivity.

Beach suggested that [3]: “Training is the organized procedure by which people leam knowledge and or skills for the definite purpose”. Furthermore, Mondy and Noe suggested that “the Training Is that those activities serve to improve an individual's performance on the job currently held or one relate to it.

Baesd on the two definitions above it is acquired some basics understanding about the training. Training is a learning process where the experience will change oneself, whether the changes of skills, knowledge, attitudes and behavior.

III. METHODOLOGY

In this paper, formulation of competence needs used interview techniques and questionnaire distribution to employees with superior abilities, average and poor. Overall, the steps in this research can be seen in Figure 1.

IV. DESIGN OF COMPETENCIES NEED

Design of competencies need through three stages, namely the establishment of competency based on job descriptions and critical incident, the identification of variables of competence in the Communication Division, and determination of training requirement for employees.

A. *The Establishment Of Competency Based On Job Descriptions And Critical Incident*

Key activities in the Communications Division illustrate the activities that be references to perform activities in the Communications Division, PT Jasa Marga (Persero). The

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critical incident is an incident that determines whether a key activity undertaken by someone is a succeed or fail.

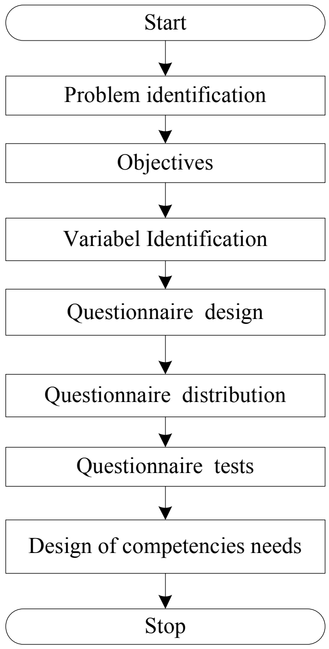

Fig. 1 Research steps

Tabel 1 shows key activities and critical incident in Communication Division on the Communication Management Position.

B. *The identification of variables of competence in the communication Division*

Based on the existing job description, the key activities, and critical incident, can be identified the competency variable for employees as description below :

1. Core Competencies
   Core competencies used in Communication Division of PT (Persero), are:
   a. *Achievement Orientation, ACH,*
   b. *Concem for Order, Quality and Accurancy,* CO
   c. *Team Work Cooperation, TW*
   d. *Analytical Thinking*, *AT*
   e. *Conseptual Thinking, CT*
   f. *Customer Service Orientation, CSO*
   g. *Initiative, INT*
   h. *Expertise*, EXP
   i. *Organizational Comitment, OC*
   j. *Organizational Awareness*, OA
2. Generics Competencies
   Generic competencies used in Communication Division of PT (Persero), are::
   a. Relationship Building, RB
   b. Information Seeking, INF
   c. Flexibility, FLX

C. *The Determination Of Training Requirement For Employees*

Based on the comparison between the competencies of employee that possessed with the company's standards, it can be determined training requirement for employees. It can be seen in Table 2

IV. ANALYSIS

Based on the results of discussion previous, it can be seen and determined which employees who need training in order to improve work performance in accordance with the desired company. By means of table 2, the analysis that can be taken is as follows :

1. The competence dimension : ACH
   - sub-dimensions of A, the employee has exceeded the criteria superior work standards that require companies except S3 training, while for employees with an average of all criteria must follow the training except for R2 and R6. for all employees with poor criteria must follow the training except for P2.
   - sub-dimension of B, employees with superior criterion has exceeded all standards of corporate work, while the criteria for employees with an average of only R5 should follow the training. For employees with only P1 poor criteria that must follow the training.
   - sub-dimensional C, all employees have exceeded the company's standard work.
2. The competence dimension : CO
   In this dimension, all employees have exceeded the company's working satandar
3. The competence dimension : INT
   - sub-dimensions of A, all employees have exceeded the company's standard work.
   - sub-dimension of B, all employees must follow the training
4. The competence dimension : CSO
   - sub-dimensions of A, the employee with the standard criteria for superior work has exceeded the company, while employees with an average criterion training entirely except R2, R4 and R5. employees with the criteria for P3 which only poor training.
   - sub-dimensions of B, all the emlpoyees must follow the training except S1 dan S2.
5. The competence dimension : TW
   - sub-dimensions of A, the employee has exceeded the criteria for superior work standards, except for S1 which require training. Employees with an average criterion training entirely, except for R5 and R6. For employees with poor criterion that only P1 has exceeded the company's working standard
   - sub-dimension of B, all employees have exceeded the company's standard work, except for P1.
   - sub-dimensional C, employees with superior criterion has exceeded all standards of corporate work. While employees with an average criterion training entirely,

ISBN : 978-602-97809-0-1

except R4, R5 and R6. For employees with poor criteria must follow the training entirely.

TABEL 1.

KEY ACTIVITIES AND CRITICAL INCIDENT ON THE COMMUNICATION MANAGEMENT POSITION

Key Activities		Critical incident
Key Achievment	Details of Activity	
Planning, control and development of corporate communications systems	1) Designing and developing corporate communication systems 2) Developing mechanisms of corporate communications. 3) Controlling the system and the type of corporate communications 4) Evaluating the corporate communications system 5) Bridging requirement of corporate information	1) Fluency of corporate communications 2) Communications companies are able to support the company's performance 3) Availability of company's information that actual, effective and productive 4) Company's Information can be understood both in internal as well as in external proportionately
Planning, control and development of Marketing Public Relations	1) Planning of Marketing public relations activities 2) Developing and implement a public relations marketing program 3) Controlling the execution of public relations Marketing 4) Evaluating the performance of public relations Marketing 5) Bridging the requirement of other Division related to the public relations Marketing	1) The fluency and successful execution of marketing public relations 2) Marketing public relations can improve company's performance and product 3) accommodated of requirement of other parts of the public-relations-related Marketing 4) Productivity and effectiveness of public relations Marketing
Control and development of relationships with internal and external media	• Maintain good relationships with all internal and external media • Coordination and cooperation with internal and external media in order to operate the function always provide information that is positive for the company • Develop utilization of internal and external media as a means of delivering information to stakeholders	• Information about company and its development can be informed and understood by stakeholders • mutually beneficial cooperation with internal and external media • existence positive relationship between using of media and company performance

TABEL. 2

DETERMINING OF TRAINING NEEDS

Competency Dimention	ACH			CO	INT		CSO		TW		AT		CT			EXP				OC	INFO	RB		OA		FLX	
	A	B	C	A	A	B	A	B	A	B	C	A	B	A	B	A	B	C	D	A	A	A	B	A	B	A	B
Company's Standard of Competency	35	15	9	25	26	32	47	24	36	14	20	28	21	26	21	28	12	19	18	29	38	37	25	36	25	35	25
S1	+	+	+	+	+	-	+	+	-	+	+	+	-	+	-	-	+	+	+	+	-	-	+	-	-	-	-
S2	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	-
S3	-	+	+	+	+	-	+	-	+	+	+	+	+	+	-	-	+	-	+	+	-	-	+	-	+	-	-
S4	+	+	+	+	+	-	+	-	+	+	+	+	-	+	-	-	+	+	+	+	-	-	+	-	+	-	-
R1	-	+	+	+	+	-	-	-	-	+	-	-	-	+	-	-	+	-	+	+	-	-	-	-	+	-	-
R2	+	+	+	+	+	-	+	-	-	+	-	-	-	+	-	-	+	-	+	-	-	-	+	-	+	-	-
R3	-	+	+	+	+	-	-	-	-	+	-	-	-	+	-	-	+	-	+	-	-	-	+	-	-	-	-
R4	-	+	+	+	+	-	+	-	-	+	+	+	-	+	-	-	+	-	+	-	-	-	+	-	+	-	-
R5	-	-	+	+	+	-	+	-	+	+	+	-	-	-	-	-	+	+	-	+	-	-	+	-	+	-	-
R6	+	+	+	+	+	-	-	-	+	+	+	+	-	+	-	-	+	-	+	-	-	-	-	-	-	-	-
P1	-	-	+	+	+	-	+	-	+	-	-	-	-	-	-	-	+	+	+	-	-	-	+	-	+	-	-
P2	+	+	+	+	+	-	+	-	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
P3	-	+	+	+	+	-	-	-	-	+	-	-	-	-	-	-	+	-	+	-	-	-	+	-	-	-	-

+ : Respondents stated competency equal to or higher than the company's standards of competence

- : Respondents stated competency less than the company's standards of competence

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6. The competence dimension : AT
   - sub-dimensions of A, the employee with all of the criteria have been malampaui superior work standards of the company. While employees with an average of criteria, all must follow the training except R4 and R6. For employees with poor criteria must follow the training entirely.
   - sub-dimension of B, all employees must follow the training, except for S2 and S3.
7. The competence dimension : CT
   - sub-dimensions of A, all employees have exceeded the company's standard work, except for R5 and all employees with poor criteria.
   - sub-dimension of B, all employees must follow the training, except for S2
8. The competence dimension : EXP
   - sub-dimensions of A, all employees must follow the training.
   - sub-dimension of B, all employees have exceeded the company's standard work.
   - sub-dimensional C, employees with superior criterion has exceeded the company's working standards, except for S3. While employees with an average of all criteria must follow the training, except for R5. For employees with poor criteria P1 only course that has exceeded the company's working standard.
   - sub-dimension D, all employees have exceeded the company's working satandar, except R5 and P2
9. The competence dimension : OC
   In this dimension, the criteria for employees with superior have all been over company's work standards. While employees with an average of all criteria must follow the training, except for R1 and R5. For employees with poor criteria must follow the training entirelyUntuk dimensi kompetensi OC
10. The dimensions of competence : INFO
    In this dimension, all employees must follow the training, except for.
11. The dimension of competence : RB
    - sub-dimensions of A, all employees must follow the training, except for S2.
    - sub-dimension of B, the employee with all of the criteria have been malampaui superior work standards of the company. While employees with an average criterion has exceeded the company's working standards, except for R1 and R6. For employees with poor criterion P2 only have to follow the training course.
12. The competence dimension : OA
    - sub-dimensions of A, all employees must follow the training, except for S2.
    - sub-dimension of B, employees with superior criterion has exceeded all standards of corporate work, except S1. While the criteria for employees with average has exceeded all standards of corporate work, except R3 and R6. For employees with poor criteria P1 only course that has exceeded the company's working standard.
13. The competence dimension : FLX
    - sub-dimensions of A, all employees must follow the training, except for S2.
    - sub-dimension of B, all employees must mengikiti tututan training because they do not meet standards of corporate work.

V. CONCLUSIONS

Overall the employee's level competence of Communication Division at PT. Jasa Marga (Persero) is assessed are lacking. It is requiered to develop competence by providing formal training programs. In accordance with this research, the recommended materials for training are materials that can develop behavioral, mental and psychological, that is how to use part of his personality and can influence behavior when employees in a special situation or when working, and at the end ultimately affect the ability to generate performance. Recommended material for training provided in accordance with the priorities of negative gap occurs on the employees. Program development and training which will be used, should be adjusted to the condition of the company, on financially, human resources, and other readiness.

Planned training curriculum are grouped into two broad outline is as follows:

b. *Personal Development Training*
   - *Achievement Orientation*, ACH
   - *Concern for Order, Quality and Accurancy*, CO
   - *Analytical Thinking*, AT
   - *Conseptual Thinking*, CT
   - *Expertise*, EXP
   - *Initiative*, INT
   - *Customer Service Orientation, CSO*

c. *Team Building Training*
   - *Information Seeking*, *INF*
   - *Organizational Comitment*, OC
   - *Team Work Cooperation*, TW
   - *Organizational Awareness,* OA
   - *Relationship Building,* RB
   - *Flexibility,* FLX

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

The Relationship among Organizational Factors, Knowledge Sharing and Work Performance

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Abstract — **Knowledge has become the most important source of competitive advantage. Individual's work performance can be done because of the knowledge sharing among employees in the company. This article examines the impact of organization factors (organization structure, employee training, top management support, organizational reward, organizational culture), knowledge sharing (donating knowledge and collecting knowledge capability) on individual work performance.**

Keywords — **organizational factors, knowledge sharing, work performance**

I. INTRODUCTION

A. *Background*

The recent interest in organizational knowledge has prompted the issue of managing the knowledge to the organization's benefit. Knowledge management refers to identifying and leveraging the collective knowledge in an organization to help the organization compete (von Krogh 1998).

Knowledge is a very important resource for preserving valuable heritage, learning new techniques, solving problems, creating core competences, and initiating new situations (Liao et al. 2007). The success of organizations to maintain and improve their competitive advantage depend on their speed in catching opportunities, reading the situations, planning the implementation strategies, and managing the process in the most effective and efficient way. This condition demands the employees to think faster, more responsive, well possessed, and have relevant abilities to increase the organizational learning capabilities in order to achieve innovation.

Knowledge sharing has emerged as a core process of knowledge management. Individual members of an organization, whose job experience and existing knowledge are diverse, create new knowledge by communicating and sharing important information and accumulated knowledge. However, knowledge sharing is more than just sharing, but synergistic. Individual information and knowledge, which tends to be dissimilar and fragmented, has become a more effective source of information for organizational performance as they are shared among members of an organization. By sharing information and knowledge, individual employees can learn from others' know-how and work experience. This is not only a cost-effective learning strategy but can also validate individual employees' accumulated knowledge (King, Kang, and Chang, 2008).

Ipe (2003) stated that an organization's ability to effectively leverage its knowledge is highly dependent on its people, who actually create, share, and use the knowledge. Leveraging knowledge is only possible when people can share the knowledge they have and build on the knowledge of others. Knowledge sharing is basically the act of making knowledge available to others within the organization. Knowledge sharing between individuals is the process by which knowledge held by an individual is converted into a form that can be understood, absorbed, and used by other individuals.

Previous researches claim that knowledge has a relationship with absorptive capacity. The company's absorptive capacity has a significant influence on the ability to innovate. For example, the research in conceptual level conducted by Zahra and George (2002) investigates the relationship among knowledge sources, absorptive capacity, and competitive advantage.

Lin (2007) developed a research model that provides links between knowledge sharing enablers, processes, and firm innovation capability. The study examines the influence of individual factors (enjoyment in helping others and knowledge self-efficacy), organizational factors (top management support and organizational rewards) and technology factors (information and communication technology use) on knowledge sharing processes and whether leads to superior firm innovation capability.

King, Kang and Chang (2008) has conducted research to analyze the relationships between organizational dimension, individual dimension, characteristic knowledge, knowledge sharing and individual work performance. According to Kwun (1996), King, Kang and Chang (2008) stated that research must be done on what prevents organizational members from sharing organizational knowledge. For example, people are reluctant to share their knowledge as they may feel that others might steal their ideas and rewards. There has been a great deal of research to explain what makes knowledge sharing successful, but little progress has been made concerning the impact of knowledge sharing on individual work performance. This study want to do a specific exploration of organizational factors which have more detail dimensions, such as knowledge sharing include donating knowledge and collecting knowledge.

B. *Research Objective*

The purpose of this paper is to explore the above issues related to organizational factors (organization structure, employee training, top management support, organizational reward, organizational culture; knowledge sharing (donating knowledge and collecting knowledge) and work performance.

II. LITERATURE REVIEW

A. *Definition of Knowledge*

Knowledge is the whole understanding and skill which are used by individual to solve problems. This includes theory, practice, rule, and instruction. Knowledge is based on data and information, but unlike data and information, knowledge is embedded to human. Knowledge is built by individual, and is representation of individual's belief about cause and effect relationship (Probst, Raub, dan Romhardt, 2000).

Nonaka, Toyama, and Konno (2000) described knowledge as something dynamic, since it is created through social interactions among individuals and organizations. Knowledge is context specific, as it depends on a particular time and space (Alwis, Hartmann, and Gemünden, 2004). According to Davenport, de Long and Beers (1998), knowledge which is new to an organization has to either be invented internally, or acquired from external sources (Alwis, Hartmann, and Gemünden, 2004).

Davenport and Prusak (1998) defined knowledge as a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms (Perez and Mitra, 2007).

B. *Knowledge Sharing*

Bartol and Srivastava (2002) defined knowledge sharing (KS) as the action in which employees diffuse relevant information to others across the organization. Szulanski (1996) defined knowledge sharing as the exchange or transfer process of facts, opinions, ideas, theories, principles and models within and between organizations including trial and error, feedback and mutual adjustment of both the sender and receiver of knowledge. Hooff and Weenen (2004) stated that knowledge sharing is a concept defined as process where individuals exchange their intellectual capital and collectively create new knowledge. This definition implies that knowledge sharing behavior consists of bringing (donating knowledge) and getting (collecting knowledge).

III. RESEARCH FRAMEWORK AND HYPOTHESES

In Figure 1 can be seen conceptual model of assessment that will be undertaken.

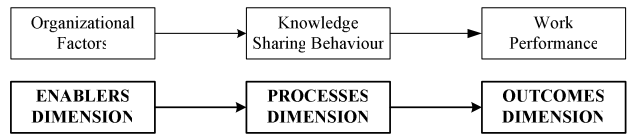

Fig 1. Conceptual Model

A. *Organizational factors as determinants of knowledge-sharing processes*

Flexible organizational structure advances knowledge sharing by encouraging horizontal communication (Chkravarthy et al., 1999). Employee training helps members of organizations realize the importance of sharing their knowledge in learning processes through which employees are involved in a multi-faceted set of learning activities (O' Dell and Grayson, 1996).

The following hypothesis is therefore formulated:

1) Hypothesis 1: The flexible organizational structure positively influences employee willingness to both (a) donate and (b) collect knowledge

2) Hypothesis 2: Employee training positively influences employee willingness to both (a) donate and (b) collect knowledge

Top management support is considered one of the important potential influences on organizational knowledge (Connelly and Kelloway, 2003). Numerous studies have found top management support essential to creating a supportive climate and providing sufficient resources (Lin, 2006). MacNeil (2004) emphasized the importance of the visible top management's support to organizational knowledge sharing climate. Moreover, Lin and Lee (2004) proposed that the perception of top management encouragement of knowledge sharing intentions is necessary for creating and maintaining a positive knowledge sharing culture in an organization. Consequently, this study expects that top management support positively influences employee willingness to share knowledge with colleagues – both in terms of donating and collecting. The following hypothesis is therefore formulated:

3) Hypothesis 3: Top management support positively influences employee willingness to both (a) donate and (b) collect knowledge.

ISBN : 978-602-97809-0-1

Organizational rewards indicate what the organization values shape employee behaviors (Cabrera and Bonache, 1999). Organizational rewards can range from monetary incentives such as increased salary and bonuses to non-monetary awards

such as promotions and job security (Davenport and Prusak, 1998; Hargadon, 1998). Several organizations have introduced reward systems to encourage employees to share their knowledge. For example, Buckman Laboratories recognizes its 100 top knowledge contributors through an annual conference at a resort. Moreover, Lotus Development, a division of IBM, bases 25 per cent of the total performance evaluation of its customer support workers on the extent of their knowledge sharing activities (Bartol and Srivastava, 2002). This study thus expects that if employees believe they

can receive organizational rewards by offering their knowledge, they would develop greater positive willingness to both donate and receive knowledge. The following hypothesis is proposed:

4) Hypothesis 4: Organizational rewards positively influence employee willingness to both (a) donate and (b) collect knowledge.

Three components of organizational culture that are related to effective knowledge sharing are clear organizational vision and goals (Gold, Malhotra, and Segars, 2001).

Kim and Lee (2006) analyzed these three cultural components to establish the degree to which they influence effective knowledge sharing. According to Kanter, Stein, and Jock (1992), organizational vision leads to the generation of a clear organizational purpose that assists in goal achievement. Others have suggested that clear organizational vision and goals engender a sense of involvement and contribution among employees (Davenport, Jarvenpaa, and Beers 1996; O' Dell and Grayson 1998).

Von Krogh (1998) argues that trust and openness in organizational culture promote active knowledge sharing among employees and that trustworthy behavior enhances communication speed by empowering coworkers to freely share personal knowledge and concerns. Nonaka (1990) observes that loyal and trusting relationships eliminate deception, cheating, and the tendency among employees to blame others for organizational failures. According to Cohen and Prusak (2001) , high levels of employee trust can lead to better knowledge sharing, shared goals, and lower transaction costs. Andrews and Delahaye (2000) also found that in the absence of trust, formal knowledge-sharing practices were insufficient to encourage individuals to share knowledge with others in the same work environment.

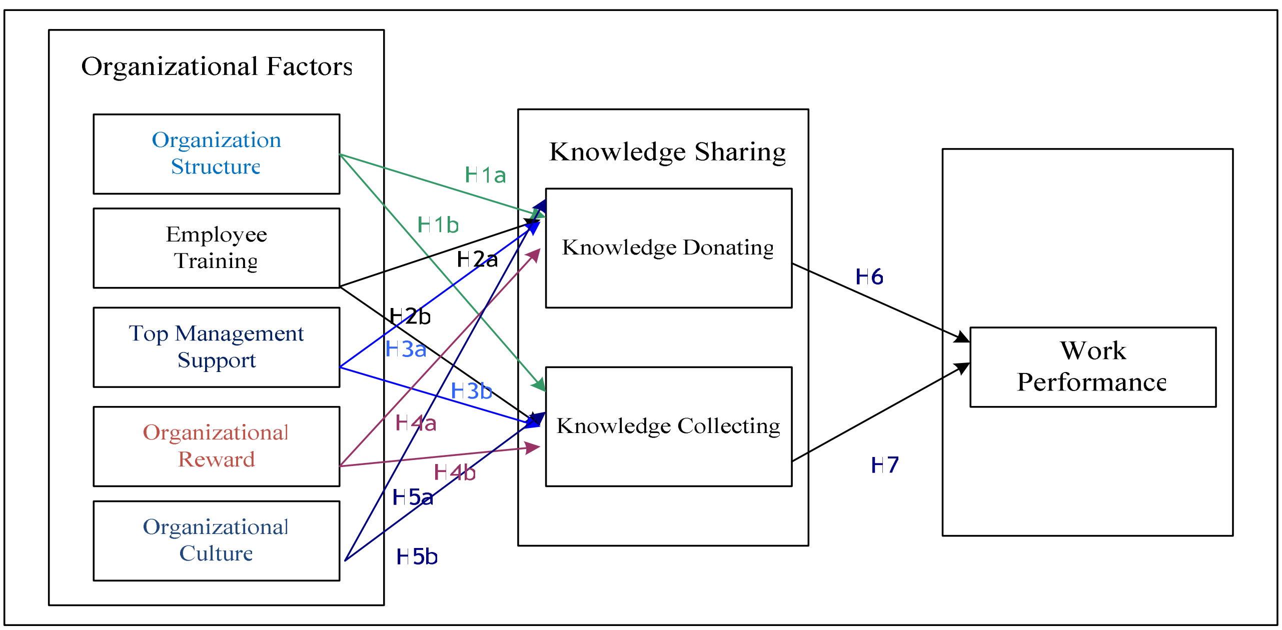

Fig 2. Research Model

Another aspect of organizational culture that influences employee knowledge sharing is social networks or informal networks within the community. Modes of sharing within networks include communication, dialogue, and individual or group interactions that support and encourage knowledge-related employee activities (Leonard and Sensiper 1998; Levinthal and March 1993). Both formal and informal relationships and contacts between employees are considered important for sharing perspectives and knowledge within organizations (O ' Dell and Grayson 1998). Although formal relationships or interactions, including training programs and structured work teams, play an important role in facilitating employee knowledge sharing, Truran (1998) found that the greatest amount of knowledge is shared in informal interactions. A study conducted by Stevenson and Gilly (1991) also found that even when clearly designated channels of communication exist in organizations, individuals tend to rely more on informal relationships for communication. In addition, Constant, Sproull, and Kiesler (1996) discuss the emerging role of practice communities (voluntary employee forums built around specific topics of interest) as knowledge-sharing networks. Social networks built into communities of practice may facilitate communication among employees, which, in turn, influences their knowledge-sharing capabilities. The following hypotheses address the impact of organizational vision and goals, trust, and social networks on employee knowledge-sharing capabilities:

5) Hypothesis 5: Organizational culture positively influence employee willingness to both (a) donate and (b) collect knowledge.

Gueutal, Surprenant, and Bubeck (1984) contended that successful knowledge sharing, using information systems, not only reduced time for a set of work processes but also improved the level of employee confidence in performing their work. Errors at work would also be reduced through consistent and repeated knowledge sharing, which eventually

improved overall efficiency and effectiveness of individual work performance. The following hypothesis is proposed:

6) Hypothesis 6: knowledge donating capability sharing positively influence to the better their work performance.

7) Hypothesis 7: knowledge donating capability sharing positively influence to the better their work performance.

Operational research variable constitutes a process of translating or defining a concept in order to make it measurable. This process is carried out by observing the behavior aspects or the characteristics shown by the concept. It is later on translated into an element which is observable and measurable. Sekaran (2003) gives a description of the relationship among concept as the abstraction of a phenomenon, dimension as the characteristics or attributes that will be measured, and the element which is the translation of dimension so that it can be observed and measured.

There are three concepts which were translated into measurable elements: organizational factors, knowledge sharing and work performance. The definition of each concept and its' variables along with the questionnaires used to measure them can be found in the following paragraphs.

The first concept is organizational factors related parties in knowledge structure and employee training refers to the concept of Kang, King, and Chang (2008), Top management support and organizational reward refers to the concept of Lin (2007), while referring to the concept of organizational culture from Kim and Lee (2006).

The second concept is in this research is knowledge sharing. This study employs the concepts of Hooff and Weenen (2004), who use knowledge donating and knowledge collecting to measure the degree of knowledge sharing between employees in a company. However, different from Hooff and Weenen (2004) that uses the term intellectual capital; this research uses the term knowledge which is divided into tacit knowledge, which consists of working experience, ideas, and expertise, and explicit knowledge, which comprises contextual information. Operationally, knowledge donating is defined as the employees' ability in giving their knowledge which includes working experience, ideas, skill, and contextual information to other employees. Knowledge collecting is the employees' ability to obtain knowledge from or to consult to other employees, in order that they are willing to share their knowledge which includes working experience, ideas, and contextual information to other employees. Some of the original questions from the original measurements from Hooff and Weenen (2004) were modified.

The third concept is measuring work performance focuses on the positive change in individual work performance gained by knowledge sharing. Four items from Igbaria and Tan[43] and Gueutal, Surprenant, and Bubeck (1984) were used to measure the perceived change in work performance

IV. CONCLUSIONS

The change towards a knowledge-based competition becomes a challenge for companies or organizations that have a competitive advantage. Awareness of the importance of managing intangible assets inherent in every individual employee should be managed in order to become organizations knowledge. It begins from the role factors in an organization that can support the behavior of employees to donating knowledge and collecting knowledge which can contribute to work performance. The conceptual model was formulated based on literature review and used as a basis, to validate require empirical testing as further research.

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Appendix: the questionnaire questions

Organizational structure

1. There is a good system of delegation of power in my department vertically and horizontally.
2. There is a standard operating procedure in handling work tasks in my department.
3. A host of work rules spell out ways to handle work tasks in my department.
4. My department secures employee participation in decision-making process.

Employee training

1. My work unit highly supports employee training for personal development.
2. My work unit has good employee training programs by which new knowledge can be successfully disseminated.
3. My work unit highly encourages employees to take educational programs in order to obtain new knowledge.

Top management support

1. Top managers think that encouraging knowledge sharing with colleagues is beneficial
2. Top managers always support and encourage employees to share their knowledge with colleagues
3. Top managers provide most of the necessary help and resources to enable employees to share knowledge
4. Top managers are keen to see that the employees are happy to share their knowledge with colleagues

Organizational rewards

1. Sharing my knowledge with colleagues should be rewarded with a higher salary
2. Sharing my knowledge with colleagues should be rewarded with a higher bonus
3. Sharing my knowledge with colleagues should be rewarded with a promotion
4. Sharing my knowledge with colleagues should be rewarded with an increased job security

Organizational culture

Vision and Goals

1. My organization has an organizational vision.
2. Top management leaders present a clear organizational vision and communicate it to employees.
3. Overall, organizational vision and goals are clearly stated in this agency.
3. I always teach what I know to other employees outside my department when they were asked
4. I always share work-related information with other employees outside my department when they were asked

Work performance

1. Knowledge sharing helps me reduce errors at work.
2. Knowledge sharing helps me enrich my work.

4. I understand my organization' s goals.
5. I can explain my organization' s vision and goals to others.

Trust

1. I have full confidence in the skills of my coworkers.
2. I trust the expertise of my coworkers.
3. If I face difficulties at work, I know my coworkers will try to help me out.
4. My coworkers do not try to deceive me for their own profit.

Social Networks

1. I communicate with other employees through informal meetings within the organization.
2. I interact and communicate with other people or groups outside the organization.
3. I actively participate in communities of practice.

Knowledge sharing

1. I always share my working experiences with other employees within my department
2. I always share ideas or suggestion with other employees within my department
3. I always teach what I know to other employees within my department
4. I always share work-related information with other employees within my department
5. I always share my working experience with other employees outside my department
6. I always share new ideas with other employees outside my department
7. I always teach what I know to other employees outside my department
8. I always share work-related information with other employees outside my department

Knowledge collecting

1. I always share my working experiences with other employees within their department when they were asked
2. I always share my ideas with other employees within my department when they were asked
3. I always teach what I know to other employees within my department when they were asked
4. I always share work-related information with other employees within my department when they were asked
5. I always share my working experiences with other employees outside my department when they were asked
6. I always share my ideas with other employees outside my department when they were asked
3. Knowledge sharing helps me improve my work performance.

ISBN : 978-602-97809-0-1

Conceptual Model for Developing Creativity in Batik Industry

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Abstract - **The purpose of this research is to develop a conceptual model of creativity in batik industry. This model was developed by conducting a study from previous research that discuss important factors for the development of creativity. This conceptual model was built based on four variable, namely creative person, intrinsic motivation, job skills training, and creative organizational climate. Creative person will stimulate the creativity development in batik industry. A creative person are more able to improve their creativity if they have intrinsic motivation, given some training that related with the job skills they needed, and supported by organization that have positive climate (climate in organization that respects creativity, provide opportunities, time, facilities, infrastructure and incentives to employees to think about, designing, researching and developing new products that better and more innovative). For the further research, this study can be continued by testing the model empirically through distributing the questionnaire to some partisipan of SMEs and processing data from the results of questionnaire distribution using the data processing software, like SPSS, LISRELL, etc.**

***Keywords* - Creativity, creative person, intrinsic motivation, training, creative organizational climate.**

I. INTRODUCTION

Creative industries are the main pillars in developing creative economic sector that provides a positive impact on national income. The role of creative industries in economy of Indonesia quite significant, with the contribution to gross domestic product (GDP) on average 6.3% in 2002-2006 (equal to 152.5 trillion rupiah) and can absorb the 5,4 million of workforce. From the export side, the average total exports of creative economy during the years 2002-2006 amounted to 10.6% [4]. Creative industries contributed in some areas of life, not just viewed from an economic, but also can provide positive impact to other aspects such as improving the image and national identity, innovation and creativity of children of the nation, resource utilization infinite (idea, talents, and creativity), and social impacts [4,5].

One type of creative industries is the batik industry. Like the other industries that are included in the creative industries, batik industry faces a number of problems that related to the quality of human resources, business climate, reward/ appreciation that given to the creative person and creative work produced, use of information of technology and communications, and funding support from the banking institutions. Among these problems, the most dominant problem is quality of human resources or human resource skill[20]. Human resources are the most important factor in the creative industries because the creative industries derived from the utilization of creativity, skill and individual talent[1].

II. LITERATURE REVIEW

A. Batik Industry as a Creative Industry

Creative industries are industry derived from the underutilization of creativity, skills and individual talents of individual to make create wealth and generate employment by producing and exploiting individual creativity. In the creative industries, creativity has a central role as the primary resource. Creative industries require more creative resources that derived from the idea or inspiration of human thought than physical resources. However, the physical resources remain necessary, especially on its role as a creative medium [16].

Indonesia arranges creative industries into 14 industrial groups, i.e.: architecture, design, fashion, film, video and photography, crafts, computer service and software, music, market and art goods, publishing and printing, advertising, interactive games, research & development, performing arts, television and radio. Craft is a creative that related in creation, production and product distribution that created and produced by a crafts person which begins with designing to product settlement process, includes some of goods that made of: gemstone, natural fiber, leather, rattan, bamboo, wood, metal (gold, silver, copper, bronze, iron) glass, porcelain, fabric, marble, clay, and chalk. Batik industry is classified to subsector handicraft in creative industry. The same classification is also expressed by KBLI (*Klasifikasi Baku Lapangan Usaha Indonesia*) [2].

B. Creativity

Creativity is the ability to generate innovative ideas and manifest them from thought into reality. The process involves original thinking and then producing. The process of creation was historically reserved for deities creating "from nothing" in

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creationist and other creation myths. Over time, the term creativity came to include human innovation, especially in art and science and led to the emergence of the creative class[23].

Creativity is construed differently by various of theorists. Sternberg and Lubart in 1999 present that "*Creativity is the ability to produce work that is both novel (i.e. original, unexpected) and appropriate (i.e. useful concerning tasks constrains)*". Runco in 2007 present several authors that define creativity as involving the creation of something new and useful (Bailin in 1988, Bean in 1992, Solomon, Powell and Gardner in 1999, Mumford in 2003, Andreasen in 2005 and Flaherty in 2005)[15]. Their point of view considers creative functioning as the manifestation of fluctuations in unstable, self-organizing local systems that reorganize into patterns of higher order thinking and coherence.Some theories and definition about creativity[22]. Guilford in 1950 found that creativity refers to the abilities that are characteristics of creative people[18]. Hulbeck in 1945 define "*Creative action is an imposing of one's own whole personality on the environment in an unique and characteristic way*" [18].

Creative refers to novel products of value, the person who produces the work, both to the capacity of produce such works and to the activity of generating such products. All who study creativity agrees that for something to be creative, it is not enough for it to be novel: it must have valued, or be appropriate to the cognitive demands of the situation[22]. Creativity is the tendency to generate or recognize ideas, alternatives, or possibilities that may be useful in solving problems, communicating with others, and entertaining ourselves and others [14].

C. Managing Creativity

As with other concepts in psychology and education, creativity is defined in many ways. Logically, any human activity may be looked at from four angles: the person who performs it, the thing which is done, the process of activity itself and the conditions which effect the above three divisions. According to Taylor in 1964 and Torrance in 1977, creative activity could be defined under the following headings[18]: creative person, creative product, creative process, and environmental influences.

In the late 1950s[3], researcher Mel Rhodes set out to find a single, all-inclusive definition of "creativity" (Rhodes in 1961). Instead he found a variety of definitions which "*overlap and intertwine*", on farther examination of these definitions, he found they comprised four general strands. He labeled these areas the "four P's": person, process, product, and press, as shown in Fig. 1.

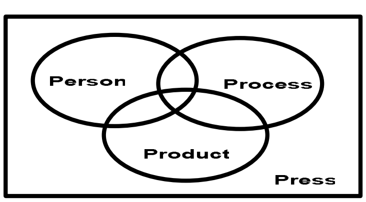

Figure 1. Venn Diagram of Rhodes' Four P's of Creativity[3]

The creative product is a production of the creative process, which is affected by creative abilities and other characteristics of a person. Similarly, the creative product is affected by environmental conditions, which also effect people and creative processes.

Creative Person: The study of the creative persons have investigated the characteristics and have presented many general forms of creative personality. According to Taylor in 1964, the common assumption is that all persons have some creative potential. This means an existence of individual differences in degree[3]. On this basis, Lowenfeld in 1960 distinguished between actual creativity and potential creativity. The first is that potential which is already developed and functioning, whereas the latter includes the total creative potential, both developed and undeveloped, within an individual. Taylor belief that all persons have some degree of potential to be creative in one or more ways[22].

Creative Product: The second element of creativity is the creative product. Defining a product what is or is not a creative product is a difficult matter, because creative products of undisputed uniqueness and distinction are few. In addition, they often appear accidentally like discoveries or inventions, so that the environment may appear more responsible for them than the individual[22]. Creativity as a product is the contribution of original ideas, a different point of view, or a new way of looking at problems[3]. Rogers in 1982 suggested criteria for creative products are[18]:

1. The creative product should be original, new or unprecedented somewhat.
2. The product should be adopted to and adequate for the actual situation.
3. It should be distinguished by a certain charm. The creative product does merely present the solution to a problem, but should have a quality of beauty and create a sense of elation and satisfaction.
4. It should be possible to assess, search for and confirm the creative product.

Creative Process: The third element of creativity, the creative process, focused on the steps, methods, and techniques which people use when applying their creativity[3]. Creative process also defined as the nature, abilities, levels, and stages of creativity. According to Vernon in 1964[22], Galton is considered the first researcher to examine the subject in his empirical study of heredity and genius. He found a wide variation, some individuals had extremely vivid pictures while others could not picture anything. Torrance in 1963 defining the creative process as "*The process of (1) sensing difficulties, problems, gaps in information, missing elements, something asked; (2) making guesses and formulating hypotheses about these deficiencies; (3) evaluating and testing these guesses and hypotheses; (4) possibly revising and retesting them; and finally (5) communicating the results.*" Torrance in 1963[22] considered problem solving as a somewhat creative thinking to the extent that one or more of the following conditions are met:

1. When thinking production is new and valuable.
2. When thinking requires change or rejection of previously accepted ideas.
3. When thinking happens accidently.
4. When thinking requires intensive stimulation, deep and persistence, and continues for a long time, weather it is sustained or broken.
5. When the problem is obscure and unlimited such that formulation of the problem itself becomes a part of the task.

Environmental (Press) Influences: The fourth element of creativity mentioned earlier is the matter of environmental influences. Creativity does not occur in a vacuum. On this basis, when creativity is viewed as a result of the interaction of environmental conditions and individual capacities, it may then be considered as a successful step into the unknown, getting off the main track, breaking out of a mold or rut, being open to experience and permitting one thing to lead to another recombining ideas or seeing new relationships among ideas. (Torrance and Goff in 1989)[22]. Torrance believes that the way creative abilities develop and function is strongly influenced by the manner in which the environment responds to a person's creative needs. In other words, the development of creativity may be related to continuities and discontinuities in the particular culture (Torrance in 1962)[18]. The extent to which creativity is encouraged, and the subsequent variety of creative products that are developed depends on the extent to which culture permits the development of both freedom within the individual and freedom among the individual and his or her environment, and on the extent to which the culture encourages diversity and tolerates the seeming ambiguity that such diversity suggests [22].

D. Intrinsic motivation

Motivation is the impulse that arises in a person consciously or unconsciously, to perform an action with a particular purpose, or those businesses which can cause a particular person or group of people moving to do something because they want to achieve desired goals or get satisfaction for his actions[19]. Ranupandoyo in 1980 states that the motivation is to try the process, influence a person to the person carrying out something that we want. Handoko in 1990 states that motivation is a state in the person of someone who encourages individuals desire to engage in certain activities to achieve goals. Sardiman in 1992 states that motivation is the effort that encourages someone to carry something or motive power of the subjects to do certain things or activities, to achieve the goal. Mulyadi in 1988 defines motivation as the will or impulse to do something to meet the needs or could be interpreted as a process that causes a person's behavior become passionate, focused and not easily discouraged[7] . From the various definition we can conclude that motivation is a psychological condition that drives someone to implement something, so that something can be expected to achieve organizational goals and objectives of individual employees concerned. Motivation that existed at someone would create a behavior that is directed at achieving goals satisfaction.

Motivation contains several elements according to Sardiman's research in 1992 [7]:

1. Motivation that started the change of energy on each individual and will be clearly visible to the human physical activities.
2. Motivation is marked by the emergence of a sense of someone. Here the motivation is relevant to psychological and emotional issues that can determines a person's behavior.
3. Motivation will be stimulated because of the particular purpose. Here the motivation is a response of an action, such as the objectives concerning the matter needs.

There are two types of motivation according to Sardiman (1992)[7]:

a. Extrinsic motivation, comes from external factors, for example threats of being fired or money as a reward.
b. Intrinsic motivation, comes from inside an individual, satisfaction, enjoyment of work etc.

E. Training

The term training refers to the acquisition of knowledge, skills, and competencies as a result of the teaching of vocational or practical skills and knowledge that relate to specific useful competencies. In addition to the basic training required for a trade, occupation or profession, observers of the labor-market recognize today the need to continue training beyond initial qualifications: to maintain, upgrade and update skills throughout working life. People within many professions and occupations may refer to this sort of training as professional development[24].

Definition of training is construed differently by various of theorists according to some authors[11]: Nitisemito in 1994 indicate that "*Training is an activity of the companies that intend to improve and develop the attitudes, behavior, skill and knowledge of the employees in accordance with the wishes of the respective companies*." Belong to Simamora in 1997 "*Training is a systematic process of changing the behavior of the employees in a direction to enhance organizational goals*." Another definition of training according to Armstrong in 1991 "*Training is a planned process to modify attitude, knowledge or skill behavior through learning experience to achieve effective performance in an activity or of activities*."

Simamora in 1997[11] classifies the purposes of training as:

1. Improve performance.
2. Updating the skills of its employees in line with technological advances.
3. Reduce the learning time for new employees to become competent in the job.
4. Help solve operational problems.
5. Preparing employees for promotion.
6. Orient employees to the organization.
7. Meet the needs of personnel growth.

F. Creative Organizational Climate

Creative climate is a meaningful concept. It has important implications for understanding human behavior in organizations. Ekvall in 1983[17] suggested that climate effects how organizational members communicate, solve problems, make decisions, handle conflicts, learn and motivate, and thus, can be noted by the efficiency and productivity of the organization. He noted that climate has an influence on job satisfaction and organization member's ability to innovate. Brtiz in 1995 defined creative climate as: "*…a conglomerate of attitudes, feelings and behaviors within an organization that allow, encourage and foster the creation of change…by producing and carrying out new or novel ideas by its members*"[10].

III. METHODOLOGY RESEARCH

Our research includes the steps that conducted a study from beginning to end. Research methods in this study begins from define problem, literature review, develop conceptual model and identification variable, as shown in Fig. 2.

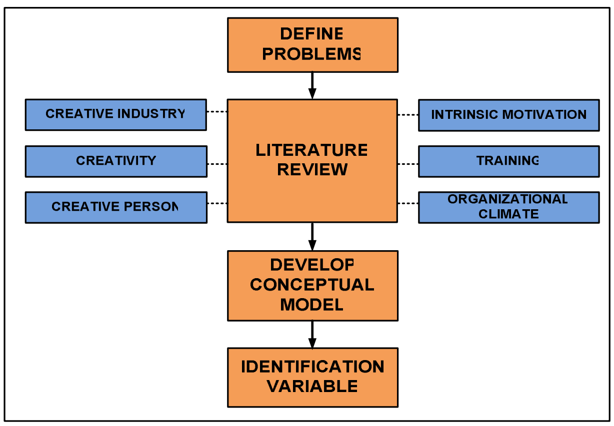

Figure 2. Methodology research

Defining problems are needed to determine the actual conditions in the field. In this preliminary study researchers will collect data from previous research about the development of creativity in batik industry. Formulation of the problem in this research are:

1. What factors that effect the improvement of industrial creativity in batik?
2. How the influence of these factors to the increasing creativity in batik industry?

Based on the formulation of the problems mentioned above, the purpose of this study are:

1. Knowing the factors that effect the improvement of creativity in the batik industry.
2. Analyzing the influence of these factors to the increasing creativity in batik industry.
3. Provide suggestions / recommendations for improving the competitiveness of the batik industry.

Literature study carried out to find the factors that influence the development of creativity in batik industry, which will be used to develop a conceptual model and identification variables.

IV. CONCEPTUAL MODEL

Conceptual model of creativity in batik industry developed by conducting a study from previous research that discuss important factors for the development of creativity, like study that conducted by Amalia in 2008, Darsono in 2007, Kurniati in 2005, Rani in 2007, and Susanty in 2009.

Research that conduct by Amalia in the year 2008 is associated with the development of creativity in the batik industry. This study aims to examine the factors that influence the development of creative human resources, creative work, creative organization, creativity in using resources that comes from the environment, and product innovation on small-scale batik industry, medium and large. One of the important results of this research is creative human resources or creative persons is one of the important factors that influence the development of creativity in batik industry [1]. **Hypothesis 1: creative person have positively influence on the development of creativity in batik industry.**

Darsono in the year 2007[12] trying to find out the relationship between intrinsic motivation and creativity in his research. Someone may have the knowledge, skills, and thinking style, but without motivation, he will not be a creative person. Someone who has a high intrinsic motivation will be working hard to complete the job well. This positive attitude is caused by the desire to achieve satisfaction (self-satisfaction) or the desire to actualize himself. When there are obstacles in their efforts to complete the job, he will try to find solutions for problems (problem-solving). In the process of seeking the problem-solving, individuals often see the problem with different viewpoints. It means that high intrinsic motivation make individuals more creative. **Hypothesis 2: intrinsic motivation have positive impact on creativity development of creative person in the batik industry**

Research of Kurniati in the year 2005[13] is an experimental study that aimed to test the relationship between training with increased the creativity relevan skills. From this research, Kurniati can conclude that training have significant impact on creativity development of the workers. **Hypothesis 3: job skills training have positive impact on creativity development of creative person in batik industry**

Research that conduct by Rani in the year 2007[6] aims to test the relationship between organizational climate and creativity of the workers in the design section on PT Danar Hadi Batik Surakarta. Results of data analysis showed that are a positive relationship between opportunities to be creative and organizational climate. Opportunities of a worker being a creative worker will be greater if the workers were engaged in an organization that has a climate that respects creativity, provide opportunities, time, facilities, infrastructure and incentives to employees to think about, designing, researching and developing new products that better and more innovative. **Hypothesis 4: creative organizational climate have positive impact on the creativity development of the creative person in the batik industry.**

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Graphically, the four hypotheses above can be illustrated in the following conceptual model.

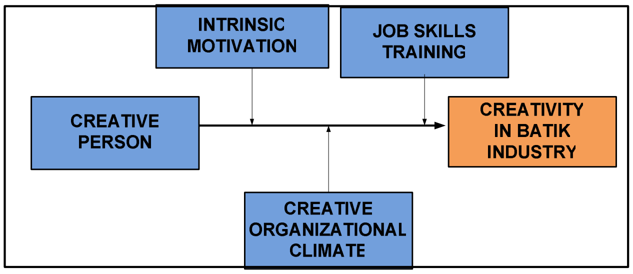

Figure 3. Conceptual model for creativity in batik industry

V. IDENTIFICATION VARIABLE

In detail, the dimensions of latent variables used in this study can be described as follows.

1. Creative person
   Characteristics personnel of creative person can be known through the habit of making it appears as specific characters. According to Guilford[8], a creative person will have some characteristics below.
   a. Have a great curiosity
      Great curiosity characterized by a huge encouragement to know more, ask many questions, always pay attention to other people, objects and situations, and sensitive observation and want to know and investigate.
   b. Imaginative
      Imaginative person characterized by ability to perform or imagine things that do not or have never occurred, but often use fantasy to know the difference between fantasy and reality.
   c. Depending on the plurality
      Someone who depends on the pluralistic society characterized by the encouragement to overcome a difficult, felt challenged by the situations are so complicated and more interested in the difficult tasks.
   d. Risk taking
      Dare to take risks characterized by courage to answer, not afraid to fail or get a critique, and not be in doubt because of lack of clarity the things that are not conventional, or a less structured.
   e. Respect
      Feel respect characterized by attitude can appreciates the guidance and meaning in life, and appreciate the abilities and talents of others.
   f. Independent
      Independent characterized by behavioral capable of initiative, able to overcome obstacles / problems, have the confidence and can do something by themselves without help from others.
   g. Adaptability
      Adaptability characterized by ability someone in adopting to the environment and co-worker.
2. Intrinsic motivation
   Amabile[16] argued that three components were needed to to enhance creativity in business, i.e: expertise (technical, procedural and intellectual knowledge), creative thinking skills (how flexibly and imaginatively people approach problems), and motivation (especially intrinsic motivation). According to Herzberg[18], intrinsic motivations consist of some dimensions as below.
   a. Enthusiasm/interest.
      Enthusiasm/interest characterized by a tendency of a person in finding out and studying a particular case.
   b. Feel challenged to work.
      Feel challenged to work is the feelings that needed to develop themselves and to realize their capabilities and potential in real forms.
3. Job skills training
   The good job skills training should created an environment where employees can acquire or learn the attitudes, abilities, skills, knowledge and behaviors which have related to specific jobs, so it can encourage them to be do a better job. According to the study that conduct by Martiningsih in the year 2007[9], there are some important dimensional of job skills training.
   a. Target of training
      Training should have a clear purpose and target.
   b. Material of training
      Material of training should be prepared based on a predetermined training objectives.
   c. Instructor of training
      Instructor of training should be able to teach about training materials with a particular method so that participant will acquire knowledge and have skills appropriate to the specified target.
   d. Frequency of training
      Includes of frequency of implementation of training and the intensity of the training organized by the government.
   e. Participation of trainees
      Participation of the trainee can enhance the transfer of knowledge between transfer agent and transfer recepient.
   f. Feedback.
      Feedback is useful to know weather the purpose and target of training have been achieve.
4. Creative organizational climate
   According to Ekvall in the year 1999, there are some important dimension of creative organizational climate[17].
   a. Challenge, the degree to which members of the organization are involved in its daily operations and long-term goals.
   b. Freedom, described as the independence in behavior exerted by the people in the organization. In a climate with much freedom, people are given autonomy to define much of their own work.
   c. Conflict, refer to the presence of personnel, interpersonal and emotional tensions (in contrast to

idea tensions in the debates dimension) in the organization.

d. Idea Support involves the new ways ideas are treated. In the supportive climate, ideas and suggestions are received in an alternative and kind of way by bosses and workmates.
e. Debates, involves encounters, exchanges often clashes among viewpoints, ideas and differing experiences and knowledge.
f. Tolerance of uncertainty and ambiguity exposed in the workplace constitutes risk taking.
g. Dynamism and liveliness are the eventfulness of the life of the organization. The atmosphere is lively and full of positive energy.
h. Trust and openness refers to the emotional safety in relationships. The communication is open and strait foreword.
i. Idea time is the amount of time people can use for elaborating on new ideas.
j. Playfulness and humor refers to the spontaneity and ease that is displayed in organization.

5. Creativity in batik industry

In this model, the measurement of creativity in batik industry adjusted to the research Susanty in the year 2009[2]. According to that research, there are some important dimensional of creativity in batik industry.

a. Improved design variations (pattern), include new design of batik and development of previous design/combinations.
b. Improved variations color in batik by using various colors and related to needs of consumers, the use of bright colors, and new color combinations of batik.
c. Utilization of residual production material. Creativity can be measured from the design of new products that use cheap materials (low cost materials), utilization of materials used (*malam*, fabric reject, remaining batik/rags, residual dye) to provide added value.

VI. Conclusions

The most dominant problems in the batik industry is human resource skill. Human resources are the most important factor in the creative industries because the creative industries derived from the utilization of creativity, skill and individual talent. In the conceptual model for developing creativity in batik industry, creative person is an important factor for development creativity in that industry. Creative person are more able to improve their creativity if they have intrinsic motivation, given some training that related with the job skills they needed, and supported by organization that have positive climate (climate in organization that respects creativity, provide opportunities, time, facilities, infrastructure and incentives to employees to think about, designing, researching and developing new products that better and more innovative). For the further research, this study can be continued by testing the model empirically through distributing the questionnaire to some partisipan of SMEs and processing data from the results of questionnaire distribution using the data processing software, like SPSS, LISRELL, etc.

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ISBN : 978-602-97809-0-1

Implementation of 360 Degree Assesment for Evaluation the Employees' Competency in PT Pupuk Kalimantan Timur

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Abstract - **PT. Pupuk Kaltim is an Indonesian Government-owned fertilizer producer, located in Bontang, East Kalimantan. At present, there are four ammonia plants and five urea plants of a total installed capacity of 1,800,000 tons annually of ammonia and 3,000,000 tons annually of urea. PT. Pupuk Kaltim empowers approximately 2,500 employees. Around 60 % of employees work in production directorate, and the others work in others directorate, e.g. finance, human resources, marketing, technical & development.**

Starting on 2010 PT. Pupuk Kaltim implemented the 360 degree assessment for evaluation the employees' competency. The implementation is consequently of implementation of competency based human resources management (CBHRM) in PT. Pupuk Kaltim. The objective of the system of 360 degree assessment is to evaluate the all PT.Pupuk Kaltim employees' soft competency. The system was designed by online system.

The Method, the type of competencies is depending on the position of the employee. The weighting factors of appraiser are also differed based on among supervisor, peer, subordinate and himself. Beside that the choosing of web based or paper based also differed depend on the work location of employees. The first time implementation of 360 degree assessment was conducted on February – May 2010, and the appraisal will be conducted on every January – March annually. The Result, all employees have conducted the appraisal, the score of employees' competency is used for calculation of the employees' merit increase. This paper explores the experience of implementation of 360 degree assessment for evaluation the employees' competency in PT. Pupuk Kaltim.

Keywords **– 360° Degree Assessment, Evaluation, Employees' competency, PT. Pupuk Kaltim**

I. INTRODUCTION

PT. Pupuk Kaltim is the own state owned company that producing urea fertilizer, located in Bontang East Borneo Island. At present, PT. Pupuk Kaltim operate four ammonia plants with total installed capacity of 1,800,000 tons annually and five urea plants with 3,000,000 tons annually of urea. The company absorbs totally approximately 2,500 employees.

Around 60 % of employees work in production area, and almost 30 % of employees work in others directorate, e.g. finance, human resources, marketing, technical & development. And the remaining employees (around 10%) are assigned in Joint Venture Company, Foundation, Fund Pension and Sub Ordinate Company. Classification of employees is staff employee and non staff employee (executor). Staff employee is consists of structural employee and functional employee.

PT. Pupuk Kaltim has adopted grading system as a replacement for echelon system and employees ranking system. In the grading system, there are two ladders for employees' carrier development, which is structural ladder and functional ladder. Before entering to the two ladders, there is available the employees' carrier development for executor (non staff employee).

II. CONCEPT OF 360 DEGREE ASSESMENT IN PT. PUPUK KALTIM

PT. Pupuk Kaltim has been implemented the competency based human resources management (CBHRM). One of the infrastructures of CBHRM is the assessment of employees' competency. Three hundred sixty degree feedback system has been implemented in PT. Pupuk Kaltim for evaluation the employees' soft competency. The first time 360 degree assessment was conducted on February – may 2010.

Three hundred and sixty degree feedback system can involve feedback for a targeted employee from four sources: (1) downward from the target's supervisor, (2) upward from subordinates, (3) laterally from peers, and (4) inwardly from the target himself.

Three hundred and sixty degree feedback system in PT. Pupuk Kaltim was designed in web based with intranet facility. In special case, paper based also can be used especially for

ISBN : 978-602-97809-0-1

employees who are assigned in Joint Venture Company, Foundation, Fund Pension and Sub Ordinate Company.

III. IMPLEMENTATION 360 DEGREE ASSESMENT

All paragraphs must be indented. All paragraphs must be justified, i.e. both left-justified and right-justified.

A. Methodology of Assessment

Methodology of 360 degree assessment in PT. Pupuk Kaltim is as follow:

1. Structural Position Employee
   The structural position employees will be assessed by Supervisor, 2 peers and 2 sub ordinates, and also himself.
2. Functional Position Employee
   The functional position employees will be assessed by Super Ordinate, 2 peers and himself.
3. Non Staff Employee (Front line level)
   The Non Staff Employees will be assessed by Super Ordinate, 2 peers and himself.

Summary of this explanation as follow:

TABLE I

No	Type of Employees Position	Appraiser			
		Supe-visor	Sub Ordin ate	Peers	Himself
1	structural	Yes	Yes	Yes	Yes
2	Functional	Yes	No	Yes	Yes
3	Non Staff Employee	Yes	No	Yes	Yes

B. Weighting of Appraiser

Determination of weighting of appraiser is as follow:

1. Super Ordinate (1 person) = 40 %
2. Peers (2 person) = 20 %
3. Sub ordinates (2 person) = 20 %
4. Himself (1 person) = 20 %

This explanation can be summarized as follow:

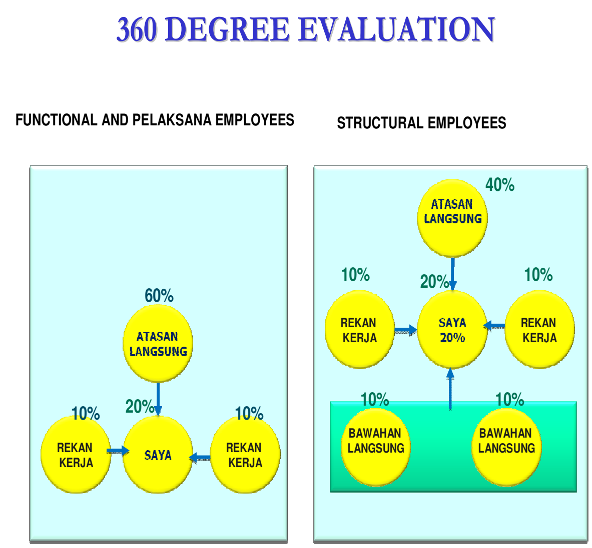

FIG. 1

C. Type of Soft Competency

Type of soft competency that used in the 360 degree assessment is:

1. Core Competency
   Core Competency consists of:
   a. Integrity
   b. Customer Service Orientation
   c. Achievement
   Assessment of core competencies is used for all employees.
2. Role Competency
   Assessment of role competencies is used only for employees in structural and functional position. Designing of role competencies for structural position are:
   a. Team leadership
   b. Strategic Thinking
   c. Business Orientation
   While designing of role competencies for functional position are:
   a. Technical Expertise
   b. Analytical Thinking
   c. Conceptual Thinking
3. Behavior Competency
   PT. Pupuk Kaltim have developed 13 behavior competencies, that is:
   a. Consent For Order
   b. Self Confidence
   c. Information Seeking

d. Interpersonal Understanding
e. Relation Building
f. Development Others
g. Impact and Influence
h. Selft Controll
i. Team Work
j. Flexibility
k. Initiative
l. Organization Commitment
m. Organization Awareness

Assessment of employees behavior competencies are conducted only for 2 behavior competencies depends on their job family. PT. Pupuk Kaltim has 18 job families, for example job family operation, maintenance, safety & environment, finance, marketing, HRD and so on. Assessment of behavior competencies are used for all employees.

Summary of this explanation as follow:

TABLE II

No	Type of Employees Posistion	Competencies			
		Core	**Role (S)**	**Role (F)**	**Behaviour**
1	structural	Yes	Yes	No	Yes
2	Fuctional	Yes	No	Yes	Yes
3	Non Staff Employee	Yes	No	No	Yes

D. Methodology of Appraisal

The methodology of Appraisal is conducted with 2 based:

1) Web based appraisal
   Web based appraisal are conducted by employees who can access the intranet facilities. For example employees who worked in internal company.
2) Paper based appraisal

Paper based appraisal is conducted by employees that cannot access the intranet facilities. For example employees who assigned by management in joint venture company, foundation, Fund Pension and others.

E. Time of Implementation

The first time implementation of 360 degree assessment for employees' competency in PT. Pupuk Kaltim has been conducted on February – May 2010. The appraisal will be conducted on January – March every year

F. Result of Assessment

The result of the first time implementation of 360 degree assessment for employees' competency as follow:

a. All employees have conducted 360 degree appraisal, only one employee did not conduct the assessment.
b. The range of employees' competency score is between 0 – 4
c. The score of employees' competency is manifestation of employee feedback from super ordinate, peers, sub ordinate and himself.
d. The score of employees' competency is used for determination of employees' merit increase.

IV. CONCLUSIONS

From the above explanation, we can make the conclusion that:

- Almost 100 % employees of PT. Pupuk Kaltim have conducted 360 degree appraisal.
- The score of employees' competency is used for calculation of employees' merit increase.
- The score of employees' competency is manifestation of feedback from supervisor, peers, sub ordinate and himself.

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

Electronic Word-of-Mouth in Indonesia Hospitality and Tourism

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Abstract – **Interpersonal influence and word-of-mouth (WOM) are ranked the most important information source when a consumer is making a purchase decision. This influence may be especially important in the hospitality and tourism industry, whose intangible products are difficult to evaluate prior to their consumption. When WOM becomes digital, the large scale, anonymous, ephemeral nature of the Internet induces new ways of capturing, analyzing, interpreting, and managing online WOM. This paper describes online interpersonal influence, or eWOM, as a potential cost-effective means for marketing hospitality and tourism, We use examples of website that uses Social Networking in hospitality and tourism in Indonesia which site access on 28 July 2010 to find which social networking reach to their customer. The result is found that Facebook is the Social Networking that reaches to most of the customers in Indonesia.**

Keywords — **eWOM, social networking, online marketing, hospitality and tourism**

I. Introduction

The product's and service's information which are communicated among customers are often called as word-of-mouth (WOM).

WOM often transforms from objective product information in addition to personal opinions and experiences. Nowadays, as internet plays one of the most important roles in communicational method, the online – WOM or electronic word-of-mouth (e-WOM) becomes significant as well [4]. E-WOM is sometimes trusted as filters which screen and recommend deciding what to read, what to buy and even what to do. Facebook and Twitter become imaginary platforms for e-WOM, which mean existing customers will become their researching engine [3].

The effects of communication from online word-of-mouth (eWOM), customer-to-customer (C2C) know- how exchange, on customer perceptions of value and customer loyalty intentions impacts customer perceptions of product value and likelihood to recommend the product, but these effects do not influence customer repurchase intensions [15].

II. Research Methodolody

This paper first reviews related studies on interpersonal influence and WOM. Second, the paper discusses WOM manifestation online and how eWOM differs from the traditional WOM. The paper then outlines challenges and opportunities for the hospitality and tourism industry and suggests relevant marketing strategies to manage and enhance interpersonal influence online. Finally, the paper touches upon ethical issues related to the industry's use of the current technologies, survey the most social networking website in hospitality and tourism in Indonesia and suggests directions for future.

III. Interpersonal Influence and Word-of-Mouth

Most of the pre-purchase decision and respondence of the customers were influenced by the information from their "friend" firstly about "brand", and then "price", "special features" (multimedia, connectivity and game), and "design". It is found that friends are the most important WOM source that affect on mobile phone purchasing which "brand" influences on the decision to purchase mobile phone [13].

Travellers are also the category that can be convinced easily from word-of-mouth communication. They mostly look for new places to travel by talking with friends and relatives about the places which are visited by them before. It would be more secure for them to travel to the places that somebody they know has been and suggest to travel to. Young travellers are the group that specially trusts the recommendations of places to visit from their friends and relatives. The suggestions from family and friends help younger people to assure that they would be satisfied and it will be worth for their budget. Recommendations from friends and relatives are especially important to travellers with young kids [9].

When the consequences of Word-of Mouth are compared to Traditional Marketing, it shows that eWOM from the popular Social Networking Websites have very strong influence on customer interest. The long-run flexibility for referred WOM communication was around 2.5 times higher than the average advertising flexibility which was reported in the literature. Furthermore, the estimated WOM that effect on new members signing-up is also significantly bigger than the traditional marketing used by the site. Interestingly, long-run WOM is nearly 20 times higher than the elasticity for marketing events and 30 times higher than the elasticity for media appearances. One of the main reasons that the high long-run effect of WOM relative to traditional marketing is that it has a much longer carry-over period. It is, moreover, found that an increase in WOM goes along to affect new members signing-up for 3 weeks while the traditional marketing impacts goes less than a week. WOM and it's result, new signing-up members, are internal factors which means that WOM causes to more new members and more new members cause to more WOM. However, WOM may also improve the consequence of traditional marketing mostly when the activity serves to stimulate [14].

IV. ELECTRONICE WORD OF MOUTH

Even though the conventional advertising, in magazine, newspaper and television work very well, many companies are still looking for the internet to be a powerful dynamic advertising that can roll by itself to supply their advertising on TV and papers. Definitely, to make marketing by using e-WOM is not going to show the result in short-term period, but it can be used in together with traditional advertising approaches to improve its impact. E-word-of-mouth marketing is mainly very cost-effective, and the text can be changed rapidly and often. The impact of an e-mail address to a direct marketer can be significant. A success from eWOM marketing can truly get to multiple promotion objectives, The e-word-of-mouth marketing method might not only increase notability of brand, it can also motivate customers to direct purchases" [4].

Blogs is one of the new forms of advertising by using Electronic word-of-mouth (eWOM). Some political candidates appear to use this forum to share their viewpoints and engage their constituents [16].

The basic purpose of social media is to allow companies to affect and observe their customers behaviour after a product or service is bought. When customers are treated as an inhabitant, they can be very useful to the company; they can help the company to increase its popularity, to improve on the style of a new product, to enhance a service. Online networking is an important external factor that can help essentially improving a brand's look, as well as promote company morale. One good example is, the development in Nike has used social media as a brand and as a socially responsible and more sustainable enterprise. At the end of the day, it's the people out doing work that are going to get us to achieve our goals, [11]. People's desire to connect, to stay in touch, to create, and to help each other, is an universal and basic need and the rise of social media has just begun" [10].

According to Riegner, 2007, the internet stands apart from other media because it enables its users to interact, it is a tool for interpersonal communication and according to Maymann 2008, the enormous growth is a consequence of people's fundamental need to communicate and engage with others. According to Granitz & Ward, 1996 today's society is increasingly characterized by social disintegration. These people turn to the web to interact with others who share their consuming passions. Therefore, social disintegration could help to explain the success of social networks in particular and eWOM in general [10].

Another powerful factor on customers purchasing habit is customer-to-customer (C2C) know-how exchange. C2C know-how exchange influences managerially relevant consequences, that is to say, the value of the company's offering and the customers' future objective. C2C exchange motions had major impacts on the whole value of the company's offering. EWOM communication was found that it is perceived to be a trustworthy source of information by customers. It is also found that findings provide experiential evidence of a direct benefit of eWOM for a company. The findings suggest that eWOM communication impacts the perceived overall value of the firm's offering in a significant manner. Furthermore, C2C know-how exchange had both direct and indirect connection with loyalty intentions that was mediated through overall value of the company's offering. Interestingly, opportunity has a minor role in the Internet context, and it also indicate to the possibility that once a minimum threshold level of opportunity is provided, increasing levels of opportunity no longer have an impact on C2C exchange" [15].

Online word-of-mouth is a complex concept as marketers struggling to find a unique promotional device that will cut through the clutter of on-line communications. Nevertheless, succeed e-word-of-mouth marketing efforts can be an effective on-line marketing tool and serve several functions for product and service marketers. EWOM marketing can create interest and create rumour leading to traffic on an especial website (e.g., typing commands for a cartoon character to follow), which will in turn promote the company's offerings. Other marketing-influenced efforts produce awareness and provide product knowledge to consumers. Some e-word-of-mouth marketing examples can be used to efficiently drive sales with coupons and website links to share with a friend. Marketers, likewise, depend on people who are self-motivated to take it forwarding these links and offers to person that they know. As communication obstacles decrease continually due in large part to continued selection of the internet, effective use of e-WOM activities will be even greater significance in the future. Thus marketers need to be conscious of the impact of both positive and negative e-WOM on their marketing efforts [4].

According to Wellman, 2001 the Internet has changed from face-to- face social based interpersonal communications to one of com- puter-based social networking. EWOM added to advertising in a third party website having a larger additive effect on consumers' involvement and likelihood to adopt a new product than in a firm-sponsored website [6]. There are many ways in which companies can leverage the increase of social networking websites in their marketing activities. A recent US study (Corporate Executive Board, 2008) formed five categories of key objectives of social networking strategies, namely (i) improve customer understanding, (ii) promote issues of social concern, (iii) promote products and services, (iv) facilitate internal knowledge sharing, and (v) increase brand awareness. *Top ranked companies such as Unilever, Xerox, P&G, Virgin, Toyota, JP Morgan, CISCO, IBM, Burger King and Honda had successfully utilized social networking websites [12].* According to Bhattacharya (1998); Sheth and Parvatiyar, (1995); Relationship managers are interested in the loyalty intentions of customers who have been successfully attracted to the firm's offering because Social capital refers to the "resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit [15].

V. STRATEGY FOR MANAGING EWOM IN HOSPITALITY AND TOURISM

Encourage or stimulating good eWOM should result in enhance business activity. Below are specific strategy suggestions for hospitality and tourism marketers to accomplish these goals in cyberspace. Ethical issues related to the potential abuse of these practices are then briefly considered [14]. According to Groundswell, 2009 Tourism business including hotels, attractions, restaurants and destinations not already utilizing social media should get into social networking game with strategy as soon as possible. This strategy should include participation in five primary sites: TripAdvisor, Facebook, Twitter, Youtube and Flickr.

5.1 **TripAdviso**r according to Groundswell, 2009 one of the activities community members can do is post reviews about hotels, attractions, and restaurant. This allows businesses to monitor what is being said to strengthen weakness and maintain and improve what visitors like. This site allows businesses to reply to comments through the Management Response feature. Doing this fosters social media transparency and is ethical as compared to impersonating a visitor and posting a positive comment.

5.2 **Facebook** according to Groundswell, 2009 creating a Facebook Fan Page allows hotels, attractions, destinations and other tourism businesses to create photo and video galleries, post events and notes of interest, interact with past and potential visitor, and fosters interaction with fans. Everyone loves sharing about their vacation and when past visitors post positive photos and comments, it is a genuine third-party endorsement which may encourage other to visit. Jet blue uses its Facebook fan page to keep customers informed and happy. Their primary form of communication is through their page wall, which regularly receives hundreds of likes and tens of comments and uses discussion board to encourage conversations and respond to problem. Virgin Atlantic uses its Facebook page to give information to their customers. Wall posts tens of comments and Virgin Atlantic often respond to problem and requests within those discussions [7]. "Addicted to Starbucks" group has almost 124.000 members, over 670 discussion topics and almost 10,000 wall posts [2].

5.3 **Twitter** according to Groundswell, 2009 "What are you doing?" Twitter allows tourism businesses to test ideas, interact in casual and fun manner through avenues such as contests and offering coupons and push information out such as media releases, events and photo. Twitter is also a marketing tool to listen to what the customer is saying and provides an opportunity to immediately react. Jet Blue also gives their tweets a personal touch not only responding to customers in need of assistance but those looking to praise or get involved in idle banter similar to Virgin Atlantic [7]. "Twitter really is about tearing down the artificial walls between customers and the individuals who work at companies" JetBlue's manager of corporate communications, Morgan Johnston said [7].

5.4 **Youtube** according to Groundswell, 2009 tourism businesses can upload professionally produced video or user-generated content created with simple camcorders such as the Flip video camera to share with potential visitors. Jet Blue uses it Youtube channel to show what Jet Blue experience is like. Virgin Atlantic's Youtube channel is used to promote Virgin's service [7].

5.5 **Flickr** according to Groundswell, 2009 the photo-sharing site allow tourism businesses to create groups which can be used for contests, testing new creative ideas, and building an image bank. A dynamic image may intrigue a potential visitor to plan a vacation so it is important the image has an appropriate description so said visitor can find the business. Jet Blue has posted thousands of pictures up on their Flickr profile. The photos give some insight into flying with Jet Blue and the staff who facilitate it all. It helps show Jet Blue as a company with face [7].

VI. ETICAL CONCERN.

Today, with social networking being the most popular way that millions of people communicate, students must understand how their behaviour online can destroy their professional reputation as well as the image of their organization. "it takes 20 years to build a reputation and five minuted to ruin it" [5]. There are some points to be concerned about when emails are being sent, firstly, the source should be distinctly indicated and never disguised. Secondly, needless emails should be avoided. Furthermore, Email addresses should be sold with permission and, lastly, 'opt-out' requests should be coped politely and punctually. Online 'stealth marketing' strategies that could attract hospitality and tourism marketers to promote eWOM and 'buzz' are easily envisioned. The most apparent of these is the use of employees to model online as consumers for posting optimistic comments on behalf of the company because the spreading of eWOM could have important power on other members' hospitality and tourism purchase decisions [14]. According to Anne Collier pointed out in Social media literacy: The new Internet safety, media literacy and critical thinking are protective against manipulation and harm. Encouraging kids to practice good digital citizenship helps protect all young people, because behaving aggressively online more than doubles the risk of being victimized [1].

VII. EWOM IN HOSPITALITY AND TOURISM IN INDONESIA.

Examples of website that uses Social Networking in hospility and tourism in Indonesia. All of site access on 28 July 2010. We determine the criteria of the most looking hospitality and tourism website based on :

• Social Networking website (Face book, Twitter, Yahoo Massager, and Google mail) to know how many people join for the social networking that using by website.

• Search engine (Google, Yahoo) to know how many people search for the website.

Website			Search Engines	
	Facebook (FANS)	Twitter (Follower)	Google	Yahoo
http://www.indo.com/	728	9	25,300,000	77,200,000
http://www.kempinski.com/en/jakarta/	359	24	2,340	68
http://www.itravelindonesia.com/	76	197	687,000	10,800
http://www.baliblog.com/	2,744	342	67,700	76,200
http://www.yogyes.com/	588	-	22,200	42,400
http://www.bali-indonesia-tourism.com/	533	77	2,900,000	95
http://www.nache-indonesia.com/	13,100	-	878,000	129
http://www.balihotelsassociation.com	943	14	9,060	2,710
http://www.indonesia.travel/	6,396	8,314	76,500,000	423,000,000
http://www.iexplore.com/	388	1016	1,210,000	2,590,000
http://www.indonesiatravelplan.co.uk/	44	1094	45,400	4,750
http://travelwan.com/blog/	12,599	-	5,440	8
http://www.tourjogja.com/all-journey.html	913	507	291	3
http://www.indonesia-tourism.com	2,944	-	6,670,000	7.830.000
http://www.panorama.tours.com	2,615	114	311,000	1,470,000
http://www.globaladventureindonesia.com	17	15	53,000	1,030
http://www.travelindonesia.com	89	45	29,600	2,490
http://www.indonesialogue.com/	2748	342	17,500	4,180
http://www.bayubuanatravel.com/	1,963	-	9,190	1,110

Fig. 1 The table of Indonesia hospitality and tourism website access on 28 July 2010.

The top three that have most fans are :

• http://www.nache-indonesia.com

NACHE-Indonesia.com is a dedicated web portal specializing in hospitality industry, located in Jakarta, the capital of Indonesia. The website focused on becoming a comprehensive service provider for the entire hospitality industry in the world. The website vision is to be the automatic choice for those in the hospitality industry requiring unique, relevant and effective support. NACHE-Indonesia.com provides clients with quick and effective solutions for all their human resource requirements. It will achieve this by continually enhancing recruitment processes, training programs and consulting interventions, to better provide quick and easy relief from challenges as they arise. To offers unique, relevant and effective support for hotels and restaurants, based upon a solid understanding of the challenges facing both hospitality businesses and their staff in today difficult environment. NACHE-Indonesia.com brings a great solution to the young professionalism, where it place high motivations, individuals in hospitality industry particular. It have program to train and assign young trainees in many hotels for a certain period and placing professionalism in many hotels around the world, this assignment is intended to enable them in gaining more valuable education, information about other countries culture, other countries business activity, then upon completion of the training and assignment when they come back to their own country they will expand their career with broader insight as a result of their engagement and socialization in their chosen country.

•http://travelwan.com/blog

TravelWan is the first and only magazine in Indonesia (and the Asia Pacific region) which focuses on the business of travel and tourism industry. Focusing mainly in the raw potential of Indonesia tourism, the magazine aims to expose the rough diamond that is Indonesia to the rest of the world—especially in regards to tourism and its development & investment potential. Published monthly, the magazine is targeted towards business owners, people who are in the travel & tourism industry, manager-level or otherwise, and also others in general who are always interested in learning more about Indonesia tourism and its neighboring countries. Indonesia is very blessed with its rich raw materials and different types of arts and culture that exist within its society. TravelWan wants to prove to the world that Indonesia is worth it—that those blessing is not such a waste in our hands. If you share our passion in Indonesia tourism and educating the rest of the world about the potential of Indonesia, we invite you to be part of our team. Now the products are Magazine, tour & travel packages, gift books, postcards, t-shirt, etc.

•http://www.indonesia.travel

This is Indonesia's official Tourism website, Inside thw website you can found a lot of Indonesia tourism , start from Indonesia's map to planning your trip.

VIII. CONCLUSIONS

From the above we can see that almost all websites using Facebook as their e-WOM. They provide place to promote their products and let the other know about them through their customer's experiences and comments in their page. Generally the topics to talk are about how nice the journey, how satisfy when they used the services. As the result we finding Facebook is famous Social Networking Site that reach to customer in Indonesia that mean Electronic word-of-mouth in Indonesia have influence to Indonesia customer.

ACKNOWLEDGMENT

It is a pleasure to thank those who helped making this journal possible such as our team who gave the moral support, we required and our University, Atma Jaya Yogyakarta helped us with some material. Lastly, we offer our regards and blessings to all of those who supported us in any respect during the completion of the project.

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

An Application of Balanced Scorecard System for Improving Business Process Performance of an Agricultural Firm

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Abstract - **Balanced Scorecard is a management system that enable organizations to clarify their vision and strategy and translate them into action. Nowadays, Balanced Scorecard has been widely used in many companies and organizations for its simplicity and applicability. Meanwhile, agricultural firms are businesses that are rarely managed with sufficient management skills. This paper provides a study whether Balanced Scorecard is applicable to these firms. The study results that Balanced Scorecard, with enough understanding to agricultural processes, is completely applicable for agricultural firms.**

Keywords - **The Balanced Scorecard, Agricultural Firm**

I. INTRODUCTION

In many countries, agricultural industries have been operated for a long time. In Indonesia, most agricultural businesses are carried out in rural areas by unskilled farmers or small firms called "Kelompok Tani" (farming groups). The absence of sufficient management skills had caused most farmers and farming groups unable to generate profit for their company.

A three-month study was performed to evaluate whether modern management tools can be used for traditional agricultural firms. The Balanced Scorecard was chosen as the model for its simplicity and commonly use. A farming group named "Karya Mandiri" producing organic vegetables was selected as the case study object.

The study had included supervisions, visual observations, interviews and literature reviewing, both for the Balanced Scorecard model and the agricultural firm. The study had proposed an integrated strategic plan using the Balanced Scorecard model for the firm.

II. THE BALANCED SCORECARD MODEL

Balanced Scorecard is a management system that enables organizations to clarify their vision and strategy and translate them into action [1]. It provides feedback to both the internal business processes and external outcomes in order to continuously improve strategic performance and results. When fully deployed, Balanced Scorecard transforms strategic planning from an academic exercise into the nerve center of an enterprise. If companies are to survive and prosper in a competitive environment, they must use measurement and management systems derived from their strategies and capabilities [2].

Besides, the Balanced Scorecard is a concept that can be implemented in many ways. One prerequisite is that it must be adapted, or changed to fit a specific organization. A good Balance Scorecard reflects the strategic plan of the organization, provides a framework that helps shape work behavior, allows each person to measure his/her individual performance and gives data to make changes immediately so that performance is enhanced [3, 4].

III. BALANCED SCORECARD FOR THE FIRM

A. Initial Problems

Karya Mandiri is an agricultural firm owned by ten farmers located in Bandung, Indonesia. Its products are low-pesticide leafy vegetables such as spinach, mustard and lettuce. Karya Mandiri has a production target as 1,000 kg of leafy vegetables per week to meet customer's demand. The vegetables seedlings are grown on the prepared nursery ~~area~~ for about two weeks. When the vegetables seedlings have grown up with their leaves, they were transplanted to other parts of the farm where they will be grown to their mature size and ready for harvesting.

However, at present Karya Mandiri seemed to faced with some problems in running its business, they are:

- Failed to meet the target of producing 1,000 kg of leafy vegetables per week. In the last few weeks, Karya Mandiri produced only 500 to 700 kg of vegetables.
- The number of plants that failed to grow up seemed to be very high and had caused financial loss to the firm.
- During delivery period, 20 to 25 percent of the vegetables were rejected as their quality does not meet the standards as required by the customers: too small, too big, too many holes in the leaves (eaten by bugs), withered or not fresh, etc.

ISBN : 978-602-97809-0-1

- In terms of financial aspect, the firm is still hampered by various unnecessary costs, such as: facilities breakdown, urgent-but-unnecessary labor costs, and etc.

In order to improve Karya Mandiri performance, the authors had proposed a four-perspective balanced scorecard for the agricultural firm.

B. Mission, Vision, Values

Karya Mandiri's mission statement:

Karya Mandiri is committed to provide vegetables for their customers with the best quality they can get as well as to create prosperity for the communities where our farms are located. Its mission consists of three interrelated parts:

1. ***Product.*** To cultivate, harvest, package and deliver high quality fresh green vegetables to our customer in domestic and international market.
2. ***Technology.*** To continuously search, develop and apply new methods in growing fresh, healthy, and well-tasted vegetables.
3. ***Social.*** To develop, empower and create prosperity to the communities where our farms are located.

The mission explains the objective of the firm. It is committed to continuously provide high quality vegetables at competitive prices to the customers. The firm has customers in domestic and international markets. The firm is also committed to enrich agricultural technology by continuously developing new methods in increasing the quality of vegetable products. Not only to generate profit, the firm is also committed to develop and to give prosperity to the community where the firm's farms are located.

Karya Mandiri's values:

1. Quality
2. Assurance
3. Togetherness

The first value, quality, describes the commitment of the firm to provide the customers with high quality products in all aspects: physical appearance, taste, texture and nutrition of the vegetables. The second value, assurance, describes the commitment of the firm to give the customers maximum safety assurance in consuming the products, applied hygiene standards in its production, packaging and delivery processes. It also includes the assurance for low pesticide content as the company states in its slogan. The third value, togetherness, describes efforts of the firm to create prosperity to the communities where the firm is located, as well as generating profit to the firm. These values guide the firm to perform its business.

Karya Mandiri's vision:

Karya Mandiri has targeted its future to become Indonesia's biggest agricultural firm producing low pesticide and organic vegetables in the next five years. It will be the leader in low pesticide and organic crops market, as well as pioneering healthy agricultural cultivation as a trend in Indonesia. Skilled and credible staffs will be employed to continuously improve the cultivation quality. It will be able to model in increasing the firm's profit fast as well as empowering people around the firm's location.

C. The Strategy Map

The financial perspective of Karya Mandiri's scorecard describes the financial targets of the firm and how it is related to the vision and mission.

Karya Mandiri has identified 23 strategic objectives across the four-perspectives of its corporate strategy map.

<u>Financial Perspective</u>

F1 – Increase long term shareholder value. The ultimate financial goal of Karya Mandiri is to increase the value of investors' invested funds. To achieved the other strategic objectives in the financial perspective.

F2 – Increase sales value. Karya Mandiri should increase sales value from selling of vegetables to the customers. This requires Karya Mandiri to expand its market share and to increase number of products it sells.

F3 – Reduce operational costs. Karya Mandiri's operational costs consist of production costs and overhead costs. These cost types should be simultaneously reduced in order to create business efficiency.

F4 – Increase asset utilization. Karya Mandiri should increase the utilization of its asset, especially land, by improving the amount of money generated by each unit area of land.

F5 – Expand revenue opportunities. Continuous and expansive networking, both to local and international markets would be performed by Karya Mandiri, as well as searching for market niche that is available for its expansion.

<u>Customer Perspective</u>

C1 – Increase customer value proposition. Karya Mandiri would perform any efforts needed to increase customer value proposition as much as possible.

C2 – Find an optimal pricing strategy. Karya Mandiri should adopt fair pricing strategy that maximize the company's profit and competitiveness with respect to competitors' product.

C3 – Produce high quality vegetables. Karya Mandiri is committed to produce high quality vegetables in all aspects: physical appearance, taste, texture and nutrition.

C4 – Ensure product availability. Karya Mandiri should manage the agricultural system so that products are available at required amount and time.

C5 – Improve product delivery. Delivering products to the customer's door is an additional service to create maximum satisfaction.

C6 – Increase networks to customers. The most important way to increase total customers is increasing the quantity and quality of networks to the customers. Karya Mandiri will perform this with maximum ability that it has.

C7 – Create strong brand and reputation. Karya Mandiri will use effective methods to create a strong brand to increase customer's recognition to its products.

<u>Internal Perspective</u>

Operation management processes.

I1 – Perform high quality soil processing and fertilizing. This is Karya Mandiri's main success factor in producing high quality vegetables because good plants can only grow in good soil.

I2 – Perform high quality plant cultivation. This objective is the key of Karya Mandiri's overall business, so this achievement must be tightly controlled.

Customer management processes.

I3 – Provide products at the time and amount required. Karya Mandiri should manage its cultivation system in such a manner so that no customer's orders or demands are rejected or not fulfilled.

I4 – Communicate well with the customers. Karya Mandiri should develop good communication skills with the customers to ensure their satisfaction and loyalty to its products and services.

Innovation processes.

I5 – Update cultivation techniques. An agricultural firm like Karya Mandiri should search progressively for better cultivation techniques from other agricultural firms or learn new methods that have been scientifically proven. In addition, Karya Mandiri can also try new techniques in its farms, and if it works, so the new technique would be set as a new process standard.

I6 – Find new commodities to produce. There are various products in vegetable classification, so Karya Mandiri should add new products having large demands and suitable with its existing farms.

I7 – Create new selling methods. New selling methods would be introduce by Karya Mandiri to increase its total customers.

Social processes.

I8 – Create interdependency between the firm and the community. Karya Mandiri would create a mutual relationship with the communities where its farms exist. The firm would take advantage from the labors, supporting environment, and security, whereas the community would take advantage from the economical and social empowerment.

Learning and Growth Perspective

LG1 – Develop competent skilled labors. Karya Mandiri would create programs to develop labors able to apply and share their competencies in the agricultural field.

LG2 – Create organization with strong and constructive culture. Karya Mandiri would develop an organization with leadership, culture and teamwork that simultaneously move to the firm's goals.

LG3 – Utilize information technology. Karya Mandiri would take advantage from information technology by utilizing it to expand market share, improve communication with the customers and strengthen the agricultural technology applied in the firm.

The Strategy Map

Based on the strategic objectives above, the strategy map for Karya Mandiri then can be shown in Figure 1.

D. Measures, Targets and Initiatives

Karya Mandiri has determined 48 measures, corresponding to 24 strategic objectives as described above. Each measure is codified with first letter M, which means 'measure'. The measures are shown in Table 1.

Table 2 describes the initial value for each measure (baseline) and what is the target for the next three years.

To achieve the strategic objectives above and its targets, Karya Mandiri has selected priority programs or activities as its initiatives. The initiatives are shown in Table 3.

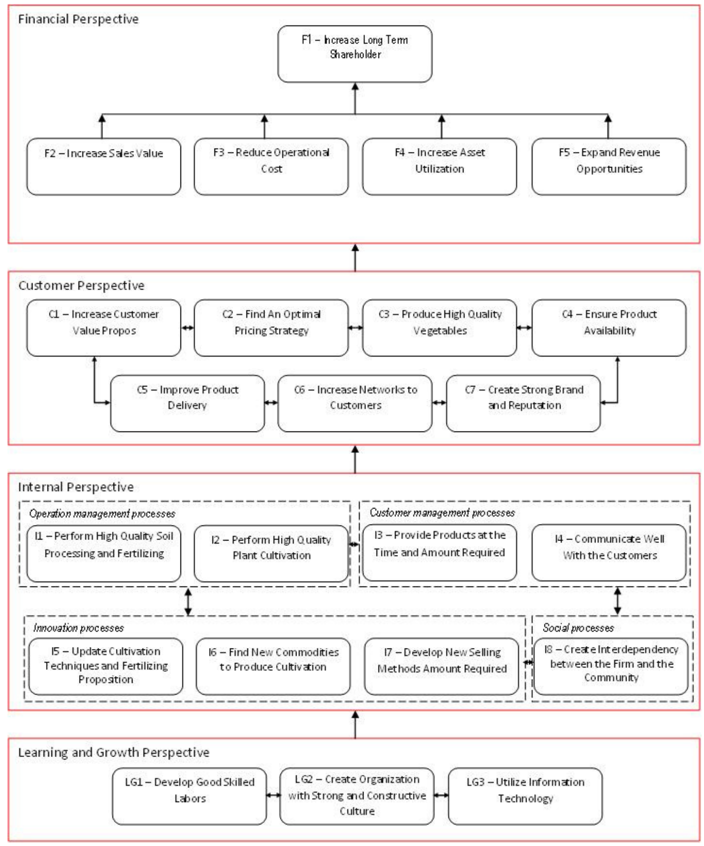

Figure 1 Strategy Map for Karya Mandiri

TABLE 1
MEASURES FOR KARYA MANDIRI

Strategic Objectives	**Measures**	**Unit in Charge***
F1 – Increase long term shareholder	M1 – Return on equity	F
	M2 – Share price	F
F2 – Increase sales value	M3 – Total revenue	M
	M4 – Revenue per employee	P,M
F3 – Reduce operational costs	M5 – Gross margin	P,M
	M6 – Net margin	P,M,F
	M7 – Profit per employee	P,M
F4 – Increase asset utilization	M8 – Revenue/assets	M,F
	M9 – Return on net assets	P,M,F
F5 – Expand revenue opportunities	M10 – Revenue growth rate	P,M
C1 – Increase customer value proposition	M11 – Market share (national)	M
	M12 – Average monthly sales per customer	M
	M13 – Customer lost to total customers	M
C2 – Find an optimal pricing strategy	M14 – Price relative to competitors	P,F
	M15 – Customer loyalty	M
C3 – Produce high	M16 – Total rejected products to total	P

ISBN : 978-602-97809-0-1

Strategic Objectives	Measures	Unit in Charge*
quality vegetables	revenue	
	M17 – Customer complaints to total customers	M
C4 – Ensure product availability	M18 – Unfulfilled demand to total demands	P,M
C5 – Improve product delivery	M19 – Delivery time average	M
	M20 – Proportion of on time delivery	M
C6 – Increase networks to customers	M21 – Number of sales proposals made per month	M,F
	M22 – Customer growth rate	M
C7 – Create strong brand and reputation	M23 – Brand recognition	M,F
	M24 – Customer satisfaction	M,F
I1 – Perform high quality soil processing and fertilizing	M25 – Proportion of seedlings failure	P
	M26 – Proportion of outgrowing failure	P
I2 – Perform high quality plant cultivation	M27 – Rejected products to total production	P
	M28 – Average qualified production per square meter	P
I3 – Provide products at the time and amount required	M29 – Demand planning accuracy	P,F
	M30 – Proportion of deteriorated overripe products	P,M
I4 – Communicate well with the customers	M31 – Total offerings per customer per year	M
	M32 – Total calls to customer care per year	M,F
I5 – Update cultivation techniques	M33 – Number of new cultivation techniques per year	P
	M34 – Percentage of seedlings failure reduction	P
I6 – Find new commodities to produce	M35 – Number of new products per year	P,M
	M36 – Sales from new products to total sales	M
I7 – Develop new selling methods	M37 – Number of new selling methods per year	M,F
	M38 – Sales from new selling methods to total sales	M
I8 – Create interdependency between the firm and the community	M39 – Community involvement index	P,F
	M40 – Number of conflicts between the firm and the community	P,F
LG1 – Develop good skilled labors	M41 – Employee productivity	P
	M42 – Number of technology benchmarking per year	P,F
LG2 – Create organization with strong and constructive culture	M43 – Employee satisfaction	P,F
	M44 – Number of conflicts between employees	P,F
LG3 – Utilize information technology	M45 – New customers from internet to total customers	M
	M46 – New cultivation methods from internet applied	P

* P: Production Division; M: Marketing Division; F: Finance and Administration Division

TABLE 2
MEASURES FOR KARYA MANDIRI

Measures	Unit	Baseline	Target		
			Year 1	Year 2	Year 3
M1 – Return on equity	%	156.1	160.0	170.0	175.0
M2 – Share price	IDR	10,000	11,500	12,500	13,500
M3 – Total revenue	million IDR	192.5	275.0	330.0	415.0
M4 – Revenue per employee	million IDR	12.03	15.0	16.5	17.5
M5 – Gross margin	%	55.2	62.5	70.0	75.0
M6 – Net margin	%	36.5	41.0	45.0	49.0
M7 – Profit per employee	million IDR	4.39	6.15	7.42	8.57
M8 – Revenue/assets	%	320.8	366.7	388.2	425.0
M9 – Return on net assets	%	117.1	150.3	174.7	208.2
M10 – Revenue growth rate	% per year	-	42.8	20.0	25.8
M11 – Market share (national)	%	5.0	7.5	9.0	11.5
M12 – Average monthly sales per customer	IDR	32,550	36,000	40,500	45,000
M13 – Customer lost to total customers	%	8.3	5.0	3.0	2.0
M14 – Price relative to competitors	%	80.0	75.0	75.0	75.0
M15 – Customer loyalty	index	Good	Excellent	Excellent	Excellent
M16 – Total rejected products to total revenue	%	25.0	20.0	15.0	10.0
M17 – Customer complaints to total customers	%	16.7	12.5	9.0	5.0
M18 – Unfulfilled demand to total demands	%	33.3	22.0	14.0	6.0
M19 – Delivery time average	minutes	45	40	35	30
M20 – Proportion of on time delivery	%	53.5	65.0	75.0	90.0
M21 – Number of sales proposals made per month	units	8	9	10	12
M22 – Customer growth rate	% per year	-	40.0	30.0	35.0
M23 – Brand recognition	%	3.0	5.0	7.5	10.0
M24 – Customer satisfaction	index	Medium	Good	Good	Good
M25 – Proportion of seedlings failure	%	20	15	12	10
M26 – Proportion of outgrowing failure	%	30	25	20	15
M27 – Rejected products to total production	%	25	22	20	18
M28 – Average qualified production per square meter	kg per m^2	0.8	1.0	1.2	1.4

ISBN : 978-602-97809-0-1

Measures	Unit	Baseline	Target		
			Year 1	Year 2	Year 3
M29 – Demand planning accuracy	%	60	70	75	80
M30 – Proportion of deteriorated overripe products	%	20	15	12	10
M31 – Total offerings per customer per year	units	-	2	4	6
M32 – Total calls to customer care per year	units	-	250	300	350
M33 – Number of new cultivation techniques per year	units	-	2	3	3
M34 – Percentage of seedlings failure reduction	%	-	25	20	16.7
M35 – Number of new products per year	units	3	3	3	3
M36 – Sales from new products to total sales	%	12.0	15.0	17.5	20.0
M37 – Number of new selling methods per year	units	1	1	1	1
M38 – Sales from new selling methods to total sales	%	30.0	30.0	25.0	30.0
M39 – Community involvement index	index	Medium	High	High	High
M40 – Number of conflicts between the firm and the community	incidents	0	0	0	0
M41 – Employee productivity	index	High	High	High	High
M42 – Number of technology benchmarking per year	activities	1	2	3	3
M43 – Employee satisfaction	index	Medium	High	High	High
M44 – Number of conflicts between employees	incidents	0	0	0	0
M45 – New customers from internet to total customers	%	0.0	2.0	3.0	5.0
M46 – New cultivation methods from internet applied	units	0	1	2	2

TABLE 3
INITIATIVES FOR KARYA MANDIRI

Strategic Objectives	Initiatives
F1 – Increase long term shareholder	Develop an effective communication with the shareholders
F2 – Increase sales value	Create effective promotion programs to increase sales
	Train sales agents to sell as many as possible
F3 – Reduce operational costs	Develop a control system for dispensing production costs
	Develop a bonus system for employees
	creating cost reduce
	Implement mechanization for high cost manual tasks
F4 – Increase asset utilization	Create new selling program to utilize idle assets
F5 – Expand revenue opportunities	Create a bonus system to motivate marketing staffs
C1 – Increase customer value proposition	Perform program distributing free trial products to competitor's buyer
	Measure customer satisfaction periodically
C2 – Find an optimal pricing strategy	Check competitor's price regularly
	Evaluate price relative to competitor periodically
C3 – Produce high quality vegetables	Develop and standardize technique for sorting vegetables
C4 – Ensure product availability	Find and implement an effective forecasting method
C5 – Improve product delivery	Reduce the average delivery time
C6 – Increase networks to customers	Develop a networking system utilizing employee's, and the customer's relations
C7 – Create strong brand and reputation	Develop and implement an effective quality control
	Measure the firm's brand equity periodically
I1 – Perform high quality soil processing and fertilizing	Develop a system for controlling soil processing activities
I2 – Perform high quality plant cultivation	Find and implement an effective forecasting method
	Develop a system for controlling plant cultivation activities
I3 – Provide products at the time and amount required	Develop a selling database
	Utilize selling database to forecast demand accurately
I4 – Communicate well with the customers	Develop and operate a free-call customer care
	Send the selling agents to communication training
I5 – Update cultivation techniques	Learn new cultivation techniques from internet and other sources
	Implement the new techniques and measure the result
I6 – Find new commodities to produce	Perform a market research and implement the result
I7 – Develop new selling methods	Search and implement new improved selling methods
I8 – Create interdependency between the firm and the community	Conduct effective communication with the community
LG1 – Develop good skilled labors	Send employees to agricultural trainings
	Periodically search and visit other bigger and more advance farms
LG2 – Create organization with strong and constructive culture	Periodically organize team gathering for consolidation
	Send team leaders to leadership training
LG3 – Utilize information technology	Develop a strong and effective website
	Perform marketing expansion utilizing website and internet

E. Cascading the Scorecard

After the firm's scorecard was established, then it is necessary to cascade it to the first-level unit. Since Karya Mandiri has three divisions, then three scorecards will be developed for each division. Each scorecard consists of similar components with the firm's scorecard, they are strategic objectives, measures, targets and strategic initiatives.

IV. ANALYSIS

Based on the results obtained, we can analyze some points as follows.

- Karya Mandiri's mission has stated the basic function of its existence. By explicitly stating it, Karya Mandiri has clearly explained its identity both to the employees and the community.
- Karya Mandiri's vision has clearly declared where and what its future is. The vision is very ambitious, but realistic to achieve. Also, the vision will give the firm's elements more spirit to develop their future.
- Karya Mandiri's 23 strategic objectives are the statements of what it does. The four-layer strategic objectives are the targets to achieve and they have represented all tasks of the firm.
- The strategic map shows the relationship between Karya Mandiri's strategic objectives. To ensure that the financial objectives are achieved, Karya Mandiri should ensure that the lower layer objectives are achieved.
- The measures are the indicators of the strategic objectives. There are 46 measures to indicate the achievement of the 23 strategic maps. The measures can be use to determine whether the strategic objectives are achieved or not. For each measure, the unit in charge is then determined. Some measures are managed by one unit, while others by two units, and the rest are managed by all three units.
- For all the 46 measures, target values for the next three years are determined based on the baseline values. Most of the targets can be determined quantitatively, while others can only be determined qualitatively.
- Finally, to ensure that all targets are achieved, strategic initiatives are created. Strategic initiatives can be viewed as non-regular and non-routine programs to break through the initial condition and to achieve the targets. Strategic initiatives are determined from the strategic objectives, where one strategic objective is related to at least one strategic initiative. In this study, 36 strategic initiatives was derived from 24 strategic objectives.

V. CONCLUSIONS

Balanced Scorecard is applicable for agricultural firms. The application of Balanced Scorecard will be able to strengthen agricultural firms since most of them are managed by people with lack of management skills. The application of Balanced Scorecard in agricultural firms needs a deep understanding about the production processes in agricultural cultivation. The scorecard developed in this paper can be applied to other agricultural firms, with necessary modifications.

ACKNOWLEDGEMENT

Authors of this paper would like to thanks to Karya Mandiri farming group in northern Bandung, Indonesia, which made this study is possible by permitting the observations, answering the interview questions and providing all necessary data.

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ISBN : 978-602-97809-0-1

The Enterprise Risk Management and The Enhancement of Shareholders' Wealth: Myth or Reality

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Abstract **- The primary research objective of the study is to investigate the relationship between the degree of the ERM implementation and financial performance. The primary data collection was through a questionnaire survey. COSO ERM framework was used as the main source to evaluate the degree of the ERM implementation. Agency and stewardship theories were used to accurately explain the rationale behind the implementation of the ERM. The results of the multiple regressions indicated no significant relationship between ERM implementation and financial performance. The empirical evidence in this study suggested that there is possibility that the ERM philosophy were not properly comprehend. The desire to achieve favourable financial outcome led the management become more interested in the final product of the ERM rather that focusing on the various important awareness and implementation process.**

Keywords **— Enterprise risk management, COSO risk management framework, Financial performance, Malaysia**

I. INTRODUCTION

Risk management is becoming a high priority for large companies especially those operating in various countries. The term Enterprise Risk Management (ERM) has become a part of the business operation. In spite of this development, research in the area of risk management that involves the enterprise widely is limited [1]-[3]. The primary objective of the ERM is to create, protect and enhance the shareholders' value by managing the uncertainties surrounding the achievement of the organisation's objectives [4]-[7]. Thus, this study is conducted to investigate the extent to which ERM could enhance shareholders' wealth. To date studies that provide empirical evidence on the impact of the ERM implementation towards the financial performance are indeed limited [3]. The need for such research is critical considering the recent development that could jeopardise the ERM philosophy as one of the governance tools. This present study is timely in providing the much needed empirical support on the implementation of the ERM.

II. THE ERM AND FINANCIAL PERFORMANCE

The implementation of the ERM became more integrated after the year 2000 and the management was more aware of the importance of having an integrated and holistic approach of the ERM [8]. Risks were now identified, assessed, analysed and responded to at all levels of the organisation including the financial, operations and strategic risks. Ideally, the management should identify all the events that could affect them from achieving any of their stated objectives at every level or department in the entire organisation. To date, there are various corporations worldwide that have implemented the ERM and have reaped the benefits from it. Examples of companies where the ERM implementation are quoted as a guidance for best practice are FirstEnergy Corporation,

ISBN : 978-602-97809-0-1

General Motors Corporation, Unocal Corporation, Wall Mart Stores, Canada Post Corporation, Bradford & Bingley Building Society, Clarica Life Insurance, Key Corp, and Infineon Technologies [8]. In addition, the recent ERM survey conducted by [6] in Malaysia found that the ERM contribute to improve the shareholder's value. Despite its implementation in these companies, the implementation of the ERM in the financial and insurance industries is mostly regulated. The banking industry in particular is subjected to the various requirements that demand strict and detailed compliance in response to risks such as the Basel I and Basel II and other Central Bank's Capital Adequacy Guidelines in Malaysia [9].

There are numerous studies in the finance literature documenting the connection or links among risk management, corporate governance and financial results. Examples of the studies are [10]-[13]. Reference [10] reported that researches that considered the impact of the integrated ERM implementation were very limited. Most studies on the ERM in the finance literature focused on individual risks such as interest rate risks, foreign exchange and commodities risks. However, [2], [14] claimed that the ERM should be studied across a broad range of its activities to reflect the integrated approach of it.

Proper implementation of the ERM would help the companies to be better prepared for any uncertainty which eventually limits the exposure from any specific risks. Investors may have a higher level of confidence to invest in companies that have a well structured ERM as it suggests that the company is well governed. It is expected that the degree of the ERM implementation would improve the shareholders' confidence and encourage them to invest in the company. Thus, this improves the value of the company measured by its share price. This is evidence from the findings of [5] that reported that the movement in stock price was dependent on the risk management strategy pursued by the managers.

In a different perspective, the ERM is a subset of a broader scope of organisational governance initiatives. Numerous studies in corporate governance may also support the justification towards the implementation of the ERM. Reference [16] who studied the relationship between governance and firm value of 21 Russian companies revealed a positive association between governance and firm value. In a larger scope of governance study by [17] involving 495 firms from 25 countries, a positive correlation was reported between governance score and market value of shares. Moreover, these results were also supported by [18] with their findings of a positive association between governance score and firm value of German companies. Reference [10] also theorised in his study that companies with a strong governance mechanism will have a better stock market performance. Despite the above studies documenting favourable linkages between governance mechanism and firm value, more recent studies by [19] reported no strong relationship between governance factors and performance measures.

The impact of good governance was also reported to influence other firm's financial measures including returns on asset (ROA), returns on equity (ROE) and operating profit. The implementation of the ERM consists of the various components including event identification, risk assessment, risk response, control activities and information and communication. Proper implementation of these elements may help companies to be better prepared to face unexpected surprises. It is important to note that the ERM does not offer absolute protection against all surprises, but by implementing the ERM the companies may not be significantly affected by such surprises. The success of the ERM depends entirely on the implementation of the whole ERM framework which also involves people within an organisation. The degree of the ERM implementation would improve the overall organisational governance. One of the elements of the ERM framework is the internal control which may provide monitoring mechanism against the management's or organisation's assets. Proper internal control could prevent employees from embezzling or misusing companies' assets. This may eventually improve the efficiency and effectiveness of the companies in utilising their assets to generate profit.

Reference [17] reported a positive association between governance and operating performance measured by ROA. Reference [20] studied the relationship between governance and operating performance by utilising the governance index (G-Index) for the periods of 1991 to 1999. Their study revealed a significant relationship between the G-Index and operating performance. Furthermore, they also predicted that a poor governance that would result in poor operating performance may signal the market, thus resulting in lower stock returns. However, they concluded that governance score did not cause a weak stock return i.e., ROE. In a recent study by [10], companies with strong governance mechanism were found to have a higher stock return. Moreover, there were also studies in the governance literature that measured the impact of good governance on operating performance. For instance, [21] reported a positive relationship between governance index and firm operating performance. Reference [10] also revealed that companies with a strong governance had a higher operating performance. Overall, the empirical results including those directly involved in risk management as well as general governance mechanism provided a platform for the present study in assessing the relationship between the ERM implementation and financial performance measured by ROE, share price and operating profit (EBIT).

To date there are limited evidence on the extent to which the ERM could improve financial performance. It is a great contribution to the literature should the present study manage to test the extent of the ERM implementation and its relationship to financial performance. Thus, the present study aims to narrow the gap by investigating the nature of the ERM implementation and its financial implication among the high performance Government-Linked Companies (GLCs) in Malaysia.

III. RESEARCH VARIABLES

The present study utilised the definition of the ERM and framework proposed by the Committee of Sponsoring

ISBN : 978-602-97809-0-1

Organisations of the Treadway Commission (COSO) [4] as the independent variable. In the framework, there are eight main ERM components which include: 1) internal environment, 2) objective setting, 3) event identification, 4) risk assessment, 5) risk response, 6) control activities, 7) information and communication and 8) monitoring. These eight components of the ERM serve as the primary variables in measuring the degree of the ERM implementation.

The variable of main interest is the dependent variable which refers to the companies' financial performance. ROE will be used in the present study as a basis to measure an organisation's performance as it has been used by the various studies on organisational governance literature. The ROE is defined as a profit before interest and tax divided by the total equity multiplied by 100. In an effort to further improve the study as well as to test other measures of companies' performances in the governance literature, other measures include EBIT [22] and share price as a proxy to the firm's value to reflect the shareholder value as proposed by [23] will be utilised. The next section discusses the two main theories utilised in explaining the research framework.

IV. THEORETICAL JUSTIFICATION

The implementation of the ERM currently can be categorised into three; first, the implementation is purely due to the management's own initiatives; second, the implementation is due to the pressure by the board representing the shareholders; and finally, the implementation of the ERM is purely due to the regulatory requirements [6]. The nature of the ERM implementation may be explained by using both the stewardship and agency theories. Perhaps, no single theory can explain the whole spectrum of the ERM implementation.

Though there is intense pressure from various stakeholders both within and outside the companies to implement the ERM, its implementation for most industries is not mandated [8]. Apparently, the implementation of the ERM is voluntary in nature with the exception to the financial institutions and listed companies in the USA [24]. The recent surveys on the ERM implementation reported that the implementation is at the discretion of the management team [6]. In fact, the key driving force of the ERM implementation is the new risk challenge posed by the new types of risk exposures, potential large exposures due to operational failures and regulatory expectations [6], [8]. Almost all public listed companies are now starting to implement the ERM or to a lesser extent, plan to implement the ERM in the next few years. These companies fall within the first category highlighted above where they are not obliged to implement the ERM or forced by the board to do so.

The management's decision to voluntarily implement the ERM perhaps can be explained using the stewardship theory. Realising the importance and potential benefits of the ERM, the management being a steward tries to protect the company within its control by implementing the ERM that aims to improve the shareholders' wealth. The management could also improve the survival of the company in facing unexpected surprises. The financial tsunami in 2008 demonstrated the vulnerability of business corporations and by having the spirit of the steward described in the stewardship theory, the managers will try their very best to protect the company. Such actions are certainly consistent with those intended by the shareholders.

In addition, the characteristics of the steward is described as the one who seeks challenging tasks and enjoys trying to solve those challenging tasks [25]-[26] could be used to explain the managers' behaviours of voluntarily implementing the ERM. The entire ERM process and implementation is very challenging and requires proper coordination and monitoring in assuring a successful execution of the ERM. The managers will also be more aware and alert of any potential events that could affect the achievement of the business objectives. The ERM provides room for the management to solve challenging tasks by properly planning the risk response. Thus, the steward in this case has the appropriate authority to implement the ERM by coordinating all necessary resources within his control. One can conclude that the degree of the ERM implementation mainly lies in the hands of the steward. Again, the stewardship theory may be able to accurately explain the management's decision to voluntarily implement the ERM with the ultimate aim to improve shareholders' wealth.

The second and third categories are companies that are required by laws or other regulatory requirements to implement the ERM or perhaps are forced by the board to do so. In these categories of companies, i.e., the banking industry, the use of the stewardship theory may not be able to appropriately explain the management's behaviour in the ERM. In this context, the management team is not voluntarily implementing the ERM; instead it is mainly due to the regulatory pressure. The agency theory may be more suitable to theorise this management behaviour. Being an agent, the managers will use all opportunities to enrich themselves at the expense of the shareholders. In an effort to solve this conflict, the shareholders as well as other regulatory agencies have to properly monitor the agents' behaviour in ensuring that the companies entrusted to them are properly governed. An example of such a control mechanism may be via the requirements to implement the ERM or for the banking industry particularly, the Capital Adequacy Guidelines by the Central Bank that are based on Basel I and II, in addition to other guidelines concerning risk management [9].

Proper implementation of the ERM should enables companies to identify potential events that could affect the achievement of the business objectives such as increase profitability. By knowing the potential events or risks in advance, it provides the opportunity to the management to identify appropriate actions to face the risks. Companies which do not implement ERM may not have such privilege. Companies may decide to convert risk into opportunity [27], avoid, reduce, share or perhaps eliminate the risk. These risks response is dependent on the individual company's risk appetite in which some are willing to accept a huge amount of risk while others may not. Proper coordination of various units within an organisation could prevent interruption in the business operation and thus prevent any financial losses.

The ERM also serves as a monitoring mechanism to alert management on any abnormal or risky business transactions being executed within an organisation. For instance, Society General, a French bank, suffered huge financial losses (USD7.4 billion) due to highly risky transactions entered by one of its traders. Perhaps if the bank had properly implemented the ERM, there would have been a mechanism to alert the management team on such a transaction once it was executed by a junior trader, i.e., Jerome Kerviel. Failure to be alert of such a transaction enabled the trader to gamble away 50 billion Euros or the bank's entire net worth [28].

To date, there are a limited number of studies to evaluate the actual stages of the ERM implementation among those affected companies particularly using the COSO ERM framework. The management team in all the companies that are subjected to a mandatory disclosure of the ERM is expected to behave as an agent as described in the agency theory. If the assumption in the stewardship and agency theories holds in both cases of the ERM implementation i.e., voluntary and mandatory, this present study expects that the ERM implementation is positively related to the firm's finance. It is hypothesised that: "There is a significant relationship between the ERM implementation and financial performance (Firm Value, EBITDA and ROE)."

V. RESEARCH DESIGN

A. The Population

This study focused on the G20 or the 20 companies which are categorised as High Performance GLCs. According to the Putrajaya Committee on High Performance GLC, these companies become the critical point for the success of the Malaysian economy [29]. The GLCs are defined as companies that have primary commercial objectives with the Malaysian Government having a direct controlling stake in the company. The G20 companies have accounted for RM169 billion in total market capitalisation or 35% of the KLCI index and 23% of total Bursa as of 2005. The G20 also employed more than 250,000 employees as of the period. The G20 are still therefore the main provider to the nation's economy and the Malaysian government has claimed that the GLCs are the critical components of the Malaysian economy [29].

B. Data Collection Procedures

Questionnaires were utilised to collect the data on the nature and status of the ERM implementation. The questionnaires were subjected to detail development and review process [30]-[33]. The cooperation from the IIA was sought to obtain the list of Chief Audit Executives (CAEs) and Chief Risk Officers (CROs) as well as the contact information of the executives from all the High Performance GLCs (i.e., G20). The researcher received great support from the IIAM Technical Director pertaining to the list of CAEs and CROs as well as introduces the study to the executives. Based on the number of the population (i.e., 968), the appropriate sample size required was 278 [34]. This study managed to collect a total of 362 valid responses thus, provide a favourable response rate of 62%. Despite the above fact, there are four companies refused to participate in this study such as Sime Darby, Maybank, Telekom Malaysia and Bank Islam Malaysia Berhad.

VI. RESULTS AND INTERPRETATION

Majority of the respondents were internal auditors (87%) or 299 while the ERM executives accounted for only 13 percent. This was expected as most of the companies that participated in the study had small ERM units to facilitate the ERM implementation.

A. The Relationship between the ERM Implementation and Financial Performance

The primary research objective was to investigate the relationship between the ERM implementation and the financial performance. Statistically, the equation of the hypothesised relationship could be written as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_{IC} IC + \epsilon$$

Where: Y = Financial performance (firm value, EBITDA and ROE)

X_1 = Event Identification Process
X_2 = Risk Information and Communication
X_3 = Risk Monitoring
X_4 = Risk Response
X_5 = Risk Assessment
IC = Industry Classification

A separate set of analyses were performed involving all the variables used as proxies for the ERM implementation with the individual financial performance of the firm value, EBITDA and ROE. The results revealed no significant relationship between the degrees of the ERM implementation and the financial performance. Therefore, there was no sufficient evidence to infer that the degree of the ERM implementation was significantly related to the financial performance. The results indicated no sufficient evidence to reject the null hypothesis. The industry classification was also not a significant variable in explaining the variation in the financial performance. Basically, the results suggested that regardless of the industry classification, the ERM implementation was not directly related to the financial performance.

The hypothesised relationship suggested that the ERM implementation was significantly related to financial performance. However, the present results reported no significant relationship between the two variables and thus, by itself provided an interesting insight for discussion. It seemed that there was no sufficient evidence to infer that the ERM implementation in the banking and non-banking industries could improve the shareholders' wealth as proposed by COSO [4]. The results were in contrary with the finding in the recent study that claimed that one of the benefits of the ERM was to improve the shareholders' wealth and firm value [6].

Moreover, [15] also reported that the movement of the share price was dependent on the ERM strategy. It is hypothesised earlier that the degree of the ERM implementation could improve organisation governance and eventually improve financial performance. The results however, failed to indicate any conclusive evidence to support this hypothesised relationship. Despite the non-significant relationship between the ERM implementation and financial performance, this was actually consistent with the findings of [19] who also reported no significant relationship between improvement in governance and profitability. Perhaps the present result substantiated the argument by [35] who questioned why the ERM failed to protect the banking industry in the USA due to the credit crisis in the late 2008. In addition, the statement made by the ACCA in conjunction with the USA credit crisis that the ERM department in the banking industry did not have sufficient influence, status and power should not be overlooked.

Although, such a claim by the ACCA was not supported by any empirical evidence, it could be a possibility for the reason why in the present study, the ERM implementation in the banking industry was significantly higher than in the non-banking industries, yet it also failed to demonstrate any influence or affect towards the financial performance. The status and power were undeniably critical to ensure a smooth execution of all the ERM activities. The ERM implementation certainly required great cooperation and coordination among the various units in an organisation. Without the necessary authority and status, the CRO may not be able to convene the top management, the board and perhaps the line managers.

Despite the fact that the present study was conducted in Malaysia, there could be a possibility that the issues on the ERM implementation raised in the USA could also be appropriate and relevant to explain the present results. The USA banking industry is known to be the most advance in terms of the ERM but yet, it failed to anticipate the credit crisis in the late 2008 [35]. Indeed, almost all the reputable banks such as the Bank of America, Citibank, Lehman Brothers and many more were badly affected by the crisis. There still is a likelihood that the statement by the ACCA could be applicable as a possible reason as to why the degree of the ERM implementation in the banking industry in Malaysia is not significantly associated with any financial performance. This is true, regardless of the fact that it is more advanced in the ERM implementation compared to the non-banking industry.

The ERM in the agency theory is viewed as one of the controlling elements that may be able to reduce uncertainties. This enables the board and the management team to make better informed decisions which ultimately could improve financial performance. However, both the agency and stewardship theories were unable to explain the fact that the ERM implementation was not significantly related to financial performance. Surprisingly, the impact from the ERM implementation towards financial performance was similar regardless of the industry. Being ahead in the ERM, the banking industry seemed to achieve little improvements in the ERM implementation compared to the non-banking industries. This is true measuring based on the impact of the ERM to financial performance.

The results of this present study added to the present limited body of knowledge where all the ERM variables from the COSO ERM framework failed to significantly improve the firm's value or indicated any impact on financial performance. It is interesting to note that most of the financial measures were not directly related to the ERM. Perhaps, the previous argument on the non-financial measures may be applicable here. The add value element may not entirely refer to the financial measures; instead the scope may be broader to include the non- financial measures. There is a possibility that the ERM implementation is the significant predictor for other non-financial measures such as the corporate governance effectiveness and sustainability of business. The above key findings also led to more research questions for instance: 1) Why does the ERM implementation in the banking industry did not indicate a significant relationship to the financial performance?. Is there any possibility that the claim made by [36] that the ERM unit is not influential and powerful applicable to the local setting?; 2) Is the ERM significantly related to other non-financial measures such as quality of governance and strategic flexibility [37]?; and 3) Does the degree of the ERM implementation reflect the quality of the ERM implemented?

VII. DISCUSSION AND CONCLUSION

The results indicated that the ERM implementation was not directly related to financial performance. There are many possibilities to explain this fact. The CROs and CAEs must view this issue seriously as they are the ones entrusted with the responsibilities and resource to implement and review the overall ERM activities. They must re-assess the overall ERM implementation by focusing not only on the degree but also on the quality of the implementation. A simple survey perhaps could help the CRO to gauge some insights on the level of acceptance by other managerial levels in the organisation of the ERM philosophy. The present study used a multi theoretical approach in explaining the relationship between variables. The use of more than a single theory is hoped to be able to provide better theoretical support due to the nature of the business complexity. The use of both the agency and stewardship theories seemed accurate in explaining the ERM implementation. Moreover, despite the contrary nature of both theories, they are also useful in explaining the ERM implementation. This new application of both theories could enhance the existing body of literature on the applicability of the theories in the present research setting.

The ERM was package as a method or mechanism that could lead to an improvement in the shareholders' wealth, an increase in the financial performance and enhance the overall organisational governance [38]. In spite of this, the present study reported no significant association between the ERM implementation and the financial performance. Another identical research on the ERM conducted in Malaysia by [39] revealed similar results. Moreover the USA's banking industries experience in dealing with risks revealed another disturbing signal on the truth of the ERM implementation [35]. This is in fact, the reality of the ERM implementation. One simple question that was ignored by many corporate executives is whether they really understand the philosophy behind the ERM? Did the line managers and other workers understand such philosophy?

The justifications on the possible reasons for the failure of the ERM to revealed significant association on financial performance remain solely as propositions. More research is needed to investigate the actual reasons that cause weak association between the ERM implementation and financial performance in Malaysia. Perhaps an alternative approach such as case studies may offer some in depth analysis about the actual problems. These future studies should also focus on the following research questions: 1) does the senior management team or the board really understands the philosophy behind the ERM? 2) does the ERM information understood by lower level management and other employees?, and 3) does the leadership and behavioural nature of the management affect the quality of the ERM implementation? Despite its empirical nature, this study was limited by the nature of the respondent where majority of them were internal auditors. Thus all the view concerning the ERM as described in this study may have some element of bias as it could reflect the internal auditors' view of the ERM.

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

Theoretical Framework : The Influence of Technology, Technical Skill and Research & Development Capability To Competitive Advantage

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***Abstract* - In the situation which hyper competitive like in this time, to be able to sustainable in its business, company have to always involved in a continuous process of change in all going concern area. Related to the mentioned, company have to be able to renew capabilities and achieve a competitive advantage. This paper proposes a model for achieve competitive advantage through technology, technical skill and R&D capability which are representing core competence for the firm in reaching performance.**

***Keywords* — technology, technical skill, R&D, competitive advantage**

I. INTRODUCTION

A resources-based view of the firm understands that the heterogeneous resources and capabilities possessed by companies will explain both the existence of the firm and any difference in its results. The company is understood to be a specific set of resources. Amit and Schoemaker [1] define resources as a stock of factors which are possessed or controlled by the company.

Capabilities are the skills of resources co-ordination and mobilisation. Capabilities (flow) are resources (stock) which work together [2] by means of well established routines [3].

Resources and capabilities are core when they are fundamental to the performance of a company and its strategy [2, 4]. Growth, the opportunity to provide new products and enter new market, does not depend so much upon demand as upon the resources and capabilities possessed by a company [5]. Core resources and capabilities can be sources of sustainable competitive advantages for the firm if they allow it to develop strategies that generate value, if they are scarce, inimitable and difficult to substitute, and if they are appropriately integrated in the organization [6, 7]. The combination, development, exploitation and protection of the company's specific resources provide the basis for these competitive advantage.

Resources and capabilities are complementary when they lever the performance of other resources and capabilities [8]. Core resources and capabilities tend to require the presence of complementary resources and capabilities in order to create or add value.

The objective of this paper is to propose some factors or variables that influence of the competitive advantage which generate from modification and combination some concept. So that give clearly picture about sources of the competitive advantage for the firm.

II. CORE COMPETENCE

Core competence is a set of skills and integrated technology that contributed to competitive position in its business [9].

A fundamental concept in the formulation of a technology strategy is core competence. An organization's core competence could be in a technology, a product, a process, or the way it integrates its technological assets [10]. An example of a technical core competence is the creation of a product or service with unique value to customers. An organization's may have core competence in marketing with its ability to access and serve markets in a unique way. Another example of core competence is an organization infrastructure that permits managing operations in a uniquely efficient and effective way. Core competence may also be the human knowledge or skill of an organization's employees.

Core competencies are collective sets of knowledge, skills, and technologies that a company applies to add value for its customers. This is what determines the company's competitiveness. A company can improve its competitive abilities by becoming a learning organization [11]. This means continuously learning and building capabilities that (a) cannot be easily duplicated by its competitors, (b) create new products and services for its customer, and (c) generate alliances and relationships with suppliers to provide its customers with cost and value advantage.

Prahalad and Hamel [4] propose that the core competencies of an organization "are the collective learning in the organization, especially how to coordinate diverse production skills and integrate multiple streams of technologies". Prahalad and Hamel use a tree analogy to illustrate the idea of core competencies in a diversified corporation: The roots are the competencies of the corporation, the trunk represents core products, the small branches represent business units, and the leaves are the end products , as shown in figure 1. Indeed competencies are the roots of competitiveness. The roots of the tree provide nourishment and keep the tree alive.

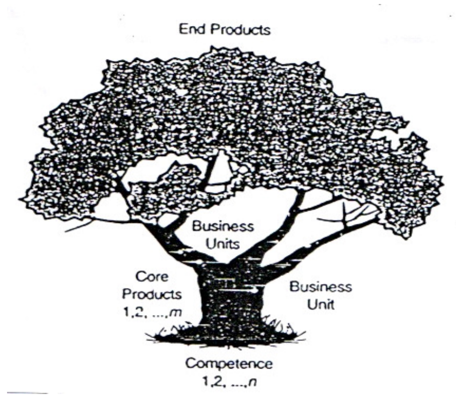

Fig. 1 Competencies: The Roots of Competitiveness

It is incumbent upon management to identify the organization's core competencies. The following common characteristics of core competencies may help an organization distinguish areas of competencies from the multitude of its other activities:

1. They provide the distinctive advantage of organization.
2. They are difficult for competitors to imitate.
3. They make a significant contribution to the end products offered by the organization.
4. They provide access to a wide variety of markets.

Management must consider the company's core competencies as its distinct advantage around which to develop technology and business strategy. The following management actions are recommended:

- Develop, cultivate, and enhance the company's core competencies.
- Deploy core competencies as widely as possible throughout the company's products and services.
- Align all other activities in the company around the areas of competencies to create synergy. When synergy exists, the whole is greater that the sum of the parts.
- Develop an optimal plan for technology integration and outsourcing.
- Build barriers to competitors' entry into the company's areas of competencies.
- Overcome temptation for short-term gains rather than long-term strategic positioning.

Mooney [12] definitions for these concepts that incorporated the concepts' key attributes.

- ❖ *Core competence*: A capability that is central to a firm's value-generating activities.
- ❖ *Distinctive competence*: A capability that is visible to the customer, superior to other firms' competencies to which it is compared, and difficult to imitate.
- ❖ *Competitive advantage*: A capability or resource that is difficult to imitate and valuable in helping the firm outperform it competitors.

A. Technology

Technology in a company (or in a product) consists of three layers, as shown in Fig. 2. The core represents the distinctive technologies; the middle circle, basic technologies; and the outer circle, external technologies. Ford [13] defined these as follows:

- *Distinctive technologies*: Those technologies in which the company's standing gives it a distinctive competence.
- *Basic technologies*: Those survival technologies on which the company's operations depend and without which it would be excluded from its markets. Basic technologies are necessary for a company to stay in business but do not differentiate or distinguish it from competitors.
- *External technologies*: Those technologies which are supplied by other companies. These type technologies are usually available to the market at large.

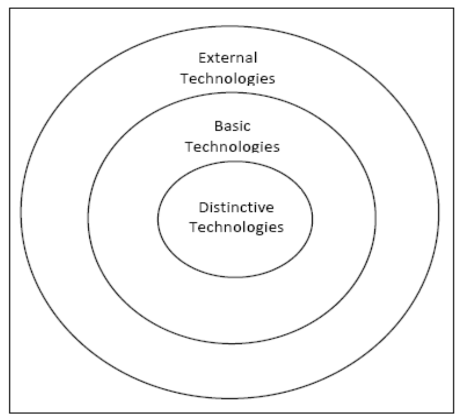

Fig. 2 Classification of technology as to its relative standing in a product

Distinctive technology is what gives an organization its unique competitive advantage in the marketplace. Organization must protect it, nourish it, and capitalize on the fact that they have something desirable that others do not have.

B. Capabilities Hierarchy

All organizations contain a large and diverse array of discrete activities, skills and disciplines (Fig. 3). These elements – termed primary capabilities – are the building blocks of core competencies. The development and operation of most primary capabilities are the responsibility of individual function of a company.

Certain capabilities are distinct from other primary capabilities in that they have a direct and significant effect on competitiveness in their own right. These capabilities, termed critical capabilities, can provide reduced cost, improved product or service differentiation, increased speed to larger barriers to competition. The development of critical capabilities is often a key element of strategies at the strategic business unit (SBU) level.

A useful way to think of core competencies is as *aggregates of capabilities*, where synergy is created that has sustainable value and broad applicability [14].

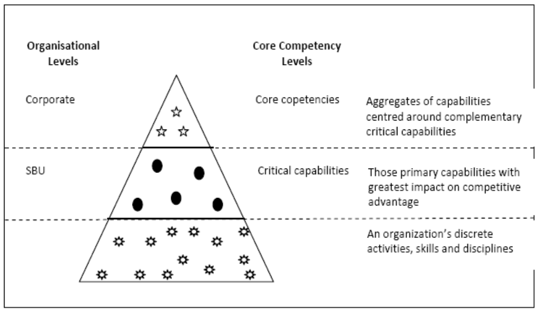

Fig. 3 Core competency thinking involves a hierarchy

Primary capabilities may be usefully divided categories, as follow:

- Market-interface capabilities – capabilities that are used in the marketplace or that are clearly visible to it; selling, advertising, consulting, invoicing or customer satisfaction monitoring are generic examples of these capabilities.
- Infrastructure capabilities – capabilities that concern the internal operations of the company and that are invisible externally; for example, management information systems or internal training.
- Technological capabilities – technical capabilities providing direct support to the product or service portfolio; these may be further subdivided into:
  - Applied science capabilities – fundamental know-how derived from basic research.
  - Design and development capabilities – disciplines employed in converting a product idea into an operational reality.
  - Manufacturing capabilities – capabilities employed in, or directly supporting, established manufacturing or operations.

Most core competencies thus rely on technological and market interface capabilities, two general categories of competency depending upon which group of capabilities predominates within the competency aggregate:

- Core technical competencies (CTCs) – where the majority of the underpinning critical capabilities are technological in nature (where technology is major determinant of uniqueness).
- Core marketing competencies (CMCs) – using the term marketing to embrace product management, pricing, communication, sales and distribution (where most of critical capabilities are market interface capabilities). CMCs are sometimes referred to as non-technical core competencies.

Competencies in each category can be equally powerful, but CTC's are especially important because they are more frequently able to cross market boundaries and can provide the basis for significant product superiority.

C. Technical Skill and R&D Capability

Potitioning and superior performance coming from superiority on skill and resources business. Skill and resources expressing past investment to increase competition potition.

The skills determine "what it is", and thus who it is we have to have on board, and the applications and markets define "what it does", and lead into the discussion of the strategic importance and appropriate level of resources for the technical area.

The company that depend on technology for successfully it business tend to concern on strategy of R&D which completed strategic business level.

Mitchell [15] expressing that the research community needs to become better hunters and gatherers of technology at the same time as it plays a more effective and integrated role in the internal commercialization processes of the firm.

A major goal of strategic planning systems for industrial research organizations is, therefore, to *transform* (in a mathematical sense) the objectives and strategies of the business into core technologies and program priorities for the laboratory, so that changes in business direction will be routinely reflected in the laboratory plan.

III. THINKING FRAMEWORK

Competitive advantage is created through the achievement of five qualities superiority, inimitability, durability, non-substitutability and appropriability. Core competences or distinctive capabilities are combinations of resources and capabilities unique to a specific organization and generating competitive advantage by creating unique customer value. A core competence must be distinctive, complex, difficult to imitate, durable and adaptable to ensure it is a sources of sustained superior performance [16].

Li Hua & Simon [17] argue that it is the triple alliance of foreign technology, government support, and excellent performance of enterprise(s) in implementing the appropriate technology strategy, that contribute to the core competitiveness of Chinese firm. The primary aim of conducting China firm competitiveness research is to apply such conceptual model and establish a practical guidance for firm to understand what their current competitive position is, hence to take the advantages of their existing strengths and enhance their performance.

Matthyssens, P. And Vandenbempt [18] argue that superior value, though, must be sought elsewhere, for instance in service integration or innovation (see infra: key success factors). Superior value creation results from a balanced and inspired management of the value drivers, "assets" and "unique skills" of the general competitive advantage model (figure 4).

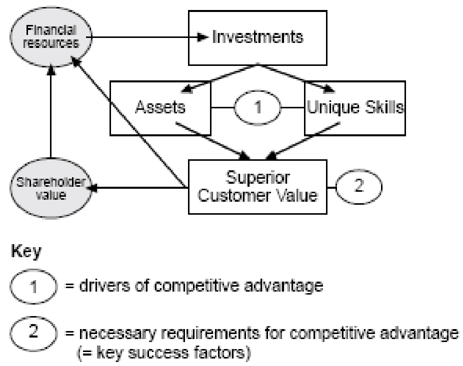

Fig. 4 : Competitive Advantage: Sources and Customer Value

The fortunes of high-technology firms depend on investment in intangible capital, which is comprised of intellectual capital as well as marketing capital. While the importance of intellectual capital – R&D capability, human capital, and the like – has been well established, the central role of complementary marketing capital – in the form of brand name and other marketing assets – in the process of innovation needs greater understanding.

Superior value is received customer representing early the acheivement competitive advantage for company. Competitive advantage is created through the achievement two matter, differentiation leadership and cost leadership.

A. *Framework Model*

Based on review literature and various reseach the above in the past which foundamental thinking to proposed topic in this paper.

Thus framework model the influence of technology, technical skill and R&D capability to competitive advantage, design as shown in model structure at Fig. 5.

Based on this model structure, key success factor competitive advantage company is created through its own capability that representing core competence.

That capability involved tangible asset and intangible asset. Tangible asset representing capital on technology capability. While intangible asset representing intangible capital through technical skill and R&D capability.

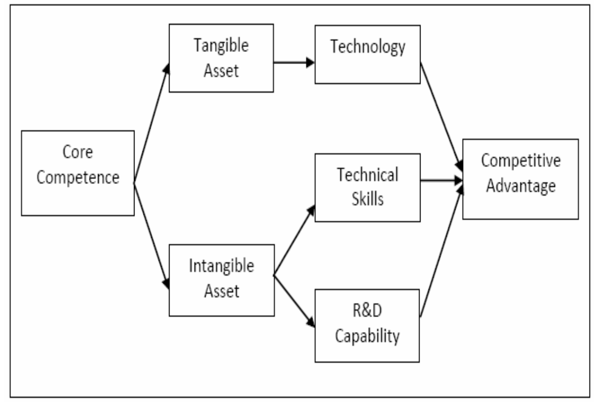

Fig. 5 : Model Structure

IV. DISCUSSION

Based on study about the influence of technology, technical skill and R&D capability to competitive advantage which presentate in this paper, there are something materials for discuss among others:

1. This model is designed based on theoretical study so that require to be conducted empirical examination.
2. Variables which are considered in intangible asset only intellectual capital while marketing capital not be include as variable.
3. This model based on Resources Based View (RBV).
4. This model emphasizing at Core technical competencies (CTCs).

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

Practical experience in the ecoFLEX flexibilty evaluation tool in medium sized companies

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Abstract - **The requirements for production systems are constantly changing as a result of changing competitive conditions and their associated performance targets of time, quality, cost and innovation. The rapid rate of change, coupled with a high complexity of the cause-and-effect relationship between industries, globally spread markets, technologies and economies, impose high demands on the production systems. Uncertain projections regarding future sales, large volume fluctuations, the steady advance of new manufacturing technologies and ever shorter product life cycles with changed product requirements; combined at the same time with increasing product variety, demands the constant adjustment of production structures to meet the current market requirements. This poses a major challenge to small and medium enterprises (SME's) in particular to find an economic balance between the prevailing market uncertainties and the correct organisation of their production systems. In the following work the flexibility assessment tool ecoFLEX ,developed at the FZI Research Centre for Informatics, will be presented along with the practical experience gained in its application at various medium sized manufacturing companies.**

Keywords — **production system, flexibility management, change management, production planning and control, SME**

I. Introduction

"*In a world of constant change the only ones to survive are those who manage to successfully adapt to the new requirements in time.*"

This statement applies to many areas of modern life, biology being a prime example, because with the beginning of life on earth and in the course of evolution there were always creatures which died out due to their changed environmental conditions, while others permanently developed further. Symbolically, this can be also transferred to the international market where a constantly advancing selection between the various competitors occurs. There are those who drop out of the market, while others maintain their position. For production companies especially, this results in the need to plan their resources so that they can be sustainably used to bring about a cost- and demand efficient production. Meaningful selection criteria are the self-imposed requirements to master the extremely high level of customer individulisation with a difficult to manage product and product variety, an ever decreasing product life cycle as well as evolving technological innovations. These criteria are exacerbated further by the current financial crisis. To continue to survive in international competition, the right answers to the following production-related core issues [1] [2] from the company's point of view must be found:

- How can production systems be most effectively developed and sustainably renewed?
- How does the ever-increasing uncertainty in production planning counteract the products to be manufactured in terms of their type and complexity?
- How are the high-quality, customized products that are subject to tighter budgets and time constraints to be produced?

To answer these and similar questions, different systems, strategies and approaches exist that can be transferred according to the company-specific interests. A critical point remains however, in that it is often very difficult for companies to have an overview of the impact of the system choice or the implementation of a concept or strategy. The reason for this is that until now no satisfactory means was available by which the overall scope and consequence of such decisions could be evaluated. Instead, they are subjected to a special application and often allow only isolated investigations [1] [3].

In order to continue to survive in the international market, the well-known strategies and concepts such as outsourcing, regional in-sourcing, operator models, lean manufacturing, integrated production systems or flexible working hours and their adaptation to the company-specific interests are not sufficient on their own [1] [4]. Often there is a lack of consideration of the overall context within which the impact of the choice and implementation of a new concept or strategy is evaluated in light of its economic efficiency. Therefore the need arises for a holistic way of viewing and evaluating production systems which requires a simple integration within the production management, especially from the perspective of the manufacturing SME's. In particular, the ability to respond to fluctuations in capacity demand must be quantifiable (volume flexibility) and, consequently, able to clarify to what extent changes in the demand for individual product types or variants influence the economical production (Mix flexibility). Furthermore, capacitive expansion- or decommissioning possibilities of systems also need to be made measurable (Expansion flexibility), since supply- and demand changes are not only significant from an operational point of view, but also have strategic relevance [1] [4-6].

II. State of the Art

However, existing PPS-/ERP-system solutions do not offer adequate solution possibilities. In fact measures that decrease costs can be achieved with their help, as for example the reduction of the cycle time which decreases costs of the production, or reducing the stock of inventory. However, flexibility or even modification oriented considerations are not regarded [3]. Thus, neither considerations in regard to economically optimal production programs of short-termed orders can be executed, nor can the existing flexibility and the adaptability be evaluated across different systems. The reason might be medium-term and long-term changes in demand or in the variant offer, with involving the construction and the deconstruction of production infrastructures or an economically wise adjustment of the supply chain at the same time. Considering digital factory planning systems, which are applied rather rarely in the SME-surroundings, they feature decisive weaknesses when it comes to the right layout, the dimensioning and personnel placement of the production equipment , above all related to their economical effect on [1] [7].

In the specialist literature one can find different approaches that are independent from the typical PPS-/ERP-function and digital factory planning tools, and that try to measure the flexibility of a production system (cp. [1] [6] [8-10]. However, it is extremely difficult to determine indices that are basically flexibility-related for this kind of considerations. On the one side, reasons therefore are unsolved problems of a universally valid measurement and the evaluation of flexibility of a production system. This traces back to the multi-dimensional character of the flexibility that is the coequal link-up of the dimensions time, costs and variety. On the other side, flexibility demands might vary in different fields of a production system, which requires unambiguous, focused consideration possibilities, of which there is a lack until now. Comprehensive investigations that were carried out according to the present state of art and research demonstrate, that indeed several evaluation methodologies exist, however many of them can be applied in certain cases only and were developed in an earmarked way. That is why they are limited to isolated considerations. Thus, procedures for measuring the flexibility in the production are given little attention in the industrial practice although they are very important [1] [3].

III. The Evaluation Methodology ecoFlex

Based on this need for action an evaluation methodology by the name of ecoFLEX (economical flexibility measurement) has been developed and implemented in the software framework at the research center *FZI Forschungszentrum Informatik* in Karlsruhe, Germany, under the direction of Dr.-Ing. Sven Rogalski. In the following the evaluation methodology will be explained from the point of view of its conceptual construction and from the use that results from its application.

A. Concept of the Methodology

Using existing resource information and their cost-, time and application dependences, as for example from PPS-/ERP-systems, quantifiable parameters can be calculated with ecoFlex. By means of these parameters, objective evaluations of the responsiveness of a production system can be executed. Depending on the purpose of the flexibility analysis, different *flexibility evaluation methodologies* are available. They evaluate to what extend capacitive fluctuations in demand and changes in demand for single product types or variants that go along with it, do influence an economical production, or what possibilities of capacitive re- and deconstruction measures exist. Beyond the state of art and research, this enables *objective flexibility analysis* on *different levels of production systems* (eg. factory, segment, line and workplace). Due to the fact that calculation parameters, which can be determined for different types of production systems, form the basis of the flexibility evaluation methodology, it can be applied in *different sectors.* Its customization to different evaluation challenge requires little effort and thus contributes to the user acceptance of SME above all. The reason for this is the *production system model* that had been designed for this purpose only, which allows to present evaluation-relevant and existing production objects in an abstracted way, and that ensures the logical, level-related gathering and structuring of the needed flexibility parameters. Besides that, due to the object orientation of the model, it offers a great freedom when it comes to the parameterisation and it permits uncomplicated, dynamic model configurations, so that the structure and causal connection of the production systems that are analysed can easily be simulated. By means of a mutual link of the production system model with the flexibility evaluation methodologies, objective analyses can be executed easily and reliably. This enables identifying flexibility-related dependences between single production objects, so that flexibility deficits can be allocated to the responsible unit. The mechanisms of the evaluation methodology ecoFLEX are implemented in a software tool of the same name, that had been developed for this purpose only, and whose conceptual set-up is represented in the following figure (figure 1) graphically.

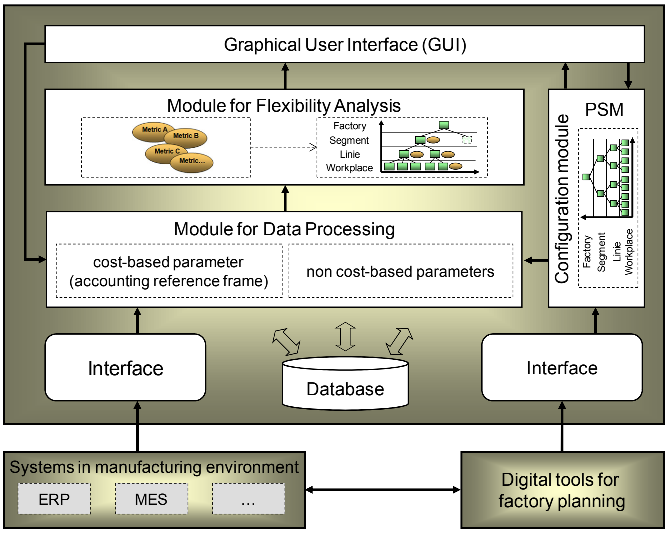

Fig. 1 *System architecture of the software tool ecoFLEX*

B. *Benefit of ecoFLEX*

The utility of ecoFLEX has repeatedly been demonstrated in practice. By now, ecoFLEX is applied in different small and medium enterprises, but also in major enterprises, where it effects a remarkable reduction of costs of the production- and change management. The potentials that result from the multiple possible fields of application shall be demonstrated by the following practical experiences that had been made in different companies:

- **Reduction of the decision-making concerning investment projects:** The decision for acquiring a new automated workplace at the production location of a series producer for infotainment products demanded a mean accumulated effort of 6 man-month (MM) , which caused mean costs of approx. 54.000 €. By means of the ecoFLEX-solution this effort can be reduced by 70% on the basis of a considerably improved transparency of the causal dependencies in the production, which equates a cost-saving of 37.8000 € per each automation workplace that has to be supplied. Due to regular changes in the production at a location, four new workplaces are currently needed in a year at an average. This results in a total saving of 151.200 € per year by means of the ecoFLEX-solution.
- **Reduction of follow-up costs due to considerably improved selection decisions:** Based on a standardized, objective evaluation-basis consistent and transparent flexibility analysis result, with which flexibility deficits at a production system can easily be identified, allocated correctly, and eliminated purposefully. As a consequence, follow-up costs can be reduced when operating materials are newly acquired, as the security in planning increases. Thus, the probability of avoidable follow-up costs by choosing a suboptimal investment decision could be reduced from 33,3% to 10% at the series producer that was mentioned before. This lead to a mean cost saving of 15.000 € per newly acquired workplace, which are 60.000 € per year.
- **Risk minimization in factory planning:** Regardless of the digital factory planning tool that had been applied in the other companies, they featured weak points in the layout and dimensioning of production equipment that are related to their economical effect above all. Here, applying ecoFLEX allowed to clearly improve the factory planning whose cost efficiency was checked, which maintains the right degree of flexibility. Thus, we were able to demonstrate economically wise alternative configurations of different production systems that minimize its dependence on certain products or product variants. This guaranteed both an improved medium-term as well as a long-term coverage of the economical production.
- **Improved planning of the labour utilisation and improvement of the production program:** Next to a simple flexibility analysis, additional production-relevant parameters can be determined with the use of ecoFLEX, like break-even quantities or time- and cost optimal production programs. That is why it can also be evaluated how Ad-hoc-orders have to be triggered in the current production program, so that they can be completed economically efficient in consideration of costs and setup configurations, as well as preliminary lead time and holding time. Besides that, the most cost-effective labour utilisation for processing upcoming production orders can be determined for different periods, and then the most profitable working time model has to be allocated to them. These are functionalities that are not covered by existing PPS- and ERP-systems /- functions. That is why those companies that applied ecoFLEX gained precious cost saving potentials in matter of short term- and medium term coverage of their economical production.

IV. Practical Experience with ecoFLEX in Production

The production company that is specified here is a producing business of the middle class for pressing- and assembling technique with about 140 employees. Due to the increasing cost pressure and the tightened competitive situation in the global market, increasing demands are made to the competitive ability of the company. A great diversity of variants, low costs that are associated with a high degree of innovation- and quality, as well as shortened times of implementation with short-term incoming orders at the same time, lead to a great uncertainty in planning. In addition to that this uncertainty is strengthened due to the worldwide financial crisis. That is why the company is forced to estimate its economically justifiable freedom of action in the production properly, in order to be able to react flexible to unexpected incoming orders. In this context the question is how the degrees of freedom of the company-specific production system can be evaluated, namely to what extend:

- It can react to varying quantities demanded,
- Changes in the composition of the product-/variant mix influence its efficiency,
- Production bottlenecks and weak points of the flexibility have to be eliminated and what kinds of action alternative have to be chosen.

Against this background it had been initiated on the part of the company to go back to digital factory planning tools, in order to ensure a higher degree of certainty in planning. As a result of the created potentials of a virtualization, different courses of action in the production planning and the production could be simulated. However, a remarkable weakness was the lack of an adequate evaluation basis for quantifying flexibility space under economical points of view. According to that it was hard to accomplish a well-directed proceeding for identifying and evaluating flexibility deficits within the production infrastructure. It was possible to evaluate the complex production relations from an economical point of view when ecoFLEX was applied only. For this purpose a interface between the existing ERP-system and the ecoFLEX-software was implemented with the cooperation of the company Open Experience GmbH in Karlsruhe, which enabled a live-access to the ERP-Data. The flexibility analysis of the production system in the company that was carried out afterwards brought out unexpected results. They shall be pointed up exemplary with the help of an analysed assembly line that produces special component parts of the automobile industry.

Thus, by means of the ecoFLEX-analysis it became apparent for the first time, how many piece numbers are needed within the assembly line to produce cost-effectively. This corresponded with the production figures of at least 1.286 pieces (break-even quantity) and at most 5.596 pieces (maximum production) with regard to a period that is not defined more exactly here (cp. figure 2 above, left side). In case that the number of pieces deviates from this range, this will inevitably lead to profit setbacks. Before applying ecoFLEX the acquisition of an automated workplace had been planned that should replace workplace *0060* and that should increase the production quantities. However, this was excluded immediately as it would have resulted in flexibility losings. It only would have effected an increase of the break-even quantity with a constant maximum production of 5.596 pieces. That is why other alternatives were taken into consideration that specially aimed for the elimination of the flexibility bottleneck, workplace *0065*. Contrary to the expectations of the production scheduler and the production manager, the extension by an additional workplace for employing an additional workman was the most efficient one. This resulted in an advancement of the flexibility of the line altogether, from originally *77,03 %* to *80,18 %*. Expressed in production figures this means a reduced break-even quantity of 1.220 pieces, as well as an increases maximum production of 6.156 pieces (cp. figure 2 above, right side).

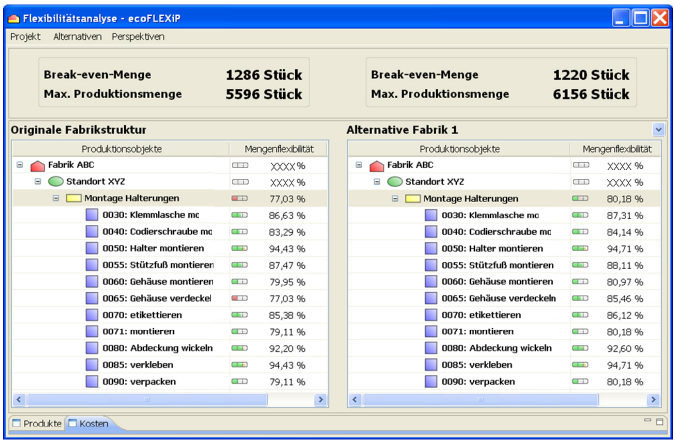

Fig. 2 *Flexibility analysis with ecoFLEX*

Furthermore, it was detected that when workplaces *0050* and *0085* were planned, a dimensioning that is too large for them was chosen. This becomes clear with the help of flexibility indices that are greater than *94 %* and that are greater than the average flexibility index, in contrast to workplace *0065* (cp. figure 2 above, on the left). As a consequence a flexibility overplus resulted, that caused avoidable additional costs due to the acquisition of both workplaces. This awareness surprised the production management, too, as no information about this was available although the production was simulated with the digital factory planning system.

Another important aspect of the ecoFLEX-analysis was the planning of the personal placement for the processing of an ad-hoc-order of 12.000 pieces for a certain type of component parts of an automobile. For this 5 weeks were available next to the running order processing, valid working time models were *single shift*, *double shift* and *working on Saturdays*. On the basis of these general conditions, by means of ecoFLEX detailed information was given about the most economically wise personnel placement at the different workplaces and at the line as a whole, as well as the resulting output quantity (e.g. workplace 0050: 0,241• 8h/shift • 60 min = **116** min./shift labor time). Here the additional value of ecoFLEX was demonstrated again, as the calculation that was executed by the company planned 21 workmen for the order processing on schedule. However, 16 workmen were needed with an efficient personnel placement planning only (cp. Figure 3).

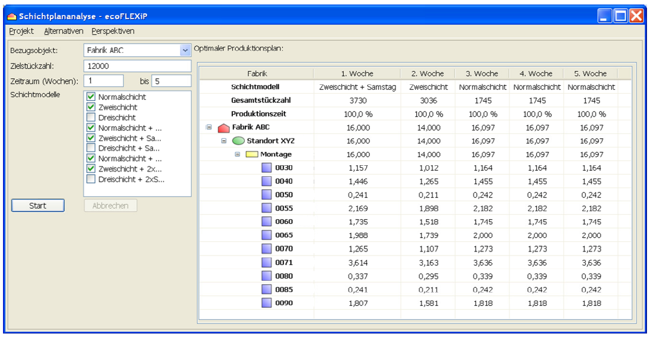

Fig. 3 *Analysis of working time models for ad-hoc-orders with ecoFLEX*

Further analyses that were carried out by means of ecoFLEX concerned considerations of scenarios of outsourcing (external processing of intermediate products that had been produced by the company itself) and insourcing (in-house production of intermediate products that were bought in addition) of single processing duties, under detailed declarations of each production costs. This also presented surprising analysis results that influence significantly the system flexibility; however, they shall not be discussed in detail at this point.

V. SUMMARY AND OUTLOOK

At an operational level, the software tool ecoFLEX proved to be very successful. It allowed the flexibility of existing as well as newly planned production systems to be quantified and assigned individual system objects, which form the basis for a detailed analysis. The unanimous opinion of various users of the software was that it allowed a rapid identification of flexibility vulnerabilities that can be correctly classified and purposefully eliminated. Thus, the existing gap can be closed between ERP / PPS systems and digital factory planning tools used to study the impact of production and system changes on the profitability of the total production.

Small and medium enterprises (SME's) in particular can benefit from this because it provides them with an evaluation tool that enables them to remain competitive, even compared to competitors from low-cost countries, despite the ever-intensifying competition, tight cost- and time budgets and increasingly complex production relationships. This is based on the one hand, on improved on-time delivery and the resulting increased customer loyalty, which ensures a steady demand and promises growth in profits. On the other hand, the unique evaluation capability of the evaluation method produces a targeted and dynamic approach to production resources, personnel, material and equipment. Unnecessary additional costs from the inefficient use of resources or the ineffective adjustments of the production infrastructure, like the construction and deconstruction of production facilities, are avoided and funds are created for future investments in the companies. Thus, existing jobs are protected and new jobs are created. Again, a representative example referred to here is a production company for stamping and assembly technology which, under the conditions of the economic and financial crisis, is building/acquiring new production sites (in the Asian market) and integrating them into their existing value network.

There are also other cooperative relationships which exist with medium-sized production companies. Large companies such as Porsche AG, Daimler AG and Harman Becker Automotive Systems GmbH also show great interest in implementing ecoFLEX as a mechanism for flexibility evaluation, as well as serving to further develop their own production- and change management. Besides such traditional manufacturing companies, there have also been co-operations with various IT companies who develop software solutions for the production environment. They promise innovative and functional advantages over their competitors through the integration and expansion of the flexibility evaluation methodology within the scope of their own product range.

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ISBN : 978-602-97809-0-1

Cross case comparison of organisational change factors in lean manufacturing implementation

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Abstract - Lean manufacturing is a proven approach for success in manufacturing industry. However, several organisations failed in their attempt to implement lean manufacturing system. The transition to lean manufacturing requires radical change which involves a total reshaping of purpose, system and culture of the organisation. This paper presents an investigation on the influence of organisational change to the transition of lean manufacturing. This study used qualitative research method involving multiple case studies of three Malaysian automotive parts manufacturing firms. For each respondent, the interview was conducted for approximately two hours. It involved key personnel that directly involved in the company's implementation of lean manufacturing. The results revealed that company which emphasized on leadership and management, change agent system, effective communication, worker's empowerment through training and team development, and also lean review system experienced smooth transition to lean manufacturing system. Failure to recognize the required organisational changes to adapt lean manufacturing system will hinder the long-term benefits of the organisation.

Keywords - lean manufacturing, organisational change, automotive industry, Malaysia

I. INTRODUCTION

Today, change is not an exception but a steady going process. The change has its own impact on both processes and people. So attention is required on the impact of change on both processes and people. The practice of organisational change management ensures the personal elements are aligned with the business strategy, technology and business process. Jones *et al.* [1] defined organisational change as the process by which organisations move from their present state to some desired state to increase their effectiveness. Whereas, Greenan *et al.* [2] pointed that organisational change is the change in the distribution of power, skills, information or communication with the changes in the distribution of skills and in skill requirement. It is suggested that, if an organisation is to change to a lean organisation, the organisation also needs to change the way they value the different dimensions of work.

So far, there is little discussion about the link between the organisational change management and lean manufacturing implementation. In fact, one of the major challenges of lean implementation is guiding the change journey as detailed in the implementation plan. This is because lean manufacturing requires change in structure, system, process and employee behaviour [3, 4]. This phenomenon is similar to the case of TQM implementation, which lean manufacturing shares a lot of similarities especially concerning the origin, methodologies and tools [5, 6]. Regarding the change management in TQM implementation as mentioned by Huq *et al.* [7], the main obstacle can be linked to ineffective change management. Cao *et al.* [8] highlighted that if organisational change is not properly addressed while implementing TQM, the implementation might easily broken to small pieces. The wrongly implemented TQM system only manages the TQM tools and practices, without looking the interaction between the tools instead of managing the whole TQM system. This idea leads to the necessity for more research for the successful implementation of lean manufacturing process where the organisational change is effectively managed.

Therefore, we need to understand what is the nature of organisational change in lean manufacturing and what are the elements needed to ensure the successful implementation of lean in a manufacturing firm. The aim of this paper is to examine the impact of organisational change to successful implementation of lean manufacturing system. Failure to recognize the required organisational changes to adapt lean manufacturing system will hinder the long-term benefits to the organisation.

ISBN : 978-602-97809-0-1

II. LITERATURE REVIEW

The change from traditional manufacturing system to lean manufacturing system is a radical process and not an easy task [9, 10]. Lean manufacturing represent a holistic approach to change. In order to create the foundation for lean manufacturing to take hold, a significant organisational change must occur within the organisation. According to Narang *et al.* [4], the process of lean transition requires significant changes in the functions of the company. In the analysis of managing the change towards a lean enterprise mentioned by Smeds *et al.* [10], lean transition requires emergent strategy. This emergent strategy emerges when the environment of the organisation becomes recognised and legitimised. Changes that requires in lean manufacturing can be divided into four categories as suggested by Cao *et al.* [8] as shown in Table 1. Table 1 show the changes requires during the transition to lean manufacturing.

Lean manufacturing involves changing and improving process. In order to success, there are prerequisites to the transition of lean manufacturing. Table 2, presents the critical factors that are required for successful lean manufacturing implementation. Leadership and management commitment is the most critical success factors in lean manufacturing followed by communication, team development, cultural readiness and employee autonomy. Transformation to lean manufacturing system can fail if the relationship between organisational changes is not fully understood. To stay competitive in today's global manufacturing environment, companies must develop a systematic change process and plan to support lean manufacturing implementation.

III. METHODOLOGY

This study used qualitative research method involving multiple case studies of three Malaysian automotive component manufacturing firms. These three companies were selected based on their willingness to participate and experience in implementing lean initiatives. Therefore the results from these case studies do not represent the actual overall situation of Malaysian automotive industry.

The authors prepared the data collection by first contacting each company to be studied to gain their cooperation, explained the purpose of the study, and record the key contact information. A semi-structured interview guide was developed upon a common case study protocol inferred from the review of literature, and an exploratory survey was done prior to the case study. The interview protocol was developed to probe the organisational change elements that influence the lean implementation process in Malaysian automotive companies. To improve the research reliability, the same interview protocol was used to different interviewees for triangulation purposes. The need for triangulation arises from the ethical need to confirm the validity of the data obtained [11].

TABLE 1
ORGANISATIONAL CHANGES REQUIRED IN LEAN MANUFACTURING

Categories in organisational change	**Changes in lean manufacturing**	**Authors**
Changes in process	Application of the full set of lean tools, multi-skilled worker.	[3, 12, 13]
Changes in function, co-ordination and control	Teamwork building, cross-functional movement, network relationship with suppliers and customers, information transparency, participative management, teamwork rewarding.	[3, 13-15]
Changes in values and human behaviour	Teamwork, open communication and information sharing, continuous improvement culture, knowledge learning and sharing.	[3, 13, 14, 16]
Changes in power within the organisation	Decentralised responsibilities, autonomous leadership.	[17, 18]

TABLE 2
CRITICAL SUCCESS FACTORS IN LEAN MANUFACTURING IMPLEMENTATION

Critical success factors	Authors								
	[16]	[14]	[3]	[15]	[13]	[17]	[19]	[20]	[21]
Leadership and management commitment	×	×	×	×	×		×	×	×
Team development		×	×			×			×
Communication	×		×	×	×	×		×	
Education/ training			×						×
Change agent					×				
Culture readiness/ organisational culture			×				×	×	
Employee autonomy				×		×		×	
Lean change review/ evaluation				×		×			
Worker empowerment								×	×

All interviews were in the form of a "one to one" discussion that lasted approximately two hours for each respondent. Each interview was recorded and transcribed. The respondents involved key personnel in the company that directly involved in implementation of lean manufacturing. They were questioned with regard to their actual experiences. For consistency in the data and its interpretation, the interview structure was provided. Table 3 summarised the case study respondent and company background. The data collected from the interviews were analysed using NVivo 8 program. The themes discovered in the analysis mirrored the study questions. The themes occurred through coding in the program and they include change readiness, leadership and management support, effective communication, review system, team development, change agent system and workers' empowerment.

TABLE 3:
SUMMARY OF THE CASE COMPANIES' RESPONDENT

	Company A	Company B	Company C
Position	Assistant General Manager	Manager – Manufacturing & Production Department	Manager – Production Control & Lean Production System
Tenure at position	18	5	9

A plant tour was requested and offered at all companies visited. During the tour, the lean activities involved were showed and explained in detail. Whenever possible, the observation was made on the organisational change elements that occurred in the transition to lean manufacturing system. The information gathered was written down in a log book with the summary from the interviews. The purpose of these observations was primarily to verify the information collected from interviews

IV. RESULT & DISCUSSION

The analysis of the case companies yielded interesting results. As can be seen, the three companies have different experiences compared to each other. Table 4 presents the summary of the case companies' background involved in the study. The three companies involved in the study are categorised as automotive industry but manufactured different automotive components. Company A and C can be classified as old companies as they were established more than 20 years ago compared to Company B, which is only 11 years of incorporation. Company A is owned by a Japanese corporation headquarter in Japan, whilst Company B is locally owned. Company C is a joint venture company with a Japanese company. All the three companies are grouped as large companies with the number of employees more than 250. Regarding lean manufacturing implementation, Company A and B had been unsuccessful in the first lean attempt. However, for Company A, after some changes made in the second lean attempt since 2002, the company is successful in implementing lean manufacturing. Whereas, for Company B, since reenergizing its lean attempt in 2007 with the assistance of one government agency, the company has shown some progress in its lean implementation. On the other hand, Company C had just started its journey to lean. As a beginner and first timer, Company C is facing lots of problems and crises but determined to the pursuit of lean firm.

In order to create the foundation for lean manufacturing to take hold, a significant organisational change must occur within the organisation. This raises key questions: How the company change to lean manufacturing system? How organisational change factors assist these companies to lean manufacturing system smoothly? In order to establish the organisational factors that support the smooth transition to lean manufacturing system, a cross case analysis was performed upon data obtained from each of the case companies. The findings discovered through theme coding in the NVivo 8 program are briefly discussed as below:

A. *Change readiness*

Change readiness is the excitement and commitment at both individuals and whole organisation to change. In the beginning of lean manufacturing implementation, all respondent companies faced resistance not only from operators but also management team. As described by one of the respondents:

TABLE 4:
SUMMARY OF THE CASE COMPANIES' BACKGROUND

	Company A	Company B	Company C
Type of product	Electronics	Metal	Electrical
Company age (years)	27	11	31
Company ownership	Foreign	Local	Joint Venture
Company size	Large (>150 employee)	Large (>150 employee)	Large (>150 employee)
Lean effort	1996 (1st attempt), 2002 (2nd attempt)	2004 (1st attempt), 2007 (2nd attempt)	Aug 2009

ISBN : 978-602-97809-0-1

> *Actually, we faced a lot barriers and challenges that delay our improvement activities. There are a lot of excuses for them not to change.*

There are many reasons of why these workers are reluctant to change. All respondent companies agreed that the main factor was the misunderstanding of lean manufacturing concept. The workers' perception of lean manufacturing is the new system will burden them with extra work load and a new way of doing work. Some workers in Company B even mentioned about manpower reduction. They believed that by implementing lean manufacturing, the management will make them redundant. However, the resistance could be overcome if there is ample attention and time given to the process of change. Stanleigh [22] suggested that to deal with change resistance, management should create a sense of need and urgency for change, communicate the change message and ensure employees participation in the change process, and provide anchor points or base for the achievement of change. Therefore, all the respondent companies had created the readiness to change by provide training on lean manufacturing concepts and tools, clear instruction from top down, successful initial lean projects and some financial incentives.

B. Leadership and management

All respondent companies claimed that their top management are very supportive to the lean manufacturing implementation especially in Company A. As the company is owned by a Japanese corporation which have a close relation with Toyota, the former Managing Director of Company A was very supportive, positive and knowledgeable in lean manufacturing. During the transition to lean manufacturing system, the manager gave clear directions and detail activities to respective departments. As highlighted from the interview with Company A's top management:

> *So the most important thing is the top management must also know about lean. The reason is they are the leader and the captain of the company. They must indicate the company's directions. What is the management policy and what is the direction they want to go.*

As mentioned by many researchers, the role of leadership and management is critical in the conversion to lean [14, 16, 19]. Scherrer-Rathje et al. [15] and Worley and Doolen [16] also agreed with the above statement that for the lean implementation to be successful, visible and active senior management is critical.

C. Communication

Effective communication in lean is regarded as the high use of communication channels to disseminate the lean manufacturing concept and feedback system. Successful implementation of lean manufacturing requires announcing, explaining and preparing people for change and the effects of the impending change especially in the early stage to become lean [16, 23]. Company A has managed to ensure the lean manufacturing concept is conveyed to the entire company. They disseminate the lean information and get feedback from Monday morning meeting or Asaichi meeting for manufacturing department, weekly management meeting between middle management and operators, bulletin boards, monthly newsletter and frequent meeting with union. However, for Company B and C, the lean communication process is only revolved among managerial level and supervisors.

D. Change agent system

The process of change within an organisation is derived fundamentally from the ability of a set of individuals within that organisation to modify the behaviours (thoughts and actions) of others. Change agent system is a system to assist the translation of change process so that it could be understood by all people in the organisation [14, 24]. All the three respondent companies have established a team or department that is responsible in lean manufacturing implementation with permanent staffs except for Company B. The main tasks of this team are: to execute improvement activities which usually based on project basis, encourage teamwork in every lean activity, give advice and monitor departments' improvement activities, and provide training in lean manufacturing. As described by Company A:

> *To make this (lean transition) effective, this person (lean leader) must understand lean. Clearly understand. A lot of people just attend the training but misinterpret the concept. They only have the theory but not practical. As a lean leader, to execute all these (lean) activities, you must have hands-on knowledge.*

Therefore, the role of change agent is crucial in lean transition. According to Stewart [13], lean change agent must be sensitive to change issues. The reasons are most of the employees are not familiar with lean work environment, and it requires a behavioural and mindset change due to the different expectation for performance and value. As mentioned by Company B, the lean change agents need to be creative.

E. Team development

Lean manufacturing is usually accompanied by a shift towards exposure and problem solving. According to Motwani

[3], the lean manufacturing process began by creating cross-functional team as a supporting structure of lean. The following comments reflect the actual situation:

Company A:

> *What we need is they (operators) to participate as a team. When they share their ideas, they will feel proud because the company appreciate them. Lean does not talk about what you have achieved. Lean is about teamwork – how to make these people to participate and join to give ideas. When these people brainstorm, a lot of ideas will generate.*

Company B:

> *Every week we have quality meeting between department such as production, quality, PPC (production planning and control), production engineering and die engineering. We also have weekly operational meeting where we shall discuss about the issues and problems occur, and the future planning or any action to be taken.*

Company C:

> *We have LPS (Lean Production System) team and supporting committee from each department. The main committee will be the LPS team, and the sub-committee is depends on the project.*
>
> *So every time we have meeting with lean expert, we go for gemba to the area to improve. We study and get some ideas. If confirmed, then we will ask the other team members to understand whether the ideas can be implemented or not. Or any suggestions or comments from them. After that, we will proceed for the improvement. That's what we are practising right now.*

F. Worker empowerment

Another effective approach to overcome the worker's resistance to lean manufacturing is workers' empowerment or reinforcement of lean attitudes through training, motivation and reward system [6, 25]. Appropriate training on concept and basic principles, and reasons of lean could give greater level of understanding of lean and encourage motivation and innovation in the work culture and employees attitudes [26, 27]. Among all the three respondent companies, Company A has a well developed lean training program compared to Company B and C. The training in Company A, which is conducted internally by the lean team have two stages. The first stage was more on the lean concept. Whilst, the second stage of training module emphasized on lean applications or hands-on activities. As mentioned by Company A's respondent:

> *Then, in the next level, we go to the shopfloor activities. Some of the activities are more detail which involved more in the application. The main purpose is to change their mindset. We don't want them to think that lean manufacturing pushes burden to them. Lean is trying to help them and at the same time help the company.*

Meanwhile, Company B and C are dependent on training organised external consultants especially from government agency and customers such as Proton, Perodua and Toyota. This is due to lack lean experts in the company. As highlighted by respondent of Company B:

> *Yes. I do the training because the HR does not have the capacity to teach in lean manufacturing. There is only me ..... The progress is quite slow because it is all under me*.

Regarding the reward system, all the respondent companies have a rewarding system scheme but only concentrated on kaizen activities. However, Company B has additional rewards given to "Best employee of the month" and productivity incentives to boost the workers' motivation.

G. Review system

Periodic change review is important to ensure whether the steps planned were followed [7]. Melton [28] and Srivinasaraghavan and Allada [29] point out that change review is important to control and sustain the lean manufacturing system. The elements that usually been analyzed are performance measurement, communication system, business and physical processes, and continuous improvement or improvement records [12, 27, 28, 30]. For Company A, the review system is extensive. They have monthly follow up meeting, quarterly reporting that need to be sent to the headquarter in Japan and also regional report for information sharing and benchmarking. Whereas, Company B have key performance index (KPI) as lean level monitoring. The KPI is divided into management fundamental activities, process stability and lean items, which is monitored every month. For Company C, the lean manufacturing review was done by lean expert from a government agency and monthly meeting with top management. However, they also have annual 5S audit which was performed by their Japanese partner.

V. CONCLUSION

On the whole, the main aim of this paper is to understand how organisational change factors assist manufacturing companies in transition to lean manufacturing system. Given the observations and results of this study, it appears that there are some factors that need to be emphasised for smooth transition to lean manufacturing system. Apparently, Company A has more positive experience in implementing lean manufacturing system. The organisational change elements that the company has emphasized are strong leadership and management, capable change agent system, effective communication, worker's empowerment through training and team development, and also extensive lean review system.

The change to lean manufacturing system is not an easy task. As lean implementation is a systemic effort, it is important to understand the organisational change issues related to lean manufacturing. This work is of particular significance not only because it is about lean manufacturing, but because it is set in a context of the transition in lean manufacturing that many manufacturing companies will be undertaking in the future. This work is intended to provide practitioners with a better understanding of the lean transition and unambiguous guidance to minimize the resistance and conflicts of implementing lean manufacturing system.

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ISBN : 978-602-97809-0-1

Organizational Commitment and Turnover Intention among Engineers in Penang, Malaysia

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***Abstract* - Organisational commitment and turnover intention has been a popular topic due to the consistent findings that both variables have significant relationship which inversely related. However, due to a limited studies conducted to ascertain the organizational commitment of engineers, this study seek to investigate whether each of the commitment (affective, continuance and normative) are having a significant relationship with turnover intention among engineers in the electrical and electronics (E & E) manufacturing organizations in Penang, Malaysia. A sample of 1034 engineers was drawn from five E&E manufacturing organizations in Penang, Malaysia. Participation in this research was voluntary. Data were gathered by means of a survey questionnaire that consisted of psychometrically sound scales to assess the employed variables in the study. Multiple regression results concluded that affective and normative commitment were found to be significantly related to turnover intention however continuance commitment was found to have no significant impact on turnover intention. Given the significant influences of affective commitment and normative commitment, the management of E & E organization is encourage to increase the employee's emotional attached and feeling of obligation to reduce the turnover intention. Key implications of the survey findings are discussed, potential limitations are specified and directions for future research are suggested.**

***Keywords* - Organizational Commitment, Turnover Intentions, Engineers, Malaysia**

I. INTRODUCTION

Organisational commitment is vital to the productivity, quality and good performance of an organisation. Survey done by the Malaysian Employee Federation and National Productivity Centre indicates that due to the employee's tendency to change employers which resulting from low organisational commitment, many organisations face skilled employee's shortage. This finding is supported by another research which stated that the organisational outcomes can be improved by increasing employees' organisational commitment because organisational outcomes are directly proportional to organisational commitment [1]. This few statements warrant a study in the area of commitment in the organization.

In addition, numerous studies have reciprocal found that one of the way which can help the organisation to increase employee's productivity, decrease the employee's absenteeism, enhanced the employee's extra-role performance and minimised the probability of employees leaving their jobs, is to increase employee's commitment towards the organisation ([2],[3],[6]). Due to the significant important of organisational commitment, this study will look into the relationship between organisational commitment and turnover intention at E & E manufacturing in Penang, Malaysia. Penang state is today the third-largest economy amongst the states of Malaysia, after Selangor and Johor. It is also the third main city and hub in Malaysia after Kuala Lumpur and Johor Bahru, serving the northern region of Malaysia. Manufacturing is the most important component of the Penang economy, contributing 45.9% of the State's GDP (2009) [4]. Therefore, it is vital and important to understand the relationship between their employee's organizational commitment and turnover intention.

II. THEORETICAL FRAMEWORK AND DEVELOPMENT OF HYPOTHESES

Organizational commitment has been considered a major factor in understanding employees' work-related behaviour in organizations. It has been found to be the strongest predictor of turnover intentions ([5], [6]). Moreover, a comprehensive research study in the food and service industry in Asian countries like Singapore, Malaysia, South Korea and Taiwan found that organisational commitment is the forefront of turnover intention [5]. This finding is consistent with a research done by [7], among hotel workers in Malaysia which has shown that affective commitment, continuance commitment and normative commitment have significant relationship with intentions to leave.

Besides that, result shows that there were significant and negative correlations between affective, continuance and normative commitment with turnover intention in the study of Malaysian government doctors [8]. The negative value of the correlation coefficients for all aspects of the independent variables shows that the higher the level of organisational commitment and job satisfaction aspects, the lower the turnover intention and vice versa. The study concludes that organisational commitment contributed the highest variance in turnover intentions among government doctors in the study.

Although organisational commitment and turnover intention has been discussed frequently in organisational psychology for almost four decades, only a limited studies had involved manufacturing sector [1]. This study will look into electrical and electronic organisation in exploration of the relation between organisational commitment and turnover intention in Malaysia's manufacturing.

A. Turnover Intentions

Turnover intention is an employee's intention to leave an organisation voluntarily [9].This has been used very often in past research. In this study, turnover intention was used instead of actual turnover, in other words, the measurement of turnover was using the "thoughts" rather than the "actions" has been taken. Turnover intentions is a mental decision intervening between an individual's attitude regarding a job and the stay or leave decision [10].

B. Organizational Commitment

Existing theoretical and field studies demonstrate that commitment has direct implications on individuals and an overall influence on organisation. In order to investigate employees' work related behaviours, one of the important factors to explore is organisational commitment. According to reference [11] a committed employee as being one "stays with an organization, attends work regularly, puts in a full day and more, protects corporate assets, and believes in the organizational goals". This employee positively contributes to the organisation because of its commitment to the organisation.

Organisational commitment has become a variable of increasing interest in organisational psychology due to its demonstrated link to turnover ([12], [13]). Organisational commitment is commonly conceptualized as an affective attachment to an organisation characterized by shared values, a desire to remain in the organisation, and a willingness to exert effort on its behalf [14]. As previous literature has suggested that if the employee organisational commitment is significant, the intention of attachment to organisations is higher, in other words, the motivation to withdraw from organisation will be lower, if the individual are organisationally committed.

This study adopted the three components model of organisational commitment – affective, continuance, and normative commitment [15]. This model has been subjected in previous literatures and received greatest support ([11],[16],[17],[18],[20],[21],[22]). The researchers viewed affective, normative and continuance commitment as components of attitudinal commitment. According to reference [17], they defined affective commitment as "an employee's emotional attachment to, identification with, and involvement in the organisation," continuance commitment as "commitment based on the costs that employee associate with leaving the organisation," and normative commitment as "an employee's feelings of obligation to remain with the organisation." Organisational commitment is thus considered to be multidimensional, which has distinct policy implications for human resource management (HRM).

1) *Affective Commitment and Turnover Intention*: Affective commitment is a feeling of emotional attachment to that organisation, as it related to identification and involvement with the organisation ([23]. This researcher defined affective or attitudinal commitment as an individual's identification with an organisation and his/ her commitment to maintaining membership to pursue the organisation's goals [24]. Affective commitment results from an agreement between individual and organisational value that makes it possible for one to become emotionally attached to and enjoy membership in an organisation ([25],[18]). Reference [13] and [14] characterized that an affective committed employee is desire to stay with the company as he/she has faith in the organisation.

According to [13], they characterize affective commitment by three factors "(1) belief in and acceptance of the organization's goals and values, (2) a willingness to focus effort on helping the organization achieve its goals, and (3) a desire to maintain organizational membership". Reference [14] further state that affective communication is "when the employee identifies with a particular organization and its goals in order to maintain membership to facilitate the goal". [11] continue to say that employees retain membership out of choice and this is their commitment to the organisation. In a nutshell, affective commitment is an emotional attachment and trust by an employee to the organisation.

The interrelationship between affective commitment and turnover has been well established in previous research ([26],[27],[28]). The meta-analysis draws the inference that affective commitment is one of the best predictors of voluntary turnover [28].

Affective commitment relies on an emotional attachment to the organisation; it is likely that affectively attached employees will be motivated to make greater contributions to the organisation compared to employees with a weak affective bond. Therefore, the model predicts that affective commitment leads to lower turnover behaviours [30]. Thus, there is a relationship between affective commitment and turnover intention.

Turnover intention is consistently, significantly, and negatively related to affective commitment and it was showed in past research ([31],[32]*).* Thus, the following hypothesis is proposed:

H1: Affective commitment is negatively related to turnover intention

2) Continuance Commitment and Turnover Intention :

Continuance commitment refers to the qualifiable materialistic loss incurred by the employee if they leave the organisation and on the other hand the materialistic gains to be made by continuing in present job. The employee's continuance commitment towards their current employer will be stronger, if the employees believe that fewer viable alternatives are available. This is because employees whose primary link to the organisation is based on continuance commitment remain with the organisation because they feel they need to do so for material benefits [20].

Reference [30] model suggests that employees with strong continuance commitment will just doing their jobs and be responsible within their jobs scope, without any extra contribution or value added activities to the organisation. Moreover, if continuance commitment is the primary tie that bonds employees to their organisations, this attachment may lead to undesirable work behaviour, thus desire on turnover increase, yet if due to the high cost of leaving, the employee will have aspiration to stay with the organisation. Hence, continuance commitment will have significant effect on turnover intention.

Continuance commitment was predicted to have the same association as affective commitment with turnover intention ([33],[27]). An employee with strong continuance commitment feel a sense of being 'locked' into the organisation due to material benefits, thus they would be less likely to leave. Research by [34] and [35] also found a negative relationship between continuance commitment and turnover intentions. Therefore, the following hypothesis is developed:

H2: Continuance commitment is negatively related to turnover intention

3) *Normative Commitment and Turnover Intention:*

Reference [15] supported this type of commitment prior to Bolon's definition, with their definition of normative commitment being "a feeling of obligation". Normative commitment can be explained as a moral commitment ,which is felt by an employee either due to the sense of belonging (if his/her parents have been working in the same organisation), sense of obligation or due to feeling of learning valuable skills or gaining experience, which will have more influence on employee as compare to material benefits [34]. Employees with a high level of normative commitment feel that they ought to remain with the organisation [36].

This model predicts that employees who feel an obligation towards organisation (normative commitment) intend to make positive contributions to reduce the likelihood of quitting. The association between normative commitment and turnover intention was hypothesized to have weaker relationship due to the feeling of obligation does not carry the same feeling of enthusiasm and involvement brought about by affection [30]. Thus, normative commitment to be predicted to have same effect on turnover intention as discussed in affective commitment.

H3 : Normative commitment is negatively related to turnover intention

III. METHODOLOGY

A. *Sample and Procedure*

We distributed questionnaire to 3000 engineers. Out of which, 1034 voluntarily completed our survey questionnaire, yielding response 34.47%. They were randomly drawn from 5 multinational E&E organizations, located in Penang, Malaysia. The organizations were primarily dealing in semiconductors components. From the total respondents, 43.3% were female and 56.7% were male. Most of the respondents were young which fall within age range 21-30 years old, where it consists of 56% and the percentage was more than half of the total respondents. Most of the respondents were Chinese, and the percentage was nearly 86 per cent, followed by Malay 9 per cent, Indian 3 per cent and 2 per cent is others race. Nearly half of the respondents were single (50.7%). About 20.9 per cent had elementary school education, 30.6 per cent a high school diploma, 46.3 per cent a bachelor's degree, and 2.2 per cent a master's degree.

Data were collected by means of printed questionnaire. The questionnaire accompanied a personally signed letter stating the purpose of the study and an assurance of complete anonymity of individual responses.

B. Measures

We administered a three-section questionnaire to measure the variables employed in the study. All measures, except for personal data section, employed a 5-point scale. The respondents were asked to indicate their responses on a 5-point Likert scale with endpoints of 1 (strongly disagree) and 5 (strongly agree).

1) *Organizational Commitment:* The survey instrument for organisational commitment was adopted from [20], where the questions was originated from [15] and it was improved version from 8 item scale to 6 item scale. Each component; affective, continuance and normative consisted of six items. A principal components analysis with equamax rotation confined the three clean factors – with factor loadings ranging between 0.60 to 0.85. The three factors together explained a total of 52.03% of the variance. The factors were named: "Affective Commitment" (3 items), "Continuance Commitment" (4 items) and "Normative Commitment"(5 items). All the three components documented fairly adequate reliability coefficients of 0.69, 0.69, and 0.86 respectively. And, they were significantly correlated (as indicated in Table I).

Table I

Cronbach's Coefficients Alpha, and zero-order Correlation of all the Study Variables

	α	1	2	3	4
1.	**Affective Commitment (0.69)**	**1**			
2.	**Continuance Commitment (0.69)**	**0.39******	**1**		
3.	**Normative Commitment (0.86)**	**0.77******	**0.35****	**1**	
4.	**Turnover Intention (0.84)**	**-0.59******	**-0.18***	**-0.61******	**1**

*****p< 0.01, correlation is significant at the 0.01 level***
****p<0.05, correlation is significant at the 0.05 level***

2) Turnover Intentions: We employed [37] 5-item scale to assess turnover intentions. In this study, a three-page questionnaire which consisted of 32 close-ended questions was employed. The reliability is 0.84. Table I contains the interrelationships among the factors. As can be seen, the four factors documented acceptable internal consistency reliability – the coefficients alpha ranged between 0.69 to 0.86.

IV. RESULTS

We tested our hypotheses by means of a multiple regression analysis. As shown in Table II, the multiple regression results indicated that two commitments; affective commitment (*beta* = -0.32, p<0.05) and normative commitment (*beta* = -0.40, p< 0.05) were negatively predicted turnover intention. The result can be interpreted as affective commitment is negatively related with turnover intention as well as normative commitment which is also having a negative relationship with turnover intention. From the standardized coefficients, we can conclude that normative commitment is having a stronger negative relationship with turnover intention compare to affective commitment. As for continuance commitment it is not a significant predictors of turnover intention (b*eta* = 0.08, p>0.10).

Table II
Multiple Regression Result for Turnover Intention

Model		**Standardized Coefficients** *Beta*	***t***	***Sig.***
1	**(Constant)**		**19.126**	**.000**
	Affective	**-.320**	**-3.014**	**.003**
	Continuance	**.080**	**1.092**	**.277**
	Normative	**-.395**	**-3.776**	**.000**

Thus, in summary, the result of affective commitment and turnover intention showed that it was significant *(* p< 0.05) and the b*eta is* 0.32 , thus we accepted H1: Affective commitment is negatively related to turnover intention.

The result obtained from multiple regression analysis showed that continuance commitment was not significant, hence we rejected H2: Continuance commitment is negatively related to turnover intention.

The test result for normative commitment and turnover intention reported value as *beta* = -0.40 was significant (p<0.01), therefore we accepted H3: Normative commitment is negatively related to turnover intention.

V. DISCUSSIONS AND CONCLUSION

From the multiple regression analysis, hypothesis H1 has been accepted, which shows that affective commitment is negatively related to turnover intention. This study had the same result as the previous literatures, which claimed higher affective commitment will reduced the desire for turnover ([27], [15], [38], [39],[40], [41],[11], [30]).

This relationship could be explained by examining the construct of affective commitment. Affective commitment concerns an individual's identification with, involvement in, and emotional attachment to the organisation. Thus, participants who are more likely to remain with the organisation more closely identify with, are involved in, and are emotionally attached to the organisation. One's perception of the organisation could be related to exchange theory, in which an individual with a positive attitude is predisposed to offer commitment in exchange for anticipated future rewards [42]. In exchange for organisation support, employees become affectively committed to their organisation and less desirability finding another job. Believe in the organisation and its mission will also increase affective commitment and less likelihood to leave their jobs [43].

This finding was also parallel with the affective commitment postulated by [15] that refers to the employee's emotional attachment to, identification with and involvement in the organisation and those with a high affective commitment will continue to stay in the organisation because they want to do so. Therefore, the same conclusion with previous literature was reached, that affective commitment had significant impact on turnover intention among engineers in E&E manufacturing organizations.

H2 was rejected, as presented continuance commitment does not have significant effect on turnover intention. The "investment" that made by employee to the organisation ties individuals to an organisation shows continuance commitment. It is widely believed that anything that increases the cost associated with leaving the organisation can lead to the development of continuance commitment. This research obtained similar result with previous studies done by ([44],[45] and [21]. "Low levels of continuance commitment should not lead to an intention to leave unless affective and normative commitments are also low" [21].

The demographic factors believe to be the strong contribution towards the research result, where most of the respondents were young (56%) which age between 21-30 years old and single (51%) as well as high education, which they seldom have the concern on material benefits to remain with the organisation, where all of this description are best describe in Generation Y characteristic. Beside, based on their status and qualification, there are plenty of alternatives available in the market. This justifies the insignificance of continuance commitment towards turnover intention.

Normative commitment is negatively related with turnover intention and hypothesis 3 was accepted. By increasing the employee's normative commitment, the likelihood that employee quitting the job will be reduced. As the result obtained, this research shows a slightly different from [30], which claimed obligation (normative commitment) does not carry the same feelings of enthusiasm and involvement brought about by affective commitment. Nevertheless, most of the respondent in this study is the employee from Generation Y, and according to the study by [46], this group of new generation are expecting not only a good pay but much more than that. They placed a much higher value on leisure time and they valued intrinsic rewards somewhat more than Generation X and boomers. In other words, employees with a high level of normative commitment feel that they ought to remain with the organization.

VI. IMPLICATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

The findings of this research will benefit the turnover literature in Malaysia manufacturing context. As mentioned in the introduction, many of the companies facing problem to preserve the valuable employees, and employee turnover will continue to be a challenging phenomenon for organisations. With the turbulent workforce that has eventuated over the last decade, the need to attract and sustain a productive workforce is increasingly essential to ensure continued organisational success.

This study also has limitations. First, the sample in this study is rather limited. Future research should cover more organisations or more regions in order for the research to generalise.

Further understanding the antecedents of commitment and turnover for the employees would greatly assist industry and the literature. Another direction for future research would be to compare the strength and affects of the components of organisational commitment on turnover. It is important for researchers to clearly distinguish the three components so that practical implications of organisational commitment can be utilized.

This research was conducted in Malaysia, which is far removed from North America where most of the previous research was conducted, and result shows some variation from research conducted in North America. The result also found that affective commitment and normative commitment are negatively related to turnover intention. This appears logical. Also, it may be due to strong unique Malaysia culture in that one is passionate and strong appreciation towards the organisation. The E & E manufacturing employees have emotional and royalty relationship rather than cost-profit relationship based on calculative self-interest behaviour, this might due to employees may want to repay the debt where devotion and dedication may be at the forefront, as this scenario also mentioned in the study of [47].

When employees feel that the organization promotes their hope and happiness, they tend to reciprocate with positive attitudes towards the organization, including the organizational affective bonds and feelings of loyalty [47].

In conclusion, this study has provided some insights into turnover intention within the Malaysia context, particularly in manufacturing industry. Specifically, affective and normative commitments were found to have inverse relationship with turnover intention. Finally, the relationship between continuance commitment and turnover intention was proven to be no significantly related.

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ISBN : 978-602-97809-0-1

Conceptual Model to Enhance Creativity of the Batik Industry

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***Abstract* - Creative industry are defined as industry derived from the use utilization of creativity, skills and individual talents of individual to create wealth and generate employment by producing and exploiting individual creativity. Creative industry's contribution to National GDP is equal to 7.8% at 2002-2008[23]. Batik industry is one of the creative industry are included in the crafts sector. The purpose of this research is to develop a conceptual model to enhance creativity batik industry. This conceptual model was built based on four aspect, namely Press, Person, Process, and Product (4P). Press or creative organizational climate will stimulate the development of creative human resources (person) and creative process (process). The interaction between the creative process (process) with the creative human resources will produce a creative product (product). Creative products is the real object that can represent creativity.**

***Keywords* – creativity, 4P of creativity, batik industry, creative industry**

I. Introduction

The Indonesian economy has not always rely on natural products, such as the commodity of oil, gas, minerals and other natural products. Indonesia also must develop and retain industries in non-oil sectors such as industry and manufacturing, commerce, tourism, and of course the creative industry. Creative industry's contribution to National GDP 2002-2008 is equal to 7.8%[22]

Creative industry as those industries which have their origin in individual creativity, skill and talent, to create new products and which have a potential for wealth and job creation through the generation and exploitation of intellectual property and content. The fourteen sectors of creative industry are advertising, architectures, art markets, crafts, design, fashion, film, video and photography, interactive games, music, performing arts, publishing and printing, computer services, radio and television[10]. Batik Industry is one type of creative industry from crafting.

Based on the fourteen sectors of creative industry, the craft is second creative industry sector after fashion which contributes 33.70464 million during 2002 to 2006 or amounted to 24.09% after fashion for 46.3%[22]. Industries do not only compete in the global market by prices or quality products, but also based on innovation, creativity and imagination. Creativity is a key in the creative industry. Therefore, it is impotant to know the factors that influencing the improvement of creativity from internal side of organization, i.e organizational climates, human resources, and process and their impact to produce the creative products.

II. Literature Review

Industry is the economic activity that processes raw materials, intermediate goods, and or finished goods into goods with higher value to its use (added value), including the activities of design engineering and industrial engineering[18].

A. Batik Industry

Riyanto et al explained that batik is a work of art on cloth, stained with hurdles, which is use wax as the color barrier. Based on that definition, it can be concluded that the difference between batik and textiles, lies in the manufacturing process [1] . There are some equipment that should be use in making batik, i.e *canting, wajan, anglo, gawangan, bandul, taplak,* and *saringan*. Raw materials in batik are fabric, wax, and dyes[24]. According to Murtihadi and Mukminatun in 1979, the process of making batik can divided into two, namely *batik tulis* and *batik cap*[1]. The steps of making batik on the mori must be done step by step. Each step can be done by different person but a piece of mori cannot be done by different person in the same time. Those steps of making batik are *nglowong, ngiseni, ngengreng, nerusi, nembok, mbliriki, mbabar (medel, mbironi, nyoga), nglorod*. [20]. There are batik industries in the various sub-province and town in Java, especially Central Java, i.e. Pekalongan, Solo, Yogyakarta and Lasem. Batik industry in those cities usually a member of one group that is known as batik industry centres.

ISBN : 978-602-97809-0-1

B. Creativity

According to Olsen, creativity is the ability to create or be creative[7]. A more complete definition abaout creativity is given by Campbell. According to Campbell, creativity is an activity that produces something that is new, unprecedented (innovative) and useful (in terms of more practical, more ease, or give a better results)[3]. Creativity is related to but distinct from the intelligence, innovation, imagination, and insight [14]. Rhodes in 1961 explains that creativity as a whole entity, consists of four sections, i.e: (i) understanding the nature, characteristics or attributes of creative people; (ii) describes the stages of thinking used in the creative process; (iii) results of identification and quality of creative products; and (iv) the situation in the context of the press creative (or environment)[15]. In line with Rhodes, Torrance in the year 1993 argues that creativity requires an interactive relationship between "Person, Press, Process and Product" (4 Ps)[16].

Torrance in 1979 and MacKinnon in 1978 also argued that creativity could not be seen as one-dimensional. Creativity does not only have one dimension, and is not only a result of what is present within an individual. Creativity is influenced by a multiply of variables such as settings, other people, time, and domain-specific knowledge (Torrance in 1979; MacKinnon in 1978; Treffinger in 1991; Harrington in 1990))[19].

III. Research Methodology

Research methodology of this study begin from define the problem, theme, literature review, purpose and output, and ending in the conceptual model of creativity. Objects of this research are batik industries in Solo, Pekalongan, Jogja, Lasem. The research methodology of this study as seen in the Fig. 1

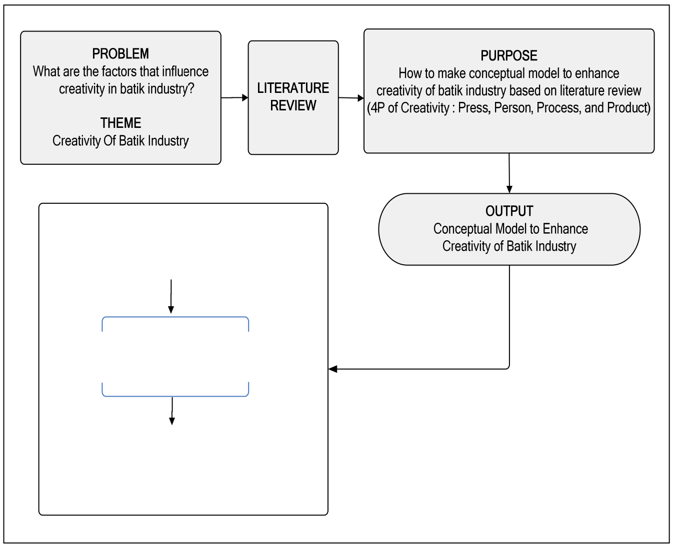

Fig 1. Research Methodology

IV. Conceptual Model

Making the conceptual model to enhance creativity in batik industry is conducted by compiling an axiomatic theory research, which is useful to explain social phenomena or natural phenomena which became the centre of attention. Theory is a set of assumptions, concept, construct, definitions, and propositions which can explain a social phenomenon in a systematic way to formulate the relationship between concepts. Based on some previous empircal study, this research tries to make some propositions about creativity in batik industry.

1. Proposition 1: There are significant relationship between personal creative and organizational climate on innovative behaviour, and the results of creative thinking will bring up the ideas or the best ideas, which finally find or create a new product (novel) from an existing[11].
2. Proposition 2: There are number of factors that affect creativity, namely the action of supervisor, organizational culture, and personality of employees[13].
3. Proposition 3: organizational climates positively correlated with probability of a worker to be creative. Beside organizational climates, there are some factors that increase the opportunity of the worker to creative, namely teamwork, motivation, and interest of the employees[7].
4. Proposition 4: There are number of factors that affect creativity in batik industries, namely human creative, creative work, creative organization, creativity in the use of environmental resources, and innovation[2].
5. Proposition 5: Skilled craftsmen is the important factor in enhancing creativity in batik industry[4].

Then, according to five propositions above, the hypothesis of this research can be arranged as follows:

1. Hypothesis 1: creative organizational climate has a positive effect to produce a creative human resources and the creative process [2,11,13,15,16].
2. Hypothesis 2 : creative human resources has positive effect to produce creative product [2,4,7,11,13,15,16].
3. Hypothesis 3: creative process has positive effect to produce creative product [2,11,15,16].

The merger of the three hypotheses above will built a conceptual model, as seen in the Fig. 2.

ISBN : 978-602-97809-0-1

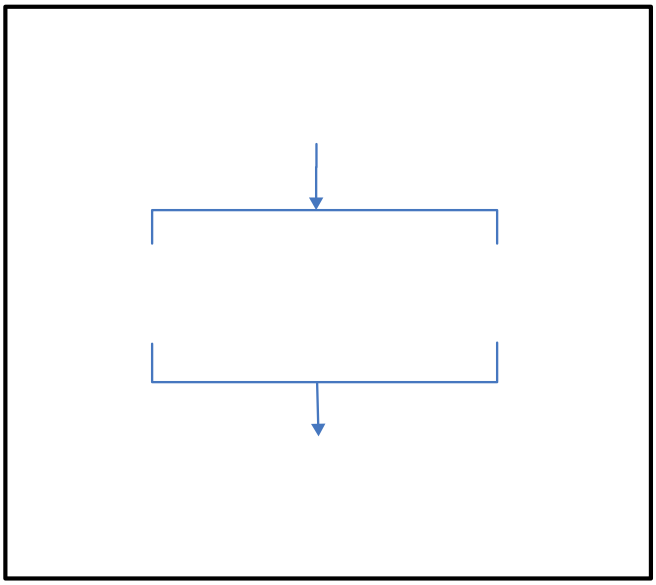

Fig 2. Conceptual Model to Enhance Creativity of Batik Industry

V. Variables Identification

Variables identified from the basic theory research, which was then adjusted to the conditions or empirical evidence in the field. Definitions of creativity depend on the terms of emphasis, creativity can be defined into four dimensions as the Four P's Creativity, namely the dimensions of Person, Process, and Product Press as follows[23].

1. *Creative Organizational climates (Press)*

   Press refers to the environment of organization where the person is in, or the product is produced, or the process occurs. It is concerned with the climates and everything that affects the climates where creativity takes place. This is where creativity and creative behaviour can flourish or be fatally hindered[15]. Ten dimensions of the creative climate by Ekvall in 1996[6] are

   - Challenge (how emotionally involved, and committed are employees to the work).
   - Freedom (how free employees are to decide how to do their job).
   - Idea time (the amount of time employees have to elaborate ideas).
   - Trust and openness (do employees feel safe speaking their minds and offering different points of view).
   - Dynamism (the eventfulness of life in the organization).
   - Playfulness (how relaxed is the workplace).
   - Debates (to what degree do people engage in lively debates about the issues)
   - Conflicts (to what degree do people engage in interpersonal conflicts).
   - Risk-taking (the promptness of response to emerging opportunities and fear of failure).
   - Idea support (are there resources to give new ideas a try). Hudson in 1966, Schaefer and Anastasi in 1968 and Simonton in 1984, states that scientific creativity may receive more benefit from preparatory activities, such as education and training, compared to artistic creativity[4].

   So, the creative organizational climate is organizational environment in which employees perceive these condition when perform their work: challenge, freedom, describes the ideas of time, trust and openness, of dynamism, relaxed and humorous, debate, conflict, risk taking, and provide support for the idea.

2. *Creative Human Resources (Person)*

   Guilford in 1950 examined that creativity refers to the abilities that are characteristics of creative peoples. Hulbeck in 1945 examined that creative action is an imposing of one's own whole personality on the environment in an unique and characteristic way[23]. Creative human resources is the creative individuals who have traits as follows:

   - Having motivation to be creative. Kreitner and Kinicki in 2005 states that people who have high creativity is usually the people who are highly motivated to use a lot of time to develop explicit and implicit knowledge about their areas of interest or about their positions[7]. Munandar in 1999 states that the tenacious and full of creative energy is a personal trait. Kaufman in 2003 argued that creative peoples have some positive characteristics, like open, motivation or never satisfied with present conditions.
   - Having characteristics for creating, such as: an open, curious, challenged plurality, dare to take the risk, high imagination, have an interest in[7]. Munandar in 1999 also describe the personal characteristics of creative have the initiative, set up, confidence, courage and confidence in the establishment. West in 2002 argued that reflexivity is also the character of creative personalities.

   Researchers have shown that there are certain personality traits associated with creative peoples (e.g., Hayes in the 1990; Runco, Nemiro, and Walberg in 1998; Stein in 1974). One such list of traits was comprised by technology educators DeVore, Horton, and Lawson in 1989 and its summarized that creative people have: (i)ability to change undesirable habits into desirable ones; (ii) a positive curiosity of the unknown; (iii) a positive attitude towards new experiences; (iv) ability to take negative criticism and turn it into constructive action; (v) ability to take risks fully knowing that his or her ideas may be attacked by others; (vi) a good sense of humour; (vii) ability to make complex relationships between unrelated items; (viii) motivation to solve problems on their own; (ix) high self-esteem and self-confidence in their abilities; and (x) ability to focus their full attention on a particular problem for an appropriate[12].

Creative human resource is the creative individual who have motivation and character to be creative. Spirit and tenacity are the traits of people who have the motivation to be creative. People who have the character to be creative are those who have curiosity, independent, confident, open, daring to take risks, reflexive, flexible, challenged with the plurality, interest and humorous

3. *Creative Process (Process)*

Munandar in 1977 examined that creativity is a process that manifest in self in fluency, in flexibility as well in originality of thinking[23]. Wallas in 1926 summarized creativity process in four steps:

- Preparation – identification an issue or problem, based on observation and study[5]; This is the first stage in which an individual identifies then investigates a problem from many different angles[12].
- Incubation – involves the unconscious processing of information[14]. At this stage the individual stops all conscious work related to the problem[5].
- Illumination – the moment when a new solution or concept is finally emerging[5,12].
- Verification – this is the last stage at which time the solution is tested[12]; checking out the applicability and appropriateness of the solution for the originally observed problem[5].

The creative process focuses on how creativity happen; a process that occurs in the human brain in discovering and developing a new, more innovative ideas and varied idea (divergent thinking). The creative process has four stages, namely preparation, incubation, illumination, verification.

4. *Creative Products (Product)*

Baron in 1976 examined that creativity is the ability to bring something new into existence[23]. Besemer and O'Quin in 1993 believe that the creative products is unique in that it combines both of the creative person and process into a tangible object representing the "true" measure of a person's creative ability[12]. Basemer dan Treffinger in 1981 explained creative products have three dimensions :

- The novelty dimension: this dimension defines the extent of newness a product possesses in terms of the number of new processes, new techniques, new materials, and new concepts. It also includes the influence the product has on future creative products. There are some element of novelty dimension: (i) germinal (the product is likely to suggest additional future creative products); (ii) original (the product is unusual or infrequently seen in a universe of products made by people with similar experience and training); and (iii) transformational (the product is so revolutionary that it forces a shift in the way that reality is perceived by users, listeners or viewers).
- The resolution dimension: This dimension defines the degree to which the product fits or meets the needs of the problematic situation. There are some element of resolution dimension: (i) adequate (the product answers enough of the needs of the problematic situation); (ii) appropriate (the solution fits or applies to the problematic situation); (iii) logical (the product or solution follows accepted and understood rules for the discipline); (iv) useful: the product has a clear and practical application); (v) valuable (the product is judged worthy by users, listeners, or viewers because it fills a financial, physical, social or psychological need).
- Elaboration and synthesis dimension: this dimension defines the degree to which the product combines unlike elements into a refined, developed, coherent whole, statement or unit. There are some elements of elaboration and synthesis dimension: (i) attractive (the product commands the attention of viewer, listener or user); (ii) complex (the product or solution contains many elements at one or more levels); (iii) elegant (the solution is expressed in a refined, understated way); (iv) expressive (the product is presented in a communicative, understandable manner); (v) organic (the product has a sense of wholeness or completeness about it); and (vi) well-crafted (the product has been worked and reworked with care to develop it to its).

Based on the above explanation, Creative Product is a product that has the features, namely new, resolution, elaboration and synthesis.

In detail, some dimension and indicator of creative organizational climate, creative human resources, creative process and creative product can be seen in Table I until Table IV.

ISBN : 978-602-97809-0-1

TABLE I
CREATIVE ORGANIZATIONAL CLIMATE INDICATORS

Construct	Dimension	Element
Creative Organizational Climate is the organizational environment in which employees perceive these condition when perform their work: challenge, freedom, describes the ideas of time, trust and openness, of dynamism, relaxed and humorous, debate, conflict, risk taking, and provide support for the idea.	Freedom is the freedom of employees to decide how to do their job	Freedom
	Trust and openness is a sense of security in the opinion and express opinions	Trust
		Open
	Relaxed level of seriousness and humour is the organizational climate at the time of employment. This can be seen from environments that are not stiff when working, humorous, good communication, and friendly	Not rigid in their work
		Humorous
		Communication
		Friendly
	Support for the idea will be given to employees in the form of company support for innovation, provide training and appreciate to employees.	Support for innovation and warmth
		Appreciation
		Training
	The challenge is the participation, commitment and responsibility to company employees.	Participation
		Commitment
		Responsibility
	Dynamism is the life in the organization who can showed from the level of cooperation.	Cooperation
	The debate is the involvement of employees in an exchange of ideas.	Exchange ideas
	When describing the idea is the amount of time required to elaborate ideas	Time
	Conflict is a problem that occurs in the company	Conflict
	Company dare to take risks fully	Risk-taking

TABEL III
CREATIVE HUMAN RESOURCE INDICATOR

Construct	Dimension	Element
Creative human resource is the creative individuals who have the motivation and character to be creative.	The motivation for creating one can be seen from the person's spirit and perseverance.	Spirit
		Diligent
	Character to be creative a person can be seen from: curiosity, self-reliant or independent, confident, open, daring to take risks, reflexive, flexible, challenged with the plurality, and humorist who has an interest owned by that person.	Curiosity
		Independent
		Confident
		Open
		Dare to take risks
		Reflexive
		Flexible
		Challenged plurality
		Humorous
		Imaginative
		Interest

TABEL IIIII
CREATIVE PROCESS INDICATOR

Construct	Dimension	Element
Creative Process focuses on how creativity happens. The creative process is a process that occurs in the human brain in discovering and developing a new, more innovative and varied idea. There are four stages in creative process, namely preparation, incubation, illumination, and verification	Preparation of information gathering, date, and materials to solve problems..	Find issues
		Data collection
	Incubation is a phase of matter under the brooding nature of pre realize	Recognizing the problem solving process
	Illumination is the stage of the emergence of ideas or solving problems.	Appears inspiration / ideas
	Verification is the evaluation stage of the emergence of the idea of critical activities	Evaluate ideas critically

TABEL IVV
CREATIVE PRODUCT INDICATOR

Construct	Dimension	Element
Creative Product is a product that has the features: new, resolution, elaboration and synthesis	New. The new product has the characteristic: germinal, original, transformational	Original
		Germinal
		Transformational
	Resolution defines the extent to which such products can meet the requirement, so that the product should be adequate, suitable or match, useful, valuable and logical.	Adequate
		Match
		Logical
		Useful
		Valuable
	Elaboration and synthesis define the extent to which these products can combine various elements, so that these products should be: interesting, complex, elegant, expressive, complete and properly processed or well-crafted.	Interesting
		Complex
		Elegant
		Expressive
		Complete
		Well-crafted

VI. CONCLUSIONS

Creativity is a key element in the creative industry. Increased creativity batik industries involves four aspects, namely creative organizational climates, creative human resources, the creative process and creative products as a measure of creativity.

1. Creative organizational climate is organizational environment in which employees perceive these condition when perform their work: challenge, freedom, describes the ideas of time, trust and openness, of dynamism, relaxed and humorous, debate, conflict, risk taking, and provide support for the idea.
2. Creative human resource is the creative individuals who have motivation and character to be creative. Spirit and tenacity are the traits of people who have the motivation to be creative. There are some character of creative people, i.e: curiosity, self-reliant, confident, open, daring to take risks, reflexive, flexible, challenged with the plurality, have an interest and humorous.
3. The creative process focuses on how creativity occurs; a process that happens in the human brain in discovering and developing a new innovative and varied idea (divergence think). The creative process has four stages, i.e: preparation, incubation, illumination, verification.
4. Creative product is a product that has certain features, i.e: new, resolution, elaboration and synthesis.

Creative organizational climates (press) will stimulate the creative human resources (person). The interaction between the creative process (process) with the creative human resources will produce a creative products (product). Creative product is the real object that can represent the level of creativity.

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ISBN : 978-602-97809-0-1

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The International Conference on Industrial Engineering and Business Management 2010

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Proceedings ICIEBM

ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

WHAT MATTERS THE MOST FOR SMS USERS' SATISFACTION AND RETENTION? EVIDENCE FROM TELECOM SECTOR OF PAKISTAN

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Abstract —**Survival and growth are the prime purposes of businesses. Companies are required to provide better quality services, so that they can meet their objectives. This study is aimed to assess the quality of service provided by telecom (cellular) companies operating in Pakistan, and its effect on level of satisfaction and intentions of customers to stay with the same company is also observed. Only one service (Short Messaging service) is taken to study the impact of quality of service on customers. SERVQUAL model by Parsurman *et al.* (1988) is used for study. Respondents of the study were 331 university students using services of mobile companies. Correlation analysis was used for analysis. Results are dissucces in finding section of the paper.**

Keywords **—**Satisfaction of customers, Service Quality, Retention intention, Telecom sector, Short Messaging Service

I. INTRODUCTION OF THE STUDY

To be a market leader is dream for every organization. Firms need to be competitive in order to realize their dreams. Organizations use various strategies that bring higher returns and positive changes. While implementing these startegies customers are said to be the most valuable element for success. Now organizations try to retain their existing customers as compared to creating new ones as it takes less cost and effort.

Retaining customers is important for all sectors of economies, whether manufacturing or services. Telecom sector is one of the mostly technologically developed sectors of the economy of Pakistan. Telecom sector is said to be one of the most developed sectors of Pakistan economy; as it has witnessed great amount of investment in recent past. The number of subscribers with in period of 1996 to 2009 increased from 68,000 to 95 million in 2009 shows the level of growth in the sector (PTA). Cellular growth time lasts for five years in Pakistan i.e. (2003-2008), it broke all world records of covering network. As Valdecantos (2009) found that cellular companies of Pakistan have experienced 100% growth rate for many years. Now the existing firms are facing stiff competition due to saturation in market, so creation of customer is quite difficult, so retention of customers is the best policy. This growth and finally saturation has attracted researchers, academicians, and business community.

Numerious studies have been conducted in various parts of the world to study telecom sector from various perspectives ranging from engineering to business and marketing perspectives. Numbers of researcher have linked satisfaction and retention with improved financial performance e.g. Reichheld and Sasser, (1990); Fornell and Wernerfelt, (1987). Steenkamp (1989) discussed that in order to increase market share firms must retain their customers. Provision of better services is one of the major tools used to retain customers. Considering all the issues of importance this study is structured to judge the effect of quality of service on satisfaction and retention intentions of customers in the cellular companies of Pakistan. To simplify and make the topic researchable one dimensions of the service quality SMS (Short Messaging Service) is taken for the study.

II. REVIEW OF PREVIOUS LITERATURE

Quality is said to be an overall experience which customers' perceive by product interaction or interaction with service. Parasuraman *et al.* (1988), has defined quality which is based on judgment. "Service quality has been described as a form of attitude, related but not equivalent to satisfaction that results from the comparison of expectations with performance" (Shepherd, 1999; Cronin Jr. and Taylor, 1992; Bolton & Drew, 1991; and Parasuraman *et al.* 1988). Quality is having long lasting affect on customer satisfaction. In the words fo (Omachanu *et al.* 2008) quality has long term and lasting relation with satisfaction of customer. While discussing importance of value Atalik & Arslan (2009) found that it leads to loyalty of customers.

Service Quality and Customer Satisfaction

Churchill (1979) has defined the term "Customer satisfaction" as consequence of comparison between reward and price by acquiring it. Customers' satisfaction has now considered as corporate level strategy (Rust and Zahorik, 1993). Various authors and researchers have given to customer satisfaction. In the words of Drucker (1973) customer satisfaction is the basis for organizational success. Customer satisfaction is a base for relation between management and marketing (Claycomb & Martin, 2002), and mean of competitive advantage. (Anderson *et al.*, 1994). Customer satisfaction is having positive impact on organizational financial performance (Anderson *et al.*, 1994; Rust & Zahorik, 1993).

Kandampully (1998) discusses that organizational loyalty towards service provision creates loyal customers. He further found that loyalty of service to customers fulfils present and future needs of customers. Offering quality service creates loyalty in customers to stay with the organization. Dissatisfaction of customers leads customers to reduced loyalty bond with organization. In words of Turel *et al.* (2007) usage adoption decision is dependent upon the price offered, social, emotional and quality offered by service provider. Quality of service is said to be impression of customer regarding inferiority or superiority service delivered (Tsoukatos & Rand 2006, Bitner & Hubert 1994). Quality of service and satisfaction of customers are closely linked as it offers value to customers and help them to make a choice whether the service justifies cost of services or not. All elements of service quality have direct impact on customers' satisfaction and value of service for them (Chau & Kao, 2009). Cavana *et al.* (2007) discusses service quality and its dimensions, he says that there are five dimensions on which service quality should be measured i.e. Assurance, Responsiveness, Empathy, Reliability and Convenience.

Measuring impact of service quality and its dimensions on customer satisfaction various researchers have given supportive evidences. Kim *et al.* (2004) while conducting his research in telecom sector of Korea found that quality of call, value added services and customer support have noteworthy impact on increasing satisfaction level of customers for mobile service providers and finally creating loyal customers. While discussing the importance of each factor of service quality Baumann *et al* (2006) also discovered that satisfaction of customers regarding empathy and affective attitude of service provider makes customers recommend others to use the services of the recommended company; they further found that responsiveness has short run relation with customer satisfaction while empathy and affective attitude have long lasting impact on the on satisfaction and retention intentions of customers. Similarly, Cavana *et al.* (2007) discovered no relation of convenience and reliability with customer satisfaction but their findings prove significant relation of assurance, responsiveness and empathy with customer satisfaction. Cronin and Taylor (1992) discovered that customer satisfaction is a function of better service quality. Ahmed *et al.* (2010) found that reliability, tangibles, responsiveness and assurance were positively related with the customer satisfaction while empathy is not related with customer satisfaction. Lai (2004) conducted his study in China and discovered that there was positive relationship of empathy, tangibles and assurance with customer satisfaction. Similar findings were discovered and quoted by Cronin and Taylor (1992) while searching for service quality and customer satisfaction relation. Brown & Gulycz (2001) say that customer satisfaction is important in order to retain customers.

Service Quality and Customer Retention

Researchers have also given lots of attention to Customers' retention. Researchers have discussed enormous returns of the retention of customers. Like, Reichheld and Sasser (1990) and Fornell and Wernerfelt (1987); discoverd retention of customers as source of reduction of costs and mean of growth in market share. Henkel *et al.* (2006) concluded that customers who are satisfied with the service provider have increased usage level of services and increased future use intentions. While discussing the importance of satisfaction Cronin *et al.* (2000) discovered that satisfaction and retention intentions of customers can be increased by offereing value added and quality services. Steenkamp (1989) have also discussed service quality as an aid to retain customers for future repurchase and it finally increases market share, similarly Fornell (1992) found satisfaction to be significantly related with customer retention intentions.

Quality of service is regard of superiority or inferiority of service provided and provider of services (Tsoukatos & Rand 2006, & Bitner & Hubert 1994). Chau & Kao (2009) also discussed the dimensions of service quality and found that these dimensions have a significant impact on evaluation of service by users and their future repurchase intentions. Kandampully (1998) discusses that provision of better services from the companies creates loyal customers for future. If service provider is committed to provide better quality services then customer loyalty and trust can be gained. Kim *et al.* (2004) discovered that increasing level of satisfaction of customers and consequently creating future loyal customers requires delivering superior service quality. Customers with high Loyalty score are reported to have higher retention intentions, are willing to spend more funds towards the service provider, and would suggest others to others to become future customers. (Keiningham, *et al.* 2007). Chen (2008) concluded that customer perception of quality of service and satisfaction regarding service is having positive and significant effect on future intentions to purchase. Cronin *et al.* (2000) concluded that customer intentions of future usage is function of service quality, value of that service and satisfaction of customer. Cöner and Güngör (2002) discovered that better service quality would create more loyal customers for future. Lai (2004) conducted research in Singapore and discovered a significant impact of dimensions of service quality with satisfaction of customers and their future retention intentions. Canadian scholar Barnes (1997) a Canadian scholar also emphasize customers who are loyal would recommend others which increases customer base and increased source of earning for organization.

Kim *et al.* (2004) concluded that call quality, offering value added services and provision of customer support plays an important role in satisfying customers and their intentions to stay with the same service provider. Deng *et al* (n.d.) also

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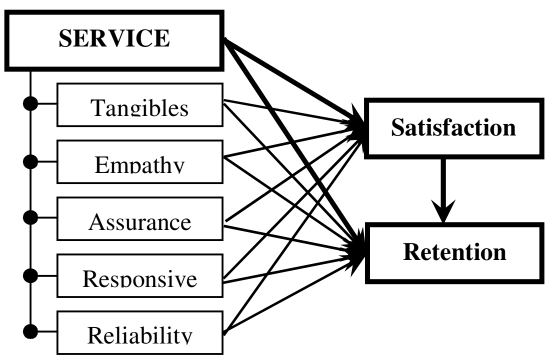
conducted study in Chinese telecom market and argue that out of many determinants of satisfaction of customers perceived quality of service is one of the most significant determinant of satisfaction of customer and loyalty of customers. According to Parasuraman *et al.* (1988) service quality has five specific dimensions i.e. tangibles, empathy, reliability, assurance, and responsiveness. Cavana *et al.* (2007) has discussed five dimensions of assurance of quality, i.e. Convenience, Responsiveness, Empathy, responsiveness and Reliability; and all these dimensions are very significant for concept of quality. Cavana *et al.* (2007) discussed that responsiveness, empathy and assurance have strong relationship with customer satisfaction and repurchase intentions, but convenience and reliability were found to be but not much relevant to the issue. Different findings were given by Ahmad *et al.* (2010), as tangibles, assurance, responsiveness, reliability were found to be positively related with retention intentions while empathy was not related with retention. It is clear that if company wants to retain its customers, they should be satisfied by provision of better service quality (Brown & Gulycz, 2001).

On the basis of above given literature following model and hypothesis can be drawn

III. RESEARCH MODEL AND HYPOTHESIS



	Hypothesis Statement
H1	Service quality and customer satisfaction are positively related
H1a	There is positive relationship between Tangibles and customr satisfaction.
H1b	There is significant relationship between Empathy and customer satisfaction
H1c	There is positive relationship between Assurance and customer satisfaction
H1d	There is positive relationship between Responsiveness and customer satisfaction
H1e	There is positive relationship between Reliability and customer satisfaction
H2	Service quality has a positive relation with customer retention
H2a	There is positive relationship between Tangibles and customer retention
H2b	Empathy has a significant relationship with the Customer retention
H2c	Assurance has a positive relationship with customer retention
H2d	Responsiveness has a positive relationship with customer retention
H2e	Reliability has a positive relationship with customer retention

IV. DESIGN OF THE STUDY

Young university students with between age of 20-25 were selected as population. This age group is selected because of the amount of attraction received by this age group by the cellular companies. This age group is the biggest target of he marketing efforts made by all cellular companies, because it covers largest portion of the population and are having highest literacy rate in the country. For survey purpose 400 students from various universities were selected and personally administrated questionnaire was used to collect data from the respondents. Out of whole sample size, 331 complete questionnaires were received back having response rate of 83%. Average age of respondents was 21.60 years, out of which 60% were male and 40% female. Service quality and satisfaction dimension questions were taken from the research work of Lai (2004); While questions regarding retention intentions were taken from from Yu *et al.* (2005). The instrument comprised on 7 point likert scale which ranges from strongly disagrees (1) to strongly agree (7). SPSS 17.0 version was used for analysis.

V. FINDINGS AND CONCLUSION

Findings from Table 1 depict the score means and standard deviation for all the dimensions of service quality and its customer satisfaction and retention intentions. The score mean of service quality shows value of 4.828, it donates that customers are slightly satisfied with service quality provided by the mobile companies. Findings score for every dimension of quality of service shows that respondents are more satisfied on the dimensions of 'responsiveness and tangibles' and moderate level of satisfaction with 'reliability and assurance, and were less satisfied with 'empathy'. The satisfaction mean score is 5.259 which show slight level of satisfaction with service quality; similarly, intentions to stay (retention) were having mean score of 5.3369 which shows that overall respondents are slightly satisfied from their SMS service providers.

Descriptive Statistics

	Mean	Std. Deviation	N
SERVQUAL	4.8208	.71827	331
Tangibles	5.4003	1.15432	331
Empathy	3.3595	1.51529	331
Assurance	4.8520	1.20069	331
Responsiveness	5.0725	1.13993	331
Reliability	4.8741	1.05820	331
Satisfaction	5.2598	1.44249	331
Retention	5.3369	1.28002	331

TABLE-1 Descriptive Statistics

Table-2 shows the results of Pearson Correlation (shown at the end). The given table shows relationship between the dimensions of services quality and customer intentions to retain with the mobile service provider. The table also shows

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relationship between the service quality dimensions and customer satisfaction and retention intentions.

The results shows that overall quality of service has a significant relation with the satisfaction of customers (r=0.538, p<0.000) and customer retention (r=0.394, p<0.001). These specific finding confirms H1 and H2 that service quality has a significantly positive relationship with customer satisfaction and retention. The service dimension, 'tangibles' also proves to have a significant and positive relationship with the customer satisfaction (r=0.183, p<0.001) and retention (r=0.190, p<0.001). This finding proves hypothesis H1a and H2a that tangibles have a positive relationship with customer satisfaction and retention. The dimension 'empathy' has surprisingly shown a significant but negative relation with the customer satisfaction (r=-0.36, p<0.001) and customer retention (r=-0.248, p<0.001). This finding further explains that there is significant but negative relationship between empathy and customer satisfaction and retention. Qualtiy dimension of 'Assurance' shows a significantly positive relationship with the customer satisfaction (r=0.425, p<0.001) and retention (r=0.359, p<0.001), and proves H1c and H2c. The quality dimension of 'Responsiveness' also shows a significant and positive relationship with the customer satisfaction (r=0.521, p<0.001) and retention (r=0.381, p<0.001) and confirms H1d and H2d hypothesis. 'Reliability' findings shows a significant and positive relationship with the customer satisfaction (r=0.435, p<0.001) and customer retention (r=0.297, p<0.001) and finally prove hypothesis H1e and H2e.

Findings also prove that there is positive relationship between customer satisfaction and retention (r=0.580, p<0.000). These findings confirm the Hypothesis H3 that there is significant relation between customer satisfaction and retention; greater the customers will be satisfied higher will be chance of their retention with the same mobile service provider.

VI. Discussion

Findings suggest that customers are slightly satisfied with the quality of service of cellular service providers where assurance and tangibles score much high than other service quality dimensions but empathy shows that the lowest score of all dimensions. Consequently correlation findings show that quality dimension of empathy has significantly negative relationship with satisfaction and retention of customers while other four dimensions have positive relation with the customer satisfaction and retention. All dimensions of service quality have a significant relationship with the customer satisfaction and retention. As this study is concerned with only one type of service provided by cellular companies, it is limited in its scope with respect to other services offered by cellular companies, its scope should be expanded and other services by cellular service provider should be included in studies. Findings of the study provides an insight and direction to the policy makers, regarding their concern for customer satisfaction and retentions and tells them the areas to be emphasized to achieve increased level of satisfaction and retention of customers, specifically towards Short Messaging Service of companies.

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Table-2 Correlation Findings of Service Quality, Customer Satisfaction and Retention

Correlations

		SERVQUAL	Tangibles	Empathy	Assurance	Responsiveness	Reliability	Satisfaction	Leave_Intentions
SERVQUAL	Pearson Correlation	1							
	Sig. (2-tailed)								
Tangibles	Pearson Correlation	.438**	1						
	Sig. (2-tailed)	.000							
Empathy	Pearson Correlation	-.058	-.086	1					
	Sig. (2-tailed)	.290	.118						
Assurance	Pearson Correlation	.705**	.145**	-.253**	1				
	Sig. (2-tailed)	.000	.008	.000					
Responsiveness	Pearson Correlation	.860**	.241**	-.323**	.539**	1			
	Sig. (2-tailed)	.000	.000	.000	.000				
Reliability	Pearson Correlation	.705**	.258**	-.119*	.394**	.479**	1		
	Sig. (2-tailed)	.000	.000	.030	.000	.000			
Satisfaction	Pearson Correlation	.538**	.183**	-.236**	.425**	.521**	.435**	1	
	Sig. (2-tailed)	.000	.001	.000	.000	.000	.000		
Leave_Intentions	Pearson Correlation	.394**	.190**	-.248**	.359**	.381**	.297**	.580**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

ISBN : 978-602-97809-0-1

Identification of Customer requirements and Technical requirements to Support WiMAX-Based Wireless Internet Product Development Using Quality Function Deployment

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Abstract – **Internet users and subscribers in Indonesia is increasing. Internet subscribers is increase from 1,7 million (2006) to 2 million (2007) and internet users is increase from 20 million (2006) to 25 million in 2007 (www.apjii.or.id). WiMAX have the ability to fulfill the needs of internet access and support the aspects of coverage and speed. There are several scenarios to implement WiMAX, one of which is to support broadband wireless internet products. Objectives of this research are (1) identify the characteristics of wireless internet products that customers expect; (2) identify the technical characteristics to fulfill such expectation; and (3) develop the product concept. The conclusions are (1) the characeteristics that expected by customers are download speed (absolute weight 36,80), easy to be accessed (18,40), data security (16,40), and upload speed (15,85); (2) the technical requirements are *Sub-Channelization Support* (dengan nilai *relative weight/relative factor* 852,03/10,64%), *Adaptive Antenna Systems (AAS) Support* (852,03/10,64%), *Transmit and Receive Diversity Support* (852,03/10,64%), *Manual Adaptive Modulation Support* (852,03/10,64%), *TDD and FDD Duplexing Support* (835,23/10,43%), and *Dynamic Quality of Service (QoS) Support* (835,23/10,43%); (3) the product concept is product with good download and upload speed, easy to be accessed, and have a good security; with technical system that mainly support *Sub-Channelization, Adaptive Antenna Systems (AAS), Transmit and Receive Diversity, Manual Adaptive Modulation, TDD and FDD Duplexing,* dan *Dynamic Quality of Service (QoS).***

Keywords - **QFD, WiMAX, wireless internet**

I. INTRODUCTION

A. Research Background

The development of wireless technology in data services can overcome the limitation of the cable network. WiMAX (Worldwide Interoperability for Microwave Access) is an international standard for Broadband Wireless Access that refers to IEEE 802.16 standard. One of the WiMAX's advantage is the coverage that can reach 50 km and the ability to handle data up to 75 Mbps. Fundamentally, the implication of WiMAX's adoption to the wireless business model is the reduction of Operational Expenditure (Opex) dan Capital Expenditure (Capex), especially the reduction of Customer Premises Equipment (CPE) price [6]. Forester Research [6] predict the CPEs cost reduction as follow:

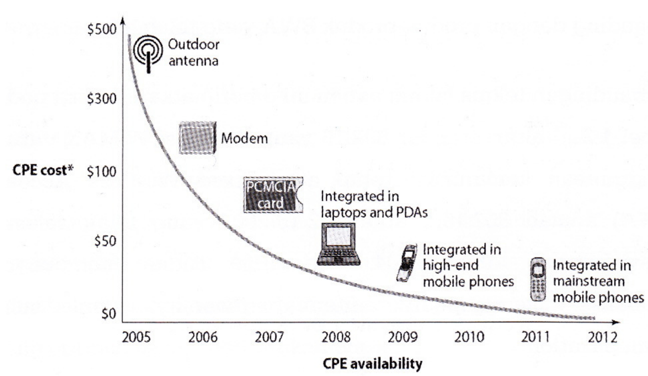

Fig 1. Prediction of CPE cost

PT.Telekomunikasi Indonesia, Tbk (PT.Telkom) is a telecommunication company and has developed their business based on fixed phone, fixed wireless phone, cellular, data & internet, and network & interconnections. Providing wireless internet service based on WiMAX will support such business development. The increasing internet usage in Indonesia has become one of the considerations to develop the product.

TABLE 1. Internet Subscribers and Users (cumulative)

Year	Subscribers	Users
1998	134.000	512.000
1999	256.000	1.000.000
2000	400.000	1.900.000
2001	581.000	4.200.000
2002	667.002	4.500.000
2003	865.706	8.080.534
2004	1.087.428	11.226.143
2005*	1.500.000	16.000.000

Broadband access in Indonesia also predicted to be increasing [7], as shown in Figure 2.

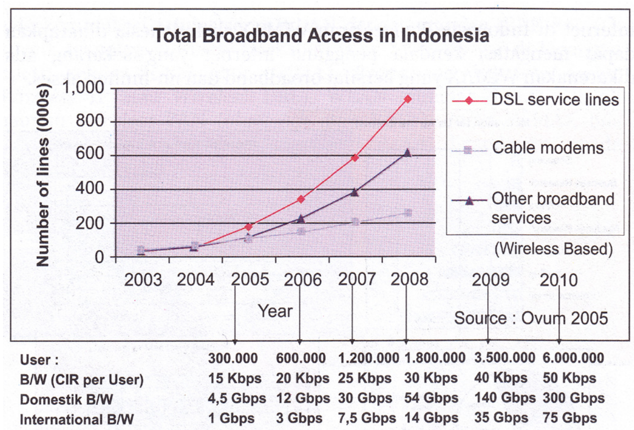

Fig. 2. *Broadband* Access in Indonesia

Developing new products need involvement of customer. "The design of products and services is the most customer-focused activity your company undertakes"[2]. This study will identify customer and technical requirements to support the development of wireless internet WiMAX-based product.

B. Problem Definition

Problem defined to be discussed in this research are :

1) What product characteristics that the customer want?
2) What are the technical requirements to fulfill those characteristics?
3) What is the WiMAX-based wireless internet product concept?

C. Research Purpose

1) Identify the product characteristics that the customers want.
2) Identify technical requirements to fulfill the characteristics.
3) Develop a WiMAX-based wireless internet product concept

II. RESEARCH METHOD

This research will define the customer requirements (what) and translate it into technical requirements (how) using Quality Functional Deployment.

Research variables are customer requirements and technical requirements. Variables operationalized into indicators as shown in table 2 and 3. Reference [5] stated the guidance to obtain the operationalized customer requirements, and reference [3] stated the guidance to obtain the operationalized technical requirements.

TABLE 2. Operationalized customer requirements

Variable	*Dimension*	*Indicator*
Customer requirements	Performance	Access speed: download speed, upload speed, wesbite access speed
		Access coverage
		Data security
		Anti-virus Protection
	Features	Geographic Information System
	Reliability	Stability of connection
	Conformance	Usage notifications
		Billing system

TABLE 3. Operationalized technical requirements

Variabel	Considerations
Technical requirements	Link Type
	Throughput-Range-Bit Error Rate
	Multipath Fading Tolerance
	Link Budget
	Frequency Band
	Back Office System Requirements

Analysis will follow the Quality Function Deployment (QFD) process using the House of Quality (HoQ) matric. The steps to perform it are [1]:

1) Analyze the *customer requirement* importance level
2) Make the *technical requirement* list
3) Analyze the relationship between customer requirements and technical requirements.
4) Identify the relationship between technical requirements.
5) Analyze *competitiveness* in fulfilling customer requirements.
6) Prioritize *customer requirments*. This is done based on the customer requirements absolute weight calculation.

Absolute weight (CR) = Customer importance x Target value x Sales point.

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7) Prioritize technical requirements. Priority determined based on absolute weight, relative weight, and degree of difficulty. Technical requirements absolute weight calculated as follow:

Absolute weight (TR) = Customer importance x Relationship score

Technical requirements relative weight calculated as follow:

Relative weight (TR) = Absolute weight (CR) x Relationship score

8) Final Evaluation.

Steps above will be executed in HoQ Matrix as follow [1]:

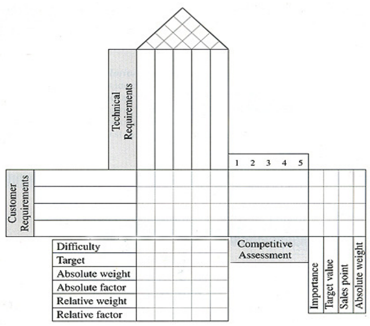

Fig 3. HoQ Matrix

III. RESULTS

A. Customer requirements importance level

This analysis will measure customer requirements importance level, i.e. how important such need be fulfilled according to customers. The average of importance level shown in table 4.

TABLE 4. The average of customer requirements importance level

No	Customer requirements	Importance
1	Download speed	3.68
2	Upload speed	3.17
3	Website access speed	3.43
4	Easily accessd everywhere	3.68
5	Data security	3.28
6	Secure from viruses	3.28
7	Connection stability	3.17
8	Speed of connected with frequent-used sites	2.77
9	Notifications of over-quota	2.60
10	Ease of accessing billing information	2.82
11	On-line information about surrounding environment where the service being accessed.	2.60

B. Technical requirements identification

Technical requirements identified by considering the considerations as stated in table 3. These requirements obtained by interviewing experts.

Technical requriements identified are:

1) *Adaptive Antenna Systems (AAS) Support*
2) *Transmit and Receive Diversity Support*
3) *High-Encryption Browser untuk User*
4) Data Transfer Software equipped with encryption feature for userFirewall
5) Antivirus *Update* on Homepage
6) *Dynamic Quality of Service (QoS) Support*
7) Charging (Billing) System and Server
8) Billing Information *Link* on Homepage
9) *Sub-channelization Support*
10) Geographic Information System (GIS) Server
11) Geographic Information System (GIS) *Link* on Homepage
12) *Manual Adaptive Modulation Support*
13) Local Server
14) *Mirror Server*
15) *Dynamic Transmit Power Control Support*
16) *Privacy Key Management (PKM) Protocol Support*
17) *Capacity Alert* to customers
18) *TDD (Time Division Duplexing) and FDD (Frequency Division Duplexing) Duplexing Support*
19) *The 802.16e Migration Support*

C. Relationship between customer requirements and technical requirements

Relationship between the two variables shows how technical requirements will contribute to the fulfillment of customer requirements.

D. Relationships between technical requirements

Relationships between technical requirements are shown in table 5:

TABLE 5. Relationships between technical requirements

No	Technical requirements	Correlation
1	*Adaptive Antenna System (AAS) Suport* with *Transmit and Receive Diversity Support*	Positive
2	*Charging (Billing) System Server* with *Information System Billing Link on Homepage*	Strong Positive
3	*Charging (Billing) System Server* with *Capacity Alert to Customers*	Strong Positive
4	*Sub-channelization Support* with *Manual Adaptive Modulation Support*	Positive
5	*Sub-channelization Support* with *Dynamic Transmit Power Control Support*	Positive
6	*Geographic Information System (GIS) Server* with *Geographic Information System (GIS) Link on Homepage*	Strong Positive

7	*Dynamic Transmit Power Control Support* with *Manual Adaptive Modulation Support*	Positive
8	*Manual Adaptive Modulation Support* with *Dynamic Quality of Service (QoS) Support*	Strong Positive
9	*TDD and FDD Duplexing Support* with *Dynamic Quality of Service (QoS)*	Positive

E. C*ompetitiveness* analysis to answer customer requirements

These analyses are supported by the calculation of average level of satisfaction. This is shown in table 6.:

TABLE 6. Technical requirements level of satisfaction

No	Customer requirements (Atribut)	Performance
1	Download speed	2.60
2	Upload speed	2.60
3	Website access speed	3.00
4	Easily accessd everywhere	3.17
5	Data security	2.77
6	Secure from viruses	2.87
7	Connection stability	3.28
8	Speed of connected with frequent-used sites	2.68

These scores will be analyzed for the determintaion of target value in the next step.

F. Prioritize customer requirements.

Prioritizing customer requirements is based on the calculation involve customer requirements importance level, target value, dan sales point. The target value obtained from the gap between the importance level and the level of satisfaction. For requirements that do not exist yet, the measurement is done by analyzing the importance level. The apporach is that the higher the gap, the higher the target value. To obtain the sales point, the approach is giving a high sales point for requirements with high importance level and low level of satisfaction. The result is as follow:

TABLE 7. Absolute weight

No	Customer Requriements	Customer Importance Level	Target Value	Sales Point	Absolute Weight
1	Download Speed	3.68	5	2	36.80
2	Easily Accessed Everywhere	3.17	5	1	15.85
3	Data Security	3.43	4	1	13.72
4	Upload Speed	3.68	5	1	18.40
5	Website Access Speed	3.28	5	1	16.40
6	Secure from Viruses	3.28	4	1	13.12
7	Connection Stability	3.17	4	1	12.68
8	Speed of Connected with Frequent-used Sites	2.77	4	1	11.08
9	Ease of Accessing Billing Information	2.60	3	1	7.80
10	Notifications of over quotas	2.82	3	1	8.46
11	On-line Information about surrounding environment where the service being accessed	2.60	3	1	7.80

G. Prioritize technical requirements

The result for technical requirements absolute weight and relative weight is as follow:

TABLE 8. Technical requirements absolute weight and relative weight

No	Technical requirements	Relative Weight	Absolute Weight
1	Adaptive Antenna Systems (AAS) Support	852.03	149.92
2	Transmit and Receive Diversity Support	852.03	149.92
3	Sub-channelization Support	852.03	149.92
4	Manual Adaptive Modulation Support	852.03	149.92
5	Dynamic Quality of Service (QoS) Support	835.23	154.00
6	TDD and FDD Duplexing Support	835.23	154.00

All technical requirements have a high degree of difficulty except Sub-channelization Support and TDD and FDD Duplexing Support, which have a medium degree of difficulty. Technical requirements that should be prioritized are shown in table 8. These technical requirements are *Adaptive Antenna System (AAS) Support, Transmit and Receive Diversity Support, Sub-Channelization Support, and Manual Adaptive Modulation Support*. Next technical requirements are *Dynamic Quality of Service (QoS) Support and TDD and FDD Duplexing Support.*The product concept derived from the information about the customer and technical requirments obtained from HoQ. The concept proposed by answering the question "What do customer wants and how are we going to act upon it?" [4]. Hence, the product concept proposed is product with good download and upload speed, easily accessed everywhere, and support good security with technical system that principally support *Sub-Channelization, Adaptive Antenna Systems (AAS), Transmit and Receive Diversity, Manual Adaptive Modulation, TDD and FDD Duplexing,* and *Dynamic Quality of Service (QoS).*

IV. CONCLUSION

This research conclusion is:

1) Determination of which product characteristics that should be prioritized is based on the *absolute weight* that includes the consideration of *customer importance*, *target value*, and *effect on sales*. Product characteristics with the highest *absolute weight* value are *Download Speed* (36,80), *Easily accessed everywhere* (18,40), *Data Security* (16,4), and *Upload Speed* (15,85).
2) Technical requirements with the highest *relative weight / relative factor* are *Sub-Channelization Support* (852,03/10,64%), *Adaptive Antenna Systems (AAS) Support* (852,03/10,64%), *Transmit and Receive Diversity Support* (852,03/10,64%), *Manual Adaptive Modulation Support* (852,03/10,64%), *TDD and FDD Duplexing Support* (835,23/10,43%), serta *Dynamic Quality of Service (QoS) Support* (835,23/10,43%).
3) The product concept proposed is product with good download and upload speed, easily accessed everywhere, and support good security with technical system that principally support *Sub-Channelization, Adaptive Antenna Systems (AAS), Transmit and Receive Diversity, Manual Adaptive Modulation, TDD and FDD Duplexing,* and *Dynamic Quality of Service (QoS).*
4) For furhter research, the cost aspect can be included to generate deeper information about this topic.

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

Real Time Control Chart System (RTCCS) for PT Sinar Terang Logam Jaya Oil Lock Collar Production Process Control

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Abstract – **The high-speed production rate of oil lock collar at PT Sinar Terang Logam Jaya (PT STLJ) requires a real time quality control system in which the measurement of process quality characteristics, the analysis of quality characteristics, and especially the control action decision-making can be done automatically and quickly. Chart Control System (CCS) is proven as an effective statistical tool in controlling the process. CCS for real time system must have methods of detecting data distribution abnormalities and existence of systematic patterns (trend pattern, shifting process pattern, mixed pattern, and stratification pattern) rules in order to bring automated process quality characteristics analysis in reality. The detection is based on Western Electric company rules. This research aims to design Real Time Control Chart System (RTCCS) application to measure the diameter of oil lock collar of PT STLJ and to analyze data based on CCS, which able to detect the abnormal data distribution and the existence of systematic patterns. Oil lock collar diameter measurement is conducted by Visual Automatic Measuring System (VAMS) application, an automated measurement system based on image processing. VAMS is built using Microsoft Studio 6.0 with the additional features from National Instrument. Measurement data analysis is performed by Automatic Process Monitoring System (APMS) application, whereby using the CCS, the data distribution abnormalities and the existence of systematic patterns from VAMS measurement results will be detected. The method of quality characteristics behavior analysis uses control chart helping lines for detecting abnormal data distribution, mixed pattern, and stratification pattern. The detection of trend and process shifting patterns is performed using linear regression techniques and Cumulative Sum (Cusum) chart. The integration of VAMS and APMS is built through data communication system yielding an RTCCS as a whole complete system. The results showed that: (i) VAMS provides an accurate dimension measurement of oil lock collar diameter, because the measurement results are not differ from manual caliper measurement, and also a precise measurement because of its repeatability, (ii) APMS can detect data distribution abnormalities and systematic patterns, (iii) RTCCS is able to give a real time quality characteristic analysis, and (iv) PT STLJ needs to improve its production processes because the abnormalities data and the systematic patterns in its production processes. This research is expected to be developed from quality control monitoring into design of automated quality control activity.**

Keywords: AMS, and APMS, control chart system, image processing,

I. INTRODUCTION

The production rate of PT Sinar Terang Logam Jaya (PT STLJ) oil lock collar reaches 2400 items per day. The quality control now performed at PT STLJ is not adequate enough to determine whether the ongoing production process is statistically in-control or not due to unrepresentative sampling technique implemented. From those 2400 items of oil lock collar produced a day only 3 items are inspected to check the ongoing production process. The very small amount of items being inspected is due to the fact that the measuring system is still performed manually and the difficulties in measuring diameter dimension. To overcome these problems, an automatic real time quality control system is needed.

The critical dimension of oil lock collar is its diameter due to be assembled with other components before functioning. The measurement of this diameter must be performed accurately and precisely. Figure 1 shows the picture of oil lock collar.

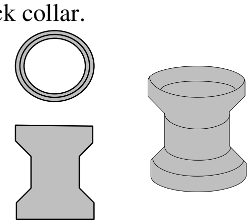

Figure 1. Oil lock collar

As the most important and widely used SPC tool [2], a Control Chart System (CCS) will be implemented at PT STLJ. Since it is designed to be implemented in a real time system, the developed systems is called a Real Time Control Chart System (RTCCS). RTCCS is a CCS that (i) maps distribution of quality characteristic data of the ongoing process, (ii) detects data abnormalities and systematic patterns and at the end (iii) states whether the ongoing production process is in-control or not.

RTCCS consists of two main functions: an oil lock collar diameter measurement and collected measurement data analysis. To measure oil lock collar diameter, a Visual Automatic Measurement System (VAMS) is built. VAMS is an automated measuring system for oil lock collar diameter through image processing. In this research, VAMS is developed from VAMS built by Saktyaji in 2009 [9]. Saktyaji's VAMS measures machining tools diameter with acquisition direction is parallel with the field base. This direction is not suitable for oil lock collar diameter measurement because oil lock collar has bad roundness. Bad roundness may give wrong diameter measurement if the direction is parallel to oil lock collar field base. The resulted image comparison between the Saktiaji's VAMS and VAMS built in this research is showed in Figure 2.

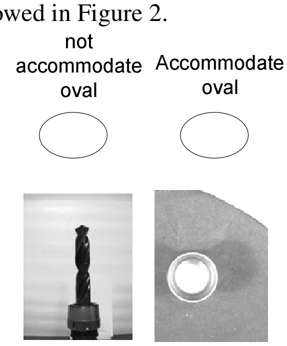

Figure 2. VAMS comparison (Left: Saktiaji's VAMS, right: VAM built in this research)

To analyze the diameter data measured by VAMS, an Automatic Process Monitoring System (APMS) is built. APMS will analyze data behavior in control chart whether it is normal or it shows abnormalities or systematic patterns.

II. METHOD

As mentioned above, RTCCS consists of VAMS and APMS. Both VAMS and APMS are built using Microsoft Visual Basic 6.0 and are connected by a data communication. Figure 3 shows RTCCS design method.

VAMS design consists of:

1. Image acquisition presetting. Image acquisition presetting determines the whole quality of object image. In image acquisition presetting, things to be set are:
   a. Image acquisition direction. The direction must produce adequate image information. In this research, acquisition direction is perpendicular to the object field base.
   b. Camera focus. Focused image gives precise measurement. Focus is set by using letter object.
   c. Image brightness. Good brightness gives accurate measurement [7].
   d. Object positioning. Oil lock collar positioning has to be concentric with camera lens.
   e. Background color. Background color should be contrasted with object color to result an accurate measurement [7].
   f. Helping devices usage. Helping device helps in object positioning.

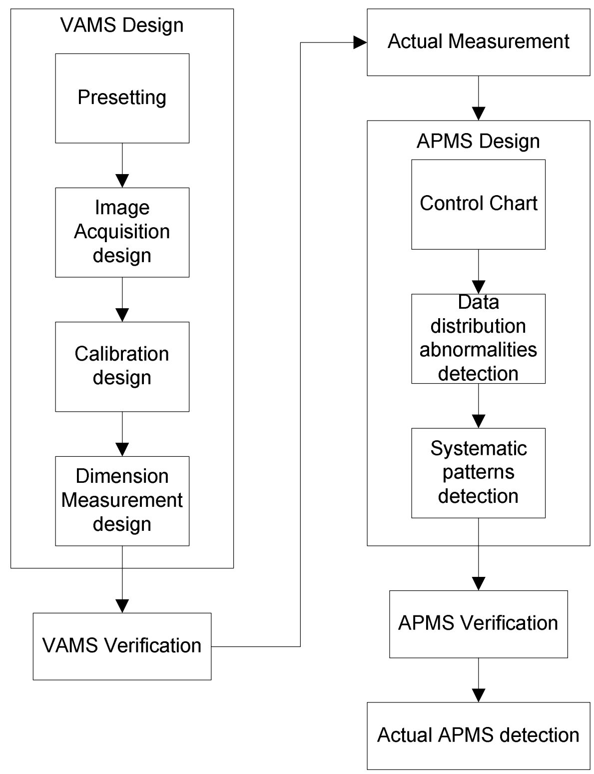

Figure 3. Design method

2. Image acquisition application design. Image acquisition application is connected with a Basler SCA1000 30gc camera. This application is used to command the camera when to acquire the object into a digital image.
3. Calibration application design. Calibration application design is needed to assure the measured diameter is conformed to real-world standard. VAMS calibration is done by comparing the diameter measured by VAMS in pixel unit with diameter measured manually in metric unit which results a conversion factor. This conversion factor is then used to convert the measurement result in pixel unit into metric unit.
4. Image measurement application design. Image measurement application uses edge detection

ISBN : 978-602-97809-0-1

technique and rake method to measure oil lock collar diameter. Edge detection find edges in the image based on contrast differences. If a pixel has a significant different contrast with the surrounding pixels, then an edge is generated on that pixel [7, 9].
In rake method, a circular region of interest (ROI) is initiated. Then, the circular ROI center generates a circle that becomes bigger and bigger which stops when the circle touches the farthest edge in the ROI. The diameter of the circle then becomes the diameter of the oil lock collar.

Verification can be done by debugging and output checking technique [3]. This technique is chosen for VAMS because VAMS is built using validated function from National Instrument. By debugging and checking the output, VAMS is proved to be verified.

According to Statistical Process Control (SPC) concept, the data is taken by sampling technique. Sample for this research is taken sequentially according to the ongoing production process. The sample is then classified in subgroups to build a control chart system. Each

APMS design consists of:

1. Control Chart (CC) design. In this stage, the CC is constructed following the CC construction standard procedure. The CC consists of a centerline, 3σ-lines (known as upper control limit (UCL) and lower control limit (LCL)), 2σ-lines and 1σ-lines. For CC construction, 20 subgroups are used while for CC implementation 90 subgroups are used.
2. Data distribution abnormality detection design. APMS detects any abnormality data distribution following Western Electric Company four type of data abnormalities as follows:
   - type-a: one data falls beyond UCL /LCL,
   - type-b: two out of three consecutive data fall beyond 2σ-warning limit or zone A.
   - type-c: four out of five consecutive data fall beyond 1σ-warning limit or zone A and B.
   - type-d: eight consecutive data fall in upper or lower side of control chart or zone A, B and C.

   APMS uses control chart helping lines to detect the four type abnormalities. The detection of type-a data abnormality uses 3σ-lines, type-b data abnormality uses 3σ-lines and 2σ-lines, type-c data abnormality uses 3σ-lines and 1σ-lines and type-d data abnormality uses the centerline [6]. Figure 4 shows the zone rules from Western Electric Company rules and control chart helping lines.

Determining the values for 1σ and 2σ-lines for R chart in subgroup of 5 is different from determining the values for Xbar. R chart in subgroup of 5 does not have symmetric range from centerline to control limit lines [5]. Determination for R chart helping lines is done by dividing the range into three proportional areas [4].

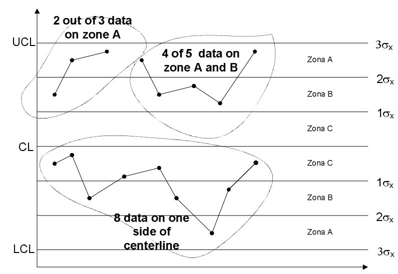

Figure 4. Zone rules from Western Electric Company Rules

3. Systematic pattern detection design. Four types of systematic patterns can be detected by APMS from implemented data on R and Xbar chart are shown in Figure 5. Those patterns are trend pattern (a), process shift pattern (b), mixture pattern (c), and stratification pattern (d).

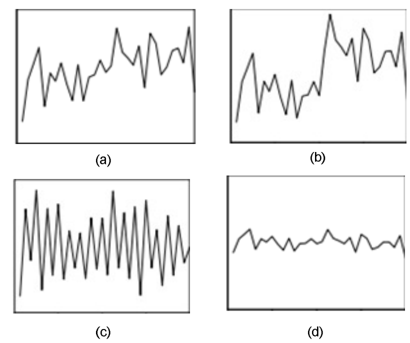

Figure 5. Systematic patterns (Gauri and Chakraborthy, 2008)

APMS detects these systematic patterns in different ways for each pattern. Trend pattern is detected utilizing linier regression technique, process shift is detected utilizing cumulative sum (Cusum) chart and mixture and stratification patterns are detected utilizing control chart 1σ-lines.

Steps for trend pattern detection for R and Xbar chart are:

1. Group the data consisted of each seven consecutive subgroup.
2. Determine the value of correlation coefficient (*r*) for each seven consecutive data.
3. If there is any absolute *r* value that is equal or bigger than 0.9 then the seven consecutive data behave a trend pattern.

Steps for process shifting pattern detection on R and Xbar chart are:

1. Determine process target, shift magnitude, allowance, and decision interval value as detection parameter.
2. Determine the value of C_i^+ and C_i^- for each subgroup data, where:
   $C_i^+ = max[0, x_i - (\mu_0 + k) + C_{i-1}^+]$
   $C_i^- = max[0, (\mu_0 + k) - x_i + C_{i-1}^-]$

ISBN : 978-602-97809-0-1

shows positive accumulation till the i^{th} data, while shoes the negative accumulation is the average value
k is the allowance
is the i^{th} sample data
δ shows the shifted value detected.

3. If either or value is bigger than decision interval (H), then process shift pattern is detected. Change target value according to detected shift magnitude to know frequency of shift that happened in the chart.

Figure 6 shows an example of process shift detection using Cusum based method.

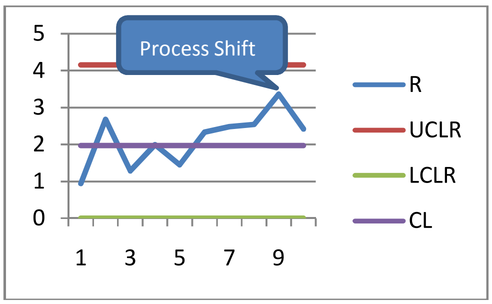

Figure 6. The detection of a shifted process

Steps for mixture pattern detection on R and Xbar are:

1. Determine CC control limit lines and 1σ-limit value.
2. Compare each R and Xbar values for each subgroup with control limit values and 1σ-limit value.
3. If eight consecutive data values are between control limit values and 1σ-values, then mixture pattern is detected.

Steps for mixture pattern detection are:

1. Determine control chart control limit lines and 1σ-lines.
2. Compare each R and Xbar values for each subgroup with control limit and 1σ-values.
3. If fifteen consecutive data values are between control limit values and 1σ-value, then mixture pattern is detected.

Figure 7 shows an example of mixture detection.

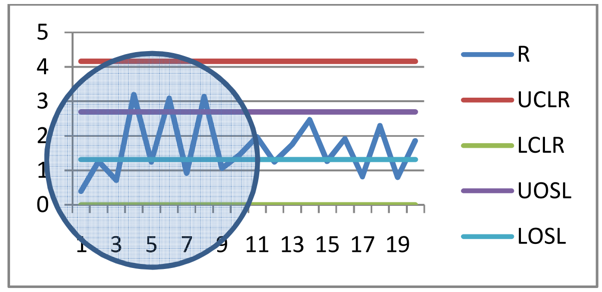

Figure 7. Example of mixture pattern detection

Verification for APMS uses simulation data according to Gauri and Chakraborthy equations [1] are shown on Table 1.

Table 1 Simulation data parameters and equations

	Pattern parameter	Parameter value	Parameter equation
Upper trend	g	$0.05\sigma \le g \le 0.1\sigma$	$y_i = xi + r_i\sigma + ig$
Lower trend		$-1.0\sigma \le g \le -0.05\sigma$	$y_i = xi + r_i\sigma - ig$
Upper shift	s, P	$1.5\sigma \le s \le 2.5\sigma$	$y_i = xi + r_i\sigma \pm ks$, $k=1$ if $i \ge P$, else $k=0$
Lower shift		$-2.5\sigma \le s \le -1.5\sigma$	
Mixture	d	$1\sigma \le d \le 3\sigma$	$y_i = xi + r_i\sigma + d(-1)^i$
Stratification	σ'	$0.2\sigma \le \sigma' \le 0.4\sigma$	$y_i = xi + r_i\sigma'$

Each pattern detection uses different parameter. Parameter used for upper and lower trend is parameter g. Parameter g is the gradient value from the generated data. Parameter g is able to make trend pattern because the value is multiplied with i, data index which is bigger sequentially. Upper shift and lower shift patterns use parameter s and P. Parameter s is desired multiplier value for process shift in simulation and Parameter P is the data number when the shift is happened.

Mixture pattern uses parameter d. Parameter d shows value departure from the centerline. To make it may occurred sequentially on upper then lower region, then parameter d is multiplied with the value of -1 (negative one) which is powered with parameter t. Parameter t is data number. Stratification pattern uses parameter σ`. Parameter $\sigma$` shows the random noise for each simulated data. Parameter σ` makes the variance is small so that all data is only occurred between 1σ-limit.

III. RESULTS

The results from VAMS are oil lock collar image and dimension. Figure 8 shows image captured by VAMS.

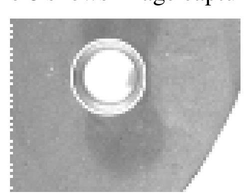

Figure 8. Oil lock collar image acquired by VAMS

Table 2 shows first 100 measurements by VAMS which grouped into 20 subgroups. Each group consists of five diameter measurements from five different oil lock collars.

Table 2 VAMS measurement result for first 20 subgroups

Subgroup	First	Second	Third	Forth	Fifth
1	20.500	20.428	20.493	20.424	20.421
2	20.610	20.512	20.448	20.580	20.395
3	20.658	20.543	20.419	20.587	20.485
4	20.223	20.294	20.593	20.412	20.406
5	20.466	20.296	20.322	20.499	20.498
6	20.371	20.362	20.548	20.467	20.672
7	20.468	20.463	20.569	20.432	20.501
8	20.613	20.524	20.722	20.409	20.487
9	20.496	20.441	20.581	20.534	20.477
10	20.420	20.277	20.345	20.374	20.324
11	20.548	20.447	20.585	20.446	20.378
12	20.398	20.437	20.475	20.457	20.483
13	20.432	20.484	20.427	20.309	20.525
14	20.378	20.563	20.604	20.604	20.346
15	20.364	20.623	20.381	20.614	20.356
16	20.326	20.551	20.551	20.704	20.642
17	20.487	20.657	20.497	20.463	20.289
18	20.502	20.845	20.463	20.701	20.511
19	20.475	20.625	20.520	20.712	20.508
20	20.553	20.573	20.573	20.518	20.287

The first result of APMS is the construction of R and Xbar charts. The implemented R and Xbar control chart for the 100 measurements are shown in Figure 9 and 10. For the R control chart, the CL, UCL and LCL values are 0.24197, 0.51119, and 0. For Xbar chart the CL, UCL, and LCL values are 20.48586, 20.66729, and 20.40443.

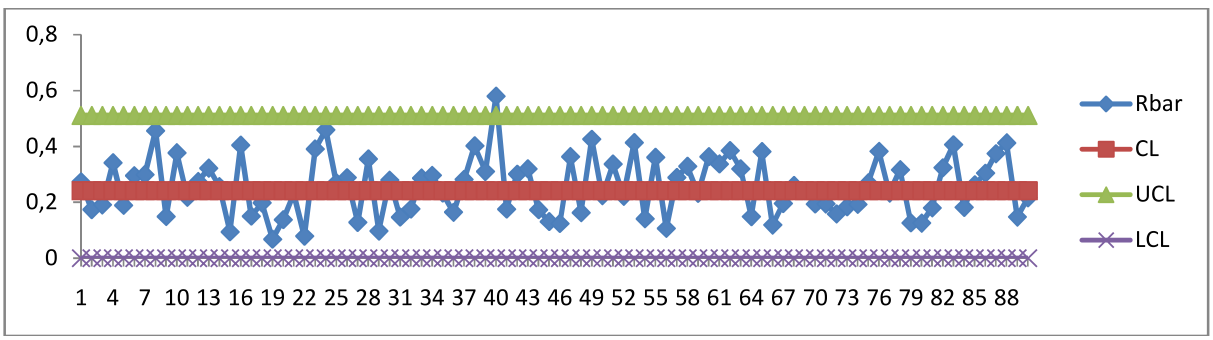

Figure 9. Implementation of R control chart

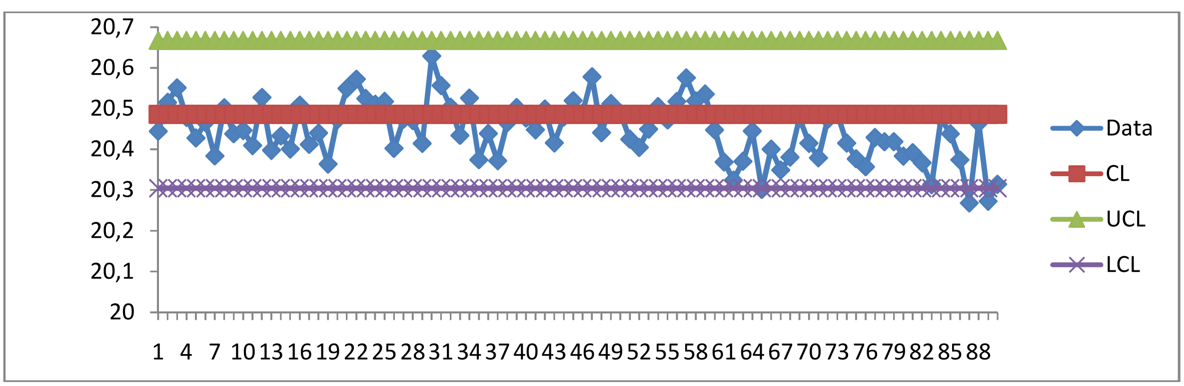

Figure 10. Implementation of Xbar control chart

The second result of APMS is the detection of data distribution abnormalities. Table 3 shows control chart analysis results.

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Table 3 Control chart analysis result summary

		Detected data number	
		R chart	Xbar
abnormility of data distribution	type-a	40	65, 87, and 89
	type-b	-	-
	type-c	-	70, 71, and 78-84
	type-d	-	73-86
systematic patterns	Upper trend	-	57
	Lower trend	-	63 and 83
	Upper shift	22, 25, 40	32
	Lower shift	72	11, 41, 63 and 80
	Mixture	-	-
	Stratification	-	-

Three types of data abnormalities are detected which are type-a in both R and X bar charts, type-c and type-d which occurred only in Xbar chart. For systematic patterns, trend patterns are detected both in upper side and lower sides in Xbar chart, while process shift is detected both in R chart and Xbar charts. For the related data, the mixture and stratification patterns do not occur. The specific group numbers when the abnormalities and systematic patterns detected are shown in Table 3.

IV. DISCUSSION

Image acquisition direction for this research is perpendicular to the object field base (Figure 11). This direction provides more information about oil lock collar diameter but very sensitive to perspective error. Perspective error occurred when object positioning is not concentric with the camera. This perspective error gives error which included in diameter measurement. To solve this problem, a positioning mark is utilized to assure the oil lock collar position is concentric. Perspective error that might occur is showed on Figure 12.

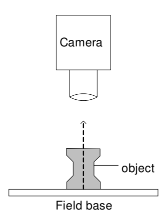

Figure 11. Direction of image acquisition

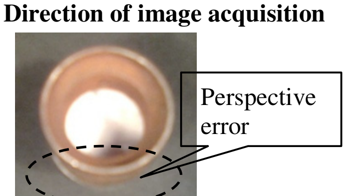

Figure 12. Example of perspective error

Paired observation test is used to compare the VAMS measurement and the manual measurement using a caliper. Hypothesis to be tested is average of both measurement is the same. Using 30 data and 95% of confidence level the rejection region of statistic t is smaller than -1.96 or bigger than 1.96. It is concluded that there is not enough evidence to reject the hypothesis. It is concluded that, both measurement is the statistically not different [10].

Table 4 Manual and VAMS measurement comparison

Data	Manual measurement	VAMS measuremen	d_i
1	20.41666667	20.50040561	-0.08374
2	20.41	20.42834439	-0.01834
3	20.46	20.49323329	-0.03323
4	20.45	20.42383602	0.026164
5	20.46666667	20.42057422	0.046092
6	20.43666667	20.60991665	-0.17325
7	20.44333333	20.51201362	-0.06868
8	20.43333333	20.44797333	-0.01464
9	20.46333333	20.5802897	-0.11696
10	20.45666667	20.39461975	0.062047
11	20.46333333	20.65840388	-0.19507
12	20.44	20.54287987	-0.10288
13	20.41666667	20.41935127	-0.00268
14	20.46666667	20.58659706	-0.11993
15	20.44	20.48534137	-0.04534
16	20.44666667	20.22268934	0.223977
17	20.39666667	20.2942781	0.102389
18	20.44	20.59268635	-0.15269
19	20.47	20.41195544	0.058045
20	20.48333333	20.40617506	0.077158
21	20.50666667	20.52335532	-0.01669
22	20.57666667	20.45911654	0.11755
23	20.37666667	20.18599585	0.190671
24	20.53333333	20.4724406	0.060893
25	20.33	20.2029599	0.12704
26	20.51666667	20.54778508	-0.03112
27	20.47	20.27119104	0.198809
28	20.51333333	20.44293534	0.070398
29	20.21666667	20.16238366	0.054283
30	20.42333333	20.19699393	0.226339
Average	**20.44544444**	**20.42989072**	**0.015554**
	Sd		**0.115187**

Calibration process not only makes VAMS able to provide an accurate measurement but also gives a precise measurement. If measurement of an oil lock collar is conducted twice, then the result variance is small. Both measurements differ only on forth decimal places.

In this research control chart, data abnormality detection and systematic pattern detections are also manually calculated and conducted. The purpose is to compare the results from manual processes with the results from the APMS. From the comparison, it is concluded that APMS can give the same results with the manual results.

V. CONCLUSION

Based on the research, it is concluded that:

1. RTCCS which consists of VAMS and APMS is well-designed to support real time quality control.
2. VAMS provide accurate and precise measurements of oil lock collar diameter.
3. VAMS measurement results are statistically not different with manual measurement. Statistical test resulting *t* equals 0.739592 which is outside the rejection region, smaller than -1.96 or bigger than 1.96.
4. VAMS measuring time is 6 seconds which is faster than 28 seconds for manual measurement for each measurement object.
5. APMS is able to detect data distribution abnormalities and systematic patterns according to Western Electric rules accurately. The time needed for APMS to analyze the data distribution is 90 seconds.
6. VAMS and APMS are well-integrated into RTCCS using a data communication system that make a real time quality control activity can be conducted.
7. PT STLJ oil lock collar production process still needs improvement because of the abnormalities and systematic patterns are detected.

ACKNOWLEDGMENT

We would like to express our gratitude to Prof. Tetsutaro Hoshi, the Nishijimax Company, the ASAHI Glass Foundation, Manufacturing Systems Research Group and Bandung Institute of Technology Internal Research Grant for the financial supports to the research.

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

Waste Reduction Strategy Using Lean Manufacturing Methods

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Abstract - **Increasing the productivity of a company must be done continuously so that allows companies to compete and grow. Therefore, planning must be done well include the improvement and control activities that occur within the company so it can eliminate waste which reduces productivity. One method that can be used to eliminate waste is lean manufacturing. Lean is an ongoing effort to eliminate waste and increase the value added of products (goods and/or services) in order to provide value to customers. The goal of lean is to promote continuous customer value by improving the ratio between the value added to the waste (the waste-to-value ratio). Based on the lean perspective, all types of waste contained along the value stream that transforms inputs into outputs, must be removed to increase the value of products and further enhance customer value. Broadly speaking Lean Manufacturing consists of two stages, Current State Gap and Future State Design. Current State Gap phase is the stage of drawing the company's current condition, while the Future State Design is the design phase of the proposed improvements will be implemented in the company. Tools used in the current State Gap phase is a Value Stream Map (VSM) which is mapping the flow of information and material, and Assessment Waste (waste assessment model) to support the analysis made by the VSM. At Future State Design phase, the proposed scheme of improvements made including the production system design, the formation of manufacturing cells/layout, and scheduling system design.**

Keywords – **Lean Manufacturing, Value Stream Map, Cellular manufacturing**

I. INTRODUCTION

Competition in the industrialized world today is more strict. A company that wants to continue to grow and can continue to compete must continue to make improvements through the achievement of high productivity. This can be achieved by improving the preparation or planning and control activities that occur within the company so it can eliminate waste that would ultimately reduce productivity. The repair process should begin with identifying waste, understanding the root of the problem and design and carry out appropriate countermeasures to overcome the problem of waste that occurs.

One effort that can be done to overcome is to eliminate wasteful activities that do not provide added value to the company. There are three categories of corporate activity, namely value added activities are activities that create products or services become more valuable from the viewpoint of customers, necessary but non value added activities are activities that do not provide added value to the product or service but can not be eliminated with technology and capability which is now owned, and non-value added activities which are activities that are totally unable to provide added value to the product or service. One method that can be used in an effort to eliminate waste is lean manufacturing. Lean is an ongoing effort to eliminate waste and increase the value added of products (goods and/or services) in order to provide value to customers. The goal of lean is to promote continuous customer value by improving the ratio between the value added to the waste (the waste-to-value ratio). Inside there are seven types of corporate activity, the main activities that have no added value in business or manufacturing process that is excess production (overproduction), waiting times (delays), unnecessary transportation, processing in excess or in error processing, excess inventory, motion not necessary as well as a defective product.

Lean is an ongoing effort to eliminate waste and increase the added value of products (goods and services) in order to provide value to customers (customer value). The objective of lean is to increase continuously improving customer value through continuous customer value through continuous improvement of the ratio between the value added to the waste (the waste-to-value ratio). In the year 2006 the value to waste ratio of Japanese firms about 50%, Toyota Motor company approximately 57%, the best companies in North America (U.S. and Canada) approximately 30%, while the value-to-waste ratio of the best companies in Indonesia, only around 10%. A company can be considered if the value of Lean-to-waste ratio has reached the minimum 30%. If the company is not lean, the company may be referred to as Un-Lean

ISBN : 978-602-97809-0-1

Enterprise and categorized as traditional companies. Lean focuses on the identification and elimination of these activities have no value added in the design, production (for manufacturing) or surgery (for services), and supply chain management, which associated directly with customers. Lean can be defined as a systemic and systematic approach to identifying and eliminating waste or activities that have no value added (non-value-adding activities) through radical continuous improvement by flowing the product (materials, work in process, output) and information using a pull system of internal and external customers to pursue excellence and perfection. Lean applied to the whole enterprise is called as lean enterprise. There are five basic principles of lean:

1. Identify the value of products (goods and/or services) based on the customer perspective, whereby customers superior quality products, competitive prices and timely delivery.
2. Identify the value stream process mapping for each product (goods and/or services). (Note: most of the management of industrial companies in Indonesia only for mapping business processes or work processes, rather than doing product process mapping. This is different from the lean approach).
3. Eliminating non-value added waste from all activities throughout the value stream processes.
4. To organize material, information, and products that flow smoothly and efficiently throughout the process of value stream using pull system.
5. Constantly looking for different techniques and equipment improvement (improvement tools and techniques) to achieve excellence and radical continuous improvement.

II. Methodology

The study began with preliminary observations, the formulation of the problem, and determine the purpose of research. Literature review conducted to find the right method to base the settlement of problems and research objectives. Data collected by direct observation at the research site (manufacturing company) and the study of relevant company documents.

In general, research conducted in two major phases namely Current State Mapping and Future State Design.

The first stage is to map the problem which occurs on the production floor, identifying the main waste, and determine the root causes of waste. This phase begins with the identification of any family products are produced as well choose one as a model. Then determine the characteristics of the line model was chosen and described all of the material flow and information flow that occurs along the production line of products selected as line models and describes how the interaction between the material and information during the production process (using the value stream mapping). The last step of the first stage is to determine the main waste that occurred, identify the cause of the waste (using root cause analysis and analysis of 5W) which can ultimately determined the root cause of the main waste.

Phase two is conducted to determine the alternative actions that need to be done in accordance with the principals of waste and to design remedial actions that can be done so that companies can solve the problem of waste that occurs in the production floor.

The last step of the research is to analyze the results of data processing that can be drawn a conclusion in accordance with the purpose of research that has been established in the early stages of research.

III. Case Study

PT. Sinar Continental is a company that produces interior fabrics for automotive and non automotive applications. PT. Sinar Continental produce thousands of products both for automotive interior fabric and non-automotive, but in this case to be discussed is related to non-automotive products. Demand data are displayed as many as 89 types of non-automotive products. Each type of product has a different need of raw materials (composition) and different sequence of production processes.
In PT. Sinar Continental, there are activities that have no value added (waste), namely the excessive production, delays in ordering, inventory the existing imbalance between production needs and still have a defective product. And the consequences of such extravagance is the company's declining productivity.

From observations made on the production floor there were many activities that generate waste, one of them is a fairly large inventory build up. Improvement efforts can be done by identifying activities that generate waste and determine the steps that need to be done to reduce or eliminate waste.

A. Current State Gap

- *Identify Product Family and Select Line Model*
  Based on the similarity processes and machines used, non-automotive products are grouped into ten family (Table 1). The model line is a selection of products that will be used as a basis in research that can be determined based on the biggest demand for the biggest demand means that these products have a long-term relationships with customers. From the results of clustering can be seen that the biggest demand is Kania family where it was found that the request amounted to 130.000 meters during a period of one year. Of all the types of products in the Kania family, Kania Red is the highest production of as many as 25.700 meters so that Kania Red was elected as the Line Models.

- *Identify the characteristics of the selected line model*
  To Identify characteristics of line Model used SIPOC (Supplier-Input-Process-Output-Customer) Diagram and Process Flow Diagram. In SIPOC diagram illustrated the key processes that occur, the sequence of interaction process, as well as suppliers and customers involved in the production process. SIPOC

ISBN : 978-602-97809-0-1

diagram illustrates the main production process of making Kania Red.

TABLE I
Family of product

NO	FAMILI	TOTAL *DEMAND*
1	*New Jasmine*	73350
2	*Jameela*	93750
3	***Kania***	**130000**
4	*Gallery*	35300
5	*Gold*	34250
6	*Scarlet*	40250
7	*Maxwell*	49300
8	*Diamond*	23100
9	*Fleurist*	27250
10	*Khanza*	32000

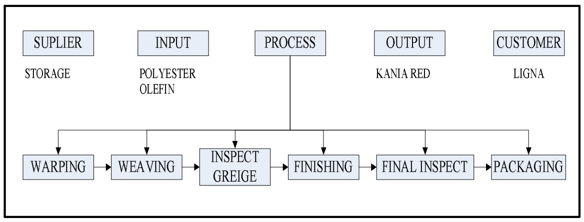

Fig. 1 SIPOC Diagram of Kania Red's Production Process

- *Value Stream Mapping : Current State Map*

  There are several stages of manufacture Value Stream Mapping: Current State Gap, namely:

  1. VSM Phase 1: explain the delivery process and the flow of information to the customer
  2. VSM Phase 2: explain about the flow of information and materials from suppliers through customers
  3. VSM Phase 3: describes the production process starting from the time of the process, lead time, as well as having direct contact during the production process
  4. VSM Phase 4: describes the information and material flow, where information such as material planning or production plan drops to trigger the flow of material and vice versa.
  5. VSM Phase 5: map of the process results in the previous phases with information on lead time and value adding time of the whole process. This information is placed at the bottom of the map. Value adding time is obtained from the total accumulation of total work time for each process, while the lead time is the result of accumulation of physical size of the overall stock day (picture a triangle = inventory) at each process.

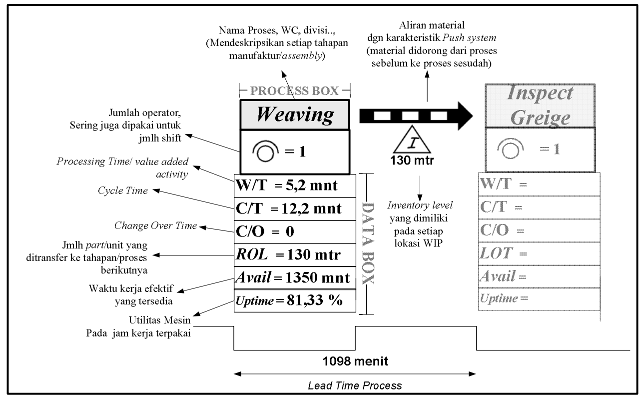

Fig. 2 Data Box for Material Flow in The VSM

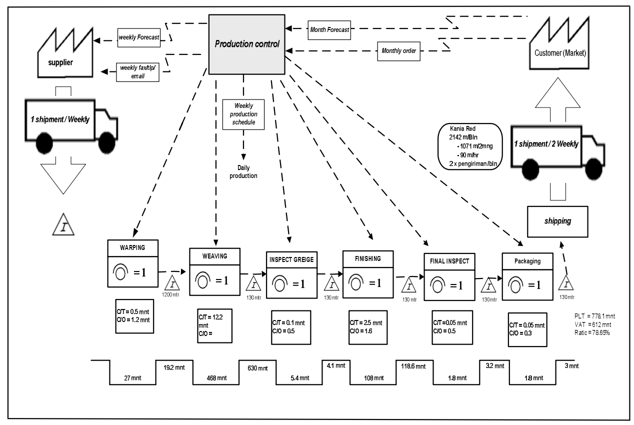

Fig. 1 Value Stream Mapping : Current Fase 5

The calculation of value-to-waste ratio is conducted for selected models are Kania red line to see if the company is in a lean condition or not. Value-to-waste ratio obtained was 78.65% (obtained from the total value divided by the value-added activity (total lead time - the total value-added activity)). From these results we can conclude that PT. Sinar Continental actually reach lean.

- *Identifying the Main Waste With Waste Assessment Model Approach*

  Waste assessment model is a combination of questionnaires with the adoption of research results. Rawabdeh (2005) identifies the strength of the relationship between the seven waste (seven waste) such as wasteful overproduction (0), inventory (I), defects (D), motion (M), transportation (T), process (P) and waiting (W). From the calculation illustrates that the largest values contained in the waste inventory. Thus, it can also be concluded that the waste located in the main inventory.

Root Cause Analysis carried out to find the root causes of waste that occurs. The main extravagance is going on the production floor PT.Sinar Continental is wasteful inventory. Said to be a waste of inventory when the inventory level exceeds demand (often referred to as excess

inventory/unnecessary inventory). Unnecessary inventory can be viewed at the time of making current state VSM map. These types of waste occurring in some areas of the storage area and production processes, including:
1. Unnecessary Inventory of raw material
2. Unnecessary Inventory WIP (work-in-process)
3. Unnecessary Finished Good Inventory

Based on the results of Root Cause Analysis process and using the "5why", got the root causes of waste in unnecessary inventory categories include the following:

1. Improper machine settings
2. Unfavorable environments such as distances between each process, air pollution and hot temperatures.
3. Inappropriate scheduling
4. Less engine maintenance

B. Future State Design

- *Mixed Production System Design (Hybrid System)*

  PT. Sinar Continental is a company which has many variations of products and production volumes vary. Therefore, PT. Sinar Continental can be classified into the category of small manufacturing. Companies in this environment has a lot of customers with different orders. Given these variations, the company can run a production system with a mixture (hybrid systems), adjusted for the order quantity and delivery period.

  From these results, the production floor can be divided into three lines of production (shop floor), each of which specifically produce a certain product families, including:

  a) The Special Shop: producing family khanza, fluerist, and diamond. The products are grouped into a special shop production line is a prototype product, has never produced before.
  b) Standard Shop: Maxwell family produces, Scarlet, gallery and gold. The products are grouped into standard shop production line are products that usually booked by consumer, attention to quality products and set ups that have been documented.
  c) Pull Shop System: producing families Kania, New Jasmine and Jameela. The products are grouped into the Pull shop Systems production line are products that have properties that are owned by the previous lines, relatively accurately forecast demand, customers with Just In Time system, and repeatedly asked for shipping orders with relatively short durations and continuous, and the company can meet the requirement in accordance with the delivery lead time specified.

  - *Establishment of Manufacturing Cells Repair And Proposed Layout (Cellular Manufacturing)*

    In this scheme only for products which include the pull production lines into the shop system Kania, New Jasmine and Jameela. From the results of the grouping of machines and products using the Rank Order Clustering (ROC) algorithm is obtained that the product-machine grouped into three cells with the distribution of products and machine (Table II). While the proposed layout can be seen in Figure 4.

With the division of cells to classify the products which fall into one family then the efficiency of the engine layout will be higher. It can be seen from a considerable distance difference between the layout before and after improvement. One example: in family 1, the distance between the sectional warping into picanol gamma can be corrected until the difference of 47,43% of the distance before improvement.

- *Working hours improvement*

  Working hours improvement needed to reduce wastes resulting from the idle machines. The design of working hours performed repairs on the family products that have the greatest demand. Kania product family is a family that has the greatest demand, with demand of 130 000 meters per year. From the result of improved working hours can be seen very significant difference between the hours of work before improvement by working hours after improvement (Table III).

TABLE II

Recapitulation of Grouping and the required number of machines in cell

Cell	Product		Machine		
	No	Name	No	Name	Qty
1	1	New Jasmine - Black 1	1	Sectional Warping	1
	2	New Jasmine - Black 2	2	Picanol Gamma	3
	3	New Jasmine - Burgundy	3	Inspect Finish	1
	4	New Jasmine - Calypso	4	Greige 2	1
	5	New Jasmine - D. Beige 1	6	Stenter	2
	6	New Jasmine - D. Beige 2	8	packing	1
	7	New Jasmine - L. Brown	5	Jet Dyeing	1
	8	New Jasmine - Mandarin			
2	9	Jameela - B. Brown	7	Coating	2
	10	Jameela - Butter	9	Sectional Warping	1
	11	Jameela - Calypso	10	Picanol Gamma	4
	12	Jameela - D. Beige	11	Inspect Finish	1
	13	Jameela - N. Brown	12	Greige 2	1
	14	Jameela - Orange	13	Stenter	3
	15	Jameela - Red	14	packing	1
3	16	Kania - Aztech Brown	15	Sectional Warping	1
	17	Kania - B. Brown	16	Picanol Gamma	5
	18	Kania - Butter	17	Inspect Finish	1
	19	Kania - Calypso	18	Greige 2	1
	20	Kania - D. Beige	19	Stenter	4
	21	Kania - Mustard	20	packing	1
	22	Kania - Orange			
	23	Kania - Red			

ISBN : 978-602-97809-0-1

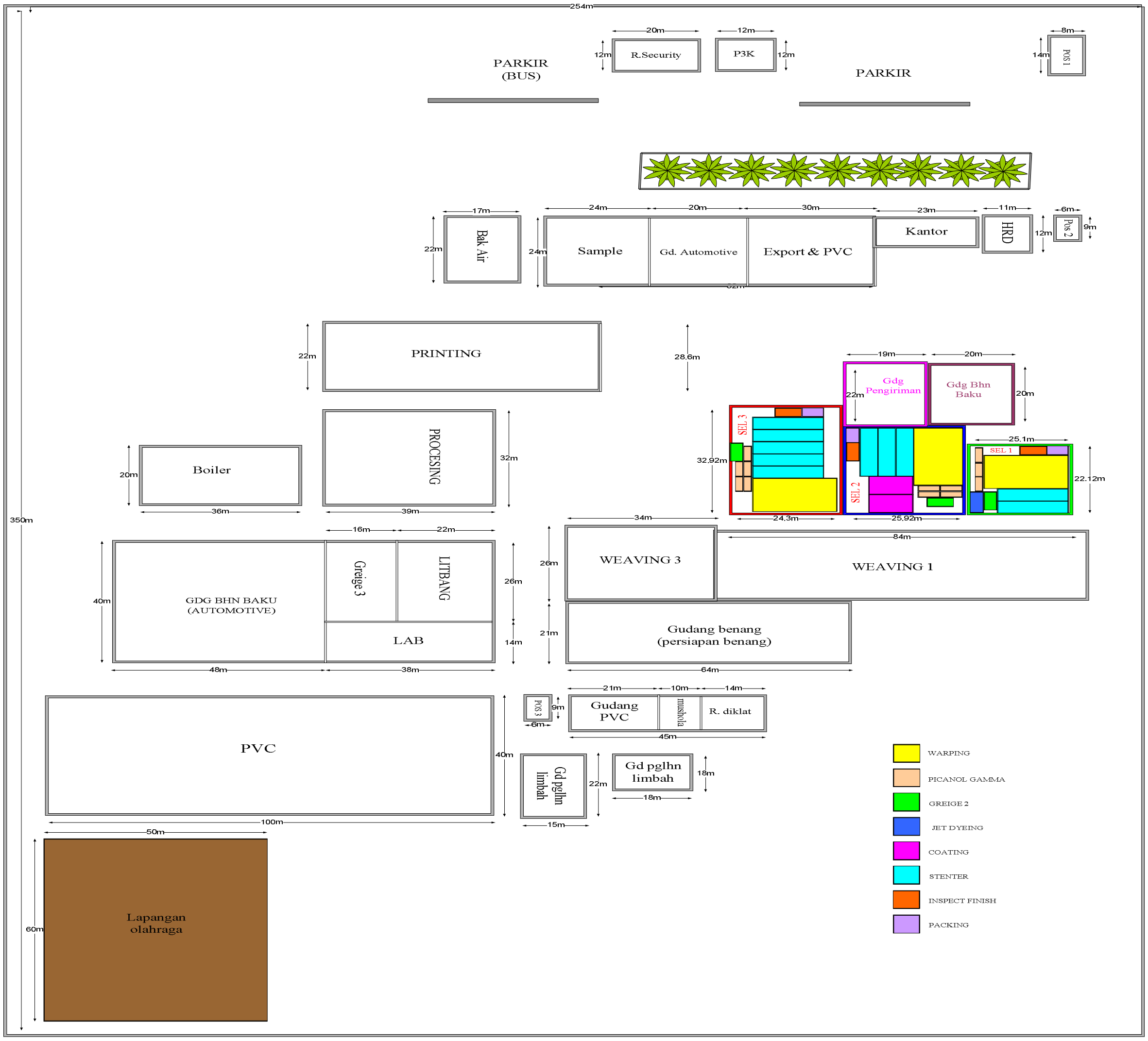

Fig. 4 Proposed Lay Out (Cell Manufacturing)

TABLE III
% Difference of Working Hours

No	Process	Working hours before improvement	Working hours needed	Difference of working hours (%)
1	Warping	16128	1083.35	93.28
2	Weaving	51840	26433.33	49.01
3	Inspect Greige	16128	216.68	98.66
4	Finishing	16128	5416.69	66.41
5	Final Inspcet	16128	108.34	99.33
6	Packaging	16128	108.34	99.33

- *Designing One Piece One Flow Scheduling*
  The design of scheduling one-piece-one flow is only performed at stenter process until packing . This is done because in the previous stage, the output for each process can not be controlled with the required demand.

IV. CONCLUSIONS

Lean manufacturing is a method to reduce activities that can lead to waste. Broadly speaking lean phase that consists of two Current State Gap and Future State Design. Current State Gap is the picture analysis of the current condition of the company to identify any activities that could lead to waste , while the Future State Design is improvements design to overcome the problem of waste which has been identified.

In research on the production floor PT. Sinar Continental can be summed up as follows:

1. Current State Gap

Based on the identification that has been done so it can inferred that the main problem lies in the wasteful extravagance of inventory. Root causes of waste are:

a) setting the machine that is not appropriate
b) the unfavorable environment, such as distances between each process, air pollution, and hot temperatures
c) Scheduling inappropriate
d) Lack of maintenance

2. Future State Design

The design improvements to address these waste are:

a) The design of the system of production with a mixture (hybrid system) which is divided into three production lines namely
   - ¬ Special Shop: producing khanza product family, fluerist, diamond.
   - ¬ Standard Shop: producing Maxwell family products. Scarlet, gallery and gold.
   - ¬ Pull Shop System: producing family products Kania, New Jasmine and Jameela.
b) Establishment of Manufacturing Cells Repair And Proposed Layout
   Machines and products are grouped into three cells, the first cell for New Jasmine family, second cell for Jameela family, and third cell for Kania family.
c) Improvement of Working Hours
d) One piece One Flow Scheduling
   Design has been done only on stenter process until packing. Each piece of the finished product sent directly to the next process using.

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ISBN : 978-602-97809-0-1

Reduction of machine cycle time variation in the Hard Disk Drive assembly line by Six Sigma approach

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Abstract **- This research applied Six Sigma approach to reduce machine cycle time variation in the Hard Disk Drive assembly line. Following Dice Game theory, the study of 38 machines presents that the cycle time variation has an impact on an output of the process. Six Sigma and statistical approach such as problem measurement, problem analysis, process improvement and control are incorporated in this study to reduce the variation. The study started with analyzing all machines to find the cycle time of each machine, then indicating the machines that have the highest probability of the cycle time higher than the target, 4.5 seconds in this study. Cause and Effect Diagram, FMEA and Hypothesis Testing were used to mark the cause of that variation. When the causes were found out, Time Series Analysis, Regression and Hypothesis Testing were also used to reduce the machine cycle time variation. Finally, the process control is designed and implemented to sustain the variation after improvement. The study indicates that Topcover Install machine has the highest probability of cycle time higher than target. The cycle time variation before improvement was 6.6952 versus 4.9482 after improvement or 26.09% lower. Basedeck Load machine is ranked the second for the machines that have the probability of cycle time higher than target. The improvement process lowered the variation from 9.8641 to 6.8153 or by 30.90% lower. By reducing machine cycle time variation at those two machines, the output of Hard Disk Drive assembly line was improved by 5.21%.**

Keywords **- Cycle time, Variation, Hard Disk Drive, Assembly line, Six Sigma**

I. INTRODUCTION

Hard Disk Drive manufacturing industries are seeking ways to reduce production cost for cost competitive purposes. The idea of continuous improvement has been used in a factory for many years to serve those purposes. Some examples of continuous improvement activities are machine cycle time reduction, overall equipment effectiveness (OEE) improvement, reducing waste in production processes and reduction of variation in the manufacturing process [1].

The process in this study involves only at the assembly line where all components of Hard Disk Drive are assembled in a clean room. In general, there are two types of assembly lines. One is "Pack" type and another type which is in this study is "Unpaced" or "Asynchronous". The assembly concepts of these two types are similar. A work piece is operated at a workstation and then passed to the next station for another process until completed. The key difference between these two types is waiting time at each station. If any workstation delays in a job completion, a conveyor in a Pack-type line will continue running and carry unfinished work piece. Unlike the pack type, the workstation in Unpaced assembly line will be halted and wait until the adjacent station completes the task. The cycle time of each workstation in an unpaced assembly line therefore could be more or less than the target cycle time of the whole assembly line [2].

Dice Game Theory suggests that a variance of machine cycle time has an impact on the output of the process i.e. lower productivity [3]. In this study, a limit of space for work in process (WIP) between two adjacent machines and a very short cycle time of the Hard Disk Drive assembly line magnify a negative result on productivity when there is a variance of machine cycle time. The capacity of the process would be dropped and eventually production costs rise.

Six Sigma is broadly used for process improvement in many industries. Many organizations follow Six Sigma approach to improve their production and experience an increase in profitability [4]. It is an effective tool in quality control that aims to control/reduce a standard deviation/variance in a process. The lower standard deviation/variance leads to the higher productivity.

II. PROBLEM DEFINITION

The 38 machines in a Hard Disk Drive assembly line were studied and the variance of each machine cycle time was recorded. At this stage, the machines that have a higher cycle time than the target are identified. In this study, the target of cycle time is assigned by the organization at 4.5 seconds. The distribution of machine cycle time at one example machine (BDL) is displayed in Fig. 1.

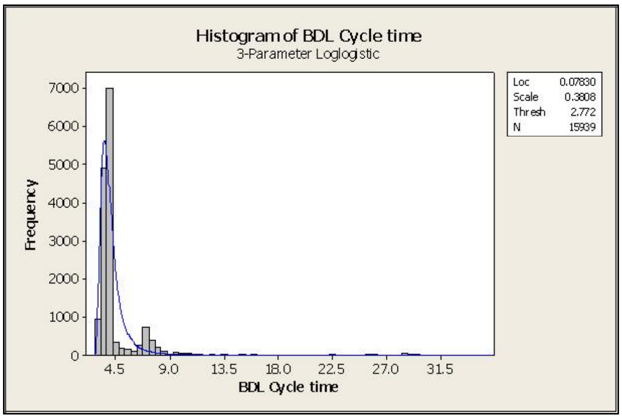


Fig. 1 Histogram of BDL machine cycle time

The variance of cycle time at each machine results in a lower daily productivity. Assumed 24 hours operation, Overall Equipment Effectiveness (OEE) at 70% and cycle time of assembly line at 4.5 seconds, the number of output per day should be 13,440 pieces a day. However, as shown in Table 1, the actual number of output in this study is by 9.4% lower than the theoretical number. The difference is partly because the variation of cycle time at some machines is higher than 4.5 seconds.

TABLE I

COMPARING CALCULABLE AND ACTUAL OUTPUTS A DAY

Date of production	Cycle time at bottleneck operation	%OEE	Calculable outputs in a day	Actual outputs in a day	%Deviation
8-Aug	4.55	72.6%	13786	12502	9.3%
9-Aug	4.53	71.3%	13599	11998	11.8%
10-Aug	4.62	75.2%	14063	12045	14.4%
11-Aug	4.60	72.4%	13599	12121	10.9%
12-Aug	4.56	71.9%	13623	12650	7.1%
13-Aug	4.53	73.2%	13961	12897	7.6%
14-Aug	4.58	69.6%	13130	12145	7.5%
15-Aug	4.52	72.6%	13878	12278	11.5%
16-Aug	4.55	73.0%	13862	12786	7.8%
17-Aug	4.54	71.2%	13550	12125	10.5%
18-Aug	4.61	73.2%	13719	12478	9.0%
19-Aug	4.59	72.8%	13704	12300	10.2%
20-Aug	4.49	71.7%	13797	12665	8.2%
21-Aug	4.52	73.6%	14069	12988	7.7%
22-Aug	4.48	68.9%	13288	12342	7.1%
Average	4.55	72.2%	13708	12421	9.4%

III. A MEASURE OF PROBLEM

The cycle time at different machines displays the different distribution. The best fit of each distribution or each machine is therefore drawn out. There are 12 types of distribution that is comparable to a dataset of machine cycle time in this study. Those are Normal, Lognormal, 3-Parameter Lognormal, Exponential, 3-Parameter Exponential, Weibull, 3-Parameter Weibull, Gamma, 3-Parameter Gamma, Logistic, Loglogistic and 3-Parameter Loglogistic. A distribution that shows the highest Anderson-Darling (AD) number implies the best fit for that dataset of machine cycle time [5]. The identified distribution and statistical value of distribution are later used to calculate the probability of machine cycle time higher than the target, 4.5 seconds. An example of probability plot of cycle time at BDL machine is shown in Fig. 2.

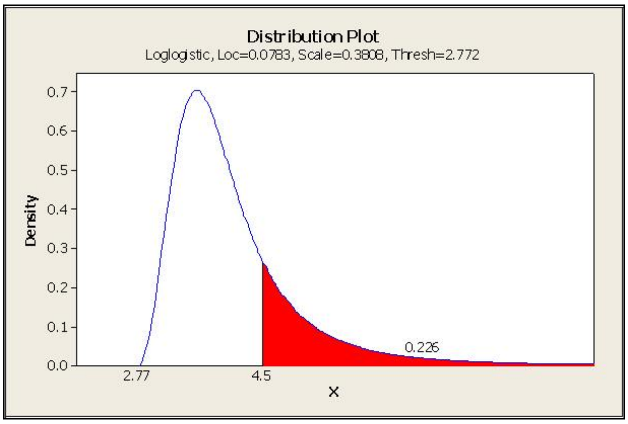


Fig. 2 The probability of BDL machine cycle time longer than the target, 4.5 seconds

The probability of cycle time longer than 4.5 seconds from all 38 machines is benchmarked. The result as expressed in Table 2 shows that the highest number is found at Topcover Install machine (TCI), at 23.50%. Following TCI, Basedeck load machine (BDL) is ranked the second at 22.60% and Topcover Screw Install 3 (CS3) machine has the third highest number at 19.60%.

As TCI machine has the highest probability of machine cycle time longer than 4.5 seconds, it is then selected to be the first target of analysis. With an assistance and brainstorming from people who work closely in the process, “Macro and Micro Process Mapping” and then “Cause and Effect” diagram are constructed [6]. All potential causes of cycle time variation, derived from Cause and Effect Diagram, are displayed in Fig. 3.

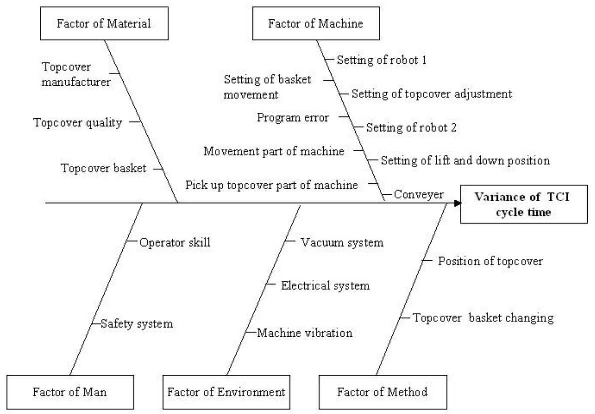


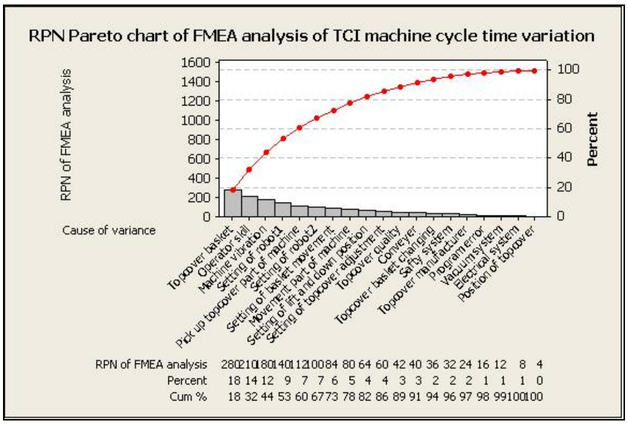
Fig. 3 Cause and Effect Diagram of TCI cycle time variation

TABLE II

BEST FIT DISTRIBUTION, STATISTICAL NUMBER AND PROBABILITY OF CYCLE TIME MORE THAN 4.5 SECONDS.

Machine	Best fit distribution	Loc	Scale	Thresh	Shape	Prob > 4.5 secs
BDL	3 Para loglogistic	0.073	0.380	2.772	-	22.60%
LVI	3 Para loglogistic	-1.373	0.264	3.366	-	0.37%
VS1	3 Para loglogistic	-0.879	0.414	3.465	-	9.93%
VS2	3 Para loglogistic	-1.189	0.552	3.564	-	11.60%
BFI	3 Para loglogistic	0.097	0.142	2.540	-	1.72%
BFV	3 Para loglogistic	0.760	0.079	1.437	-	1.05%
DSI	3 Para loglogistic	0.972	0.1016	1.1950	-	9.98%
CSI1	3 Para loglogistic	0.117	0.435	2.768	-	16.10%
CSI2	3 Para lognormal	-1.348	0.301	3.366	-	0.74%
SS1	3 Para loglogistic	-1.069	0.389	3.564	-	6.65%
SS2	3 Para loglogistic	-1.036	0.440	3.564	-	9.96%
SS3	3 Para loglogistic	-0.785	0.330	3.465	-	7.70%
SS4	3 Para loglogistic	-0.824	0.305	3.465	-	5.67%
BLM1	3 Para lognormal	-1.280	0.706	3.366	-	2.33%
BLM2	3 Para loglogistic	-1.940	0.252	3.465	-	0.04%
BLV1	3 Para loglogistic	-1.938	0.237	3.465	-	0.02%
BLV2	3 Para loglogistic	-1.225	0.448	3.366	-	4.68%
SS21	3 Para loglogistic	-1.038	0.427	3.564	-	9.33%
SS22	3 Para loglogistic	-1.092	0.405	3.564	-	7.36%
HSI1	3 Para loglogistic	-1.609	0.485	2.772	-	1.16%
HSI2	Loglogistic	1.093	0.041	-	-	5.00%
FS1	3 Para loglogistic	0.806	0.082	1.341	-	1.51%
FS2	3 Para loglogistic	0.746	0.050	1.439	-	0.06%
HMM1	3 Para loglogistic	-1.273	0.317	2.673	-	0.27%
HMM2	3 Para gamma	-	0.423	2.574	1.160	5.00%
UVI	3 Para loglogistic	-1.060	0.414	3.564	-	8.29%
VS3	3 Para loglogistic	0.732	0.171	1.679	-	14.40%
RFI	3 Para loglogistic	0.027	0.304	2.554	-	10.90%
TCI	3 Para loglogistic	0.067	0.357	2.870	-	23.50%
CS1	3 Para loglogistic	0.196	0.020	2.219	-	6.83%
CS2	3 Para loglogistic	0.064	0.250	1.131	-	1.01%
CS3	3 Para loglogistic	-0.609	0.520	3.366	-	19.60%
CS4	3 Para loglogistic	0.521	0.144	1.698	-	2.85%
CS5	3 Para loglogistic	-0.619	0.408	3.366	-	13.90%
CS6	3 Para loglogistic	-0.761	0.441	3.465	-	14.10%
CS7	3 Para loglogistic	-0.617	0.385	3.366	-	12.70%
CS8	3 Para loglogistic	-0.824	0.484	3.465	-	14.50%
CS9	3 Para loglogistic	0.531	0.155	1.748	-	0.43%

By Failure Mode and Effect Analysis (FMEA) technique, all potential causes of TCI cycle time variation is then ranked. The FMEA technique identifies potential failure modes and rates the severity of those effects. The severity is measured in 3 aspects; Severity, Occurrence and Detection. The outcome from the measurement is Risk Priority Number (RPN) [7]. RPN of each cause is ranked in a Pareto chart shown in Fig. 4. Repeating the analysis of TCI machine, an analysis BDL machine is carried out as the machine has the second highest probability of machine cycle time longer than target. The RPN of BDL machine cycle time is displayed below with the RPN of TCI machine in Fig. 4.



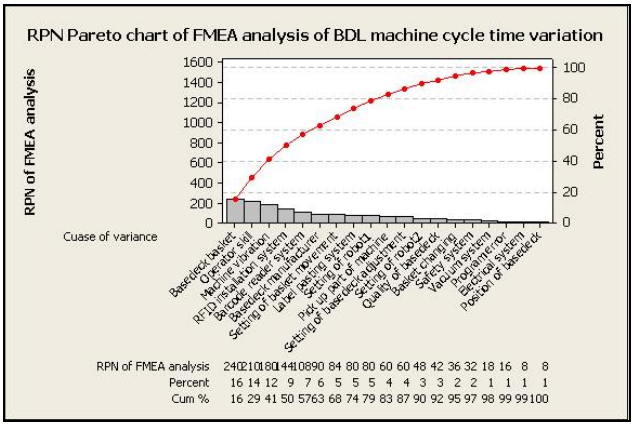


Fig. 4 RPN of FMEA analysis of TCI and BDL cycle time variation cause

IV. PROBLEM ANALYSIS

Statistic analysis is intensively used in this study. Hypothesis stating and Hypothesis testing are the keys to find the real root cause of a variation in machine cycle time [8].

The hypothesis test targets the causes of machine cycle time variation that show the high RPN in FMEA analysis. The causes that have an impact on machine cycle time variation are differentiated from the causes that have no impact by this test. The possible causes at TCI machine are topcover basket, operator skill, machine vibration, setting of robot1 and pick-up part in TCI machine. The possible causes at BDL machine are basedeck basket, operator skill, machine vibration, RFID installation system, barcode reader system and basedeck manufacturer.

As the cycle time of TCI and BDL machine is not normally distributed, Levene's hypothesis test is used for testing [9]. All hypotheses are tested at Confidence Interval (CI) 95%. If P-value is less than 0.05 then the Null hypothesis (H0) is rejected – there is a significant difference in machine cycle time variation caused by the experimented cause. If P-value is more than 0.05, H0 cannot be rejected - there is no significant difference in machine cycle time variation from the experimented cause. The hypothesis test of all causes at TCI and BDL machine are shown in Table 3.

TABLE III

SUMMARY OF HYPOTHESIS TEST OF TCI AND BDL MACHINE

Machine	Null hypothesis (H_0)	P-Value of Levene's test	Conclusion
TCI	$\sigma_1=\sigma_2$; Quality of topcover basket does not affect cycle time variation	0.001	Affect
TCI	$\sigma_1=\sigma_2$; Operator skill does not affect cycle time variation	0.832	Not affect
TCI	$\sigma_1=\sigma_2$; Machine vibration does not affect cycle time variation	0.941	Not affect
TCI	$\sigma_1=\sigma_2$; Lifetime of pick up tool does not affect cycle time variation	0.040	Affect
TCI	$\sigma_1=\sigma_2$; Setting of distance of robot1 does not affect cycle time variation	0.020	Affect
BDL	$\sigma_1=\sigma_2$; Quality of basedeck basket does not affect cycle time variation	0.397	Not affect
BDL	$\sigma_1=\sigma_2$; Operator skill does not affect cycle time variation	0.606	Not affect
BDL	$\sigma_1=\sigma_2$; Machine vibration does not affect cycle time variation	0.030	Affect
BDL	$\sigma_1=\sigma_2$; RFID transportation does not affect cycle time variation	0.046	Affect
BDL	$\sigma_1=\sigma_2$; Basedeck manufacturer does not affect cycle time variation	0.565	Not affect
BDL	$\sigma_1=\sigma_2$; Barcode reader system does not affect cycle time variation	0.046	Affect

V. PROCESS IMPROVEMENT

Results of hypothesis test indicates the causes of TCI machine cycle time variation which are the quality of topcover basket, a lifetime of pick-up tool and the distance setting at robot1. The causes of BDL machine cycle time variation are machine vibration, RFID transportation effectiveness and barcode reader system.

The process improvement consists of two parts. The first part is to optimally improve at machines, gadgets, control system and machine setting. The second part is to assess that improvement by testing the hypothesis of cycle time variation at two different periods – before and after improved.

A. Improvement methods

At some cycles, the dimension of topcover basket does not meet the specification because the basket is deformed after used in process for many cycles. The deformation occasionally occurs after the basket passes hot, cool and grating process before it is used in TCI machine. The change of Process Instruction (PI) by transferring topcover from uncontrolled basket to controlled basket before loading to TCI machine protects out of specification basket in to machine.

The material of pick-up tool in TCI machine is another part that is deformed after used for a long period. The defection at the tool impacts the effectiveness of pick-and-place elements accordingly. Finding an optimal time for changing pick-up tool is therefore required. Time Series analysis was conducted to examine a proper lifetime of the tool [10]. The results of the analysis show that the variance of cycle time increases significantly after the tool is used for more than 13 days.

The optimum setting of movement distance of robot1 was computed by Regression analysis. In the analysis, the cycle time variation was regressed against allowable distance setting [11] and the calculated optimum distance as expressed in equation 1 is 46.475 cm.

$$\text{Variance} = 6.3 + 64.6\text{Distance} + 895.5\text{Distance}^2 - 12819\text{Distance}^3 \quad (1)$$

BDL machine vibration was reduced from 1.05 mm/sec to 0.85 mm/sec at topcover basket loading area and from 1.12 mm/sec to 0.90 mm/sec at tocover installation area. The reduction of machine vibration is a result of firming machine base at the floor and installing beams on the frame of machine. This modification makes the machine more rigid and therefore lessens the vibration.

The cycle time variance from RFID transportation system in BDL machine is caused by an obstruction at RFID. The blower tube was installed to remove any particle that comes in RFID flowing process.

Barcode reader system is a part in BDL machine that is used for data recording system. The new model of barcode reader was recommended by several producers and was replaced with the old model. The new equipment outperforms the old one in terms of capability, accuracy and frequency.

B. Improvement assessment

After improvement process, a verification of variance reduction needs to be carried out A hypothesis of cycle time variation between two periods; before improvement and after improvement, was tested. The enhancement at topcover basket quality, pick-up tool lifetime, machine vibration, RFID transportation and barcode reader system exposes a significant reduction of machine cycle time variation as measured by P-

ISBN : 978-602-97809-0-1

Value from Levene's test. In contrast, the alteration of distance setting at robot1 does not reduce variance significantly. The summary of P-Value from Levene's test of variances before improvement and after improvement is shown in Table 4.

TABLE IV

SUMMARY OF IMPROVEMENT ASSESSMENT

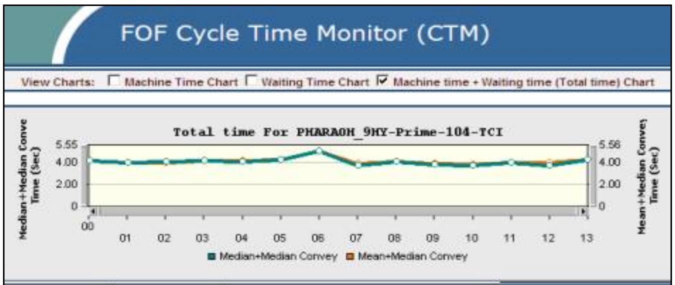
Machine	Cause	P-Value of Levene's test of variances before improvement and after improvement
TCI	Quality of topcover basket	0.001
TCI	Lifetime of pick-up tool	0.009
TCI	Distance setting at robot1	0.860
BDL	Machine vibration	0.021
BDL	RFID transportation	0.037
BDL	Barcode reader system	0.017

VI. PROCESS CONTROL

After defining the problem, determining the causes of the problem and implementing problem solutions, the process control would be the next step. The aim is to prevent the problem reoccurring. The process control targets at the machine that had machine cycle time variation improved.

All executed improvement checked regularly and included in weekly Preventive Maintenance (PM) program. The check covers inspecting the dimension of topcover basket, replacing topcover pick-up part, monitoring machine vibration and using RFID blower.

The concept of Real-time Monitoring (RTM) system was developed to monitor machine cycle time variation [12]. The data of machine cycle time in the Hard Disk Drive assembly line is reported to users by real time. The data include Mean, Median, Variance and Histogram of each machine on an hourly basis as shown in Fig. 5. It allows engineers or any operators to spot a trend of machine cycle time and take an action promptly when an outlier of machine cycle time appears.



Hour	Sample Size	Machine Time (secs) Mean	Median	Variance	Total Time (secs) Median+Median Wait	Mean+Median Wait
00	114	3	3	0.184	4.2	4.2
01	141	3	3	0.163	4	4
02	143	2.96	3	0.087	4.1	4.06
03	118	3.01	3	0.158	4.2	4.21
04	117	3.09	3	0.263	4.1	4.19
05	156	3.01	3	0.235	4.3	4.31
06	102	3.01	3	0.163	5.05	5.06
07	113	3.11	3	0.572	3.8	3.91
08	128	3.04	3	0.187	4.1	4.14
09	80	3.08	3	0.304	3.85	3.93
10	74	3.06	3	0.147	3.8	3.86
11	130	3.03	3	0.209	4	4.03
12	82	3.24	3	3.039	3.8	4.04

Fig. 5 Real-time Monitoring (RTM) system of machine cycle time in assembly line

VII. CONCLUSION

The results of improvement at two machines show that the cycle time variance of TCI machine was improved by 26.09%, 6.695 before improvement and 4.948 after improvement. The cycle time variance BDL machine was lower from 9.864 before improvement to 6.815 after improvement, or by 30.90%. Overall, the reduction of machine cycle time variation of two machines increases the number of finished work pieces in the Hard Disk Drive assembly line by 5.21%. Improving the next machine continuously can produce the continuous improvement on assembly line.

The design of an improvement on machine cycle time variation in a Hard Disk Drive assembly line by Six Sigma approach is exhibited in Fig. 6. The same steps can be applied to improve other areas of the Assembly line

1. Collect the data of machine cycle time from all machines in assembly line.

⇩

2. Test the data of cycle time to find the best-fit distribution of each dataset.

⇩

3. Calculate statistical values of each set of machine cycle time with the distribution derived from step 2.

⇩

4. Calculate probability of each set of machine cycle time longer than the target defined by assembly line cycle time.

⇩

5. Compare the probability derived from step 4 of all machines. The machine with the highest probability is selected for improvement process.

⇩

6. Study all related elements of selected process by using Macro and Micro Process Mapping technique.

⇩

7. Find potential causes of machine cycle time variation from step 5 by brainstorming with concern parties to picture Cause and Effect Diagram

⇩

8. Perform FMEA analysis of all causes defined in step 7 and prioritize the most important cause

⇩

9. Examine the root causes that have an effect on machine cycle time variation by a hypothesis test.

⇩

10. Reduce the cause of machine cycle time variation from step 9 by Process changes, Regression, Time series, Hypothesis test, etc.

⇩

11. To measure the improvement, perform a hypothesis test of the variation at 2 periods (before and after improvement)

⇩

12. Implement process control and monitor the process regularly to prevent a repetition of a high machine cycle time variation.

Repeat the 1st step

Fig. 6 Steps of applying Six Sigma and statistical approach to reduce machine cycle time variation in an assembly line

ACKNOWLEDGMENT

We gratefully acknowledge the continuous support and co-operation with Asst.Prof.Pramual Suteecharuwat, Ph.D Chulalongkorn University and the case study company.

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ISBN : 978-602-97809-0-1

The Application of Taguchi Method to Reduce Number of Defects in Coloring Cloth Process

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Abstract **– PT Sariyunika Jaya is a company in textile industry facing the problem of defective products, which are unable to be categorized as grade A, instead they go into the lower grades B and K2. This research intends to improve the quality by improving the process design, in terms of determining the best levels of process parameters. Taguchi method is chosen to accomplish such purpose, since it is efficient in terms of time and able to minimize the process variance as well. It is found out that the number of defects is significantly affected by nozzle diameter, nozzle pressure, supporting rail speed, and temperature increment. The new suggested levels for those parameters are confirmed to perform better than the existing level settings for colored cloth type 4033. The suggested levels are nozzle pressure = 3bar, nozzle diameter = 80cm, supporting rail speed = 500rpm, and temperature increment = 0.5°C/min.**

Keywords **- Taguchi, robust, parameters, factors**

I. INTRODUCTION

PT Sariyunika Jaya (SJ) is a company in textile industry. To survive the competition in the industry, it needs to maintain good quality of its products in order to keep customers satisfied. However, defects are still found in the output of its production process. Those defective clothes are obviously unfavorable for SJ and undesirable for the customer.

In order to reduce the number of defects, some actions in terms of quality control must be taken. One of the possible actions is off-line quality control. Off-line quality control is a preventive action, which is done before the actual production process runs. The purpose of such quality control is optimizing the product design and process design in order to support on-line quality control [1].

The production process in SJ may be divided into two stages. The first stage is the preparation stage, which includes processing thread as raw material into the cloth called grey cloth. The second stage is the processing stage, which includes the coloring of grey cloth. This research is focused on the latter stage, as it contributes more into the number of defects than the preparation stage.

The quality of cloth produced by SJ is classified into certain grades. Grade A is given to the clothes with the best quality. Grade B is the category for medium quality. Grade K2 is the category for the worst quality, having the number of defects exceed the determined standard. The type of cloth being the focus of this research is the one having high demand and high percentage of defects as well, i.e. the twill cloth type 4033.

To reduce the number of defects, it is important to know the factors related to the quality of the colored clothes. To know the contributing factors and how significant each factor influence the number of defects, design of experiment may be conducted. Taguchi method is selected in this research to conduct the design of experiment.

Taguchi method is selected because it is able to reduce the experiment time. Using the method, not all factors and their interactions are observed, but only a few of them such that the number of experiments may be reduced. The method is also able to create a robust design against all possible combinations of noise factors, therefore it is able to minimize variability as well.

The colored cloth type 4033 is a cloth type having the highest percentage of defects in SJ. The percentage of defects fluctuates from day to day. Fluctuating defect percentage shows that SJ has not found any effective solution to solve the problem of defects. The defects obviously become a loss for the company, since the defective products must be sold at a considerably lower price.

Based on the interview with the people in charge for the production activities in SJ, the factors causing defects may come from the operator (man), machine, material, method, and environment.

This research identifies the factors causing defects, then tests whether or not each particular factor significantly affects the quality of colored cloth type 4033. For each significant factor, the parameters inside the factor is optimized. In other word, the optimal level for each parameter is sought.

Thus, the research objectives may be defined as follows:

1. Identifying the factors affecting the number of defects of colored cloth type 4033.
2. Identifying the factors significantly affecting the number of defects of colored cloth type 4033.
3. Analyzing the effect of level differences of each factor to the quality of colored cloth type 4033 produced.
4. Determining the correct combinations of the level of parameters to minimize the number of defects of colored cloth type 4033.

ISBN : 978-602-97809-0-1

5. Comparing the result of suggested level of parameters and the current result (based on the currently used levels).

However, there the research is limited to the defects caused by machine, while the defects caused by other factors are abandoned. It is also assumed that the number of defects equals to the length of clothes (in meter) classified into both grade B and K2.

II. Type of Defects

Based on the observation, there are 7 types of defect that may occur for cloth type 4033, i.e.

1. Uneven coloring (a part of cloth is either darker or lighter than it should be), shown on Fig. 1.
2. Sparsely woven thread, shown on Fig. 2.
3. Excessive friction (defect caused by excessive friction between cloth and machine), shown on Fig. 3.
4. Spot (caused by spilled chemical substances)
5. Dirt
6. Hole
7. Tear

The first three defects (uneven coloring, sparsely woven thread, and excessive friction) are caused by machine, thus taken into account in this research. Besides, those defects are indeed the most frequently happened ones for cloth type 4033.

Fig. 1 Defect caused by uneven coloring

Fig. 2 Defect caused by sparsely woven thread

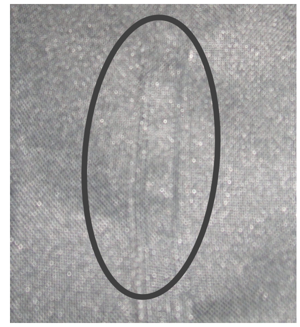

Fig. 3 Defect caused by excessive friction

III. Controllable and Uncontrollable Factors

The controllable factors affecting the quality (number of defects) in the production process of cloth type 4033 are:

1. Nozzle diameter
2. Nozzle pressure
3. Supporting rail speed
4. Temperature increment
5. Material quantity

The sole uncontrollable factor affecting the quality (number of defects) considered is the group of operators.

Each controllable factor is divided into two levels, while the uncontrollable one is divided into three levels. It is shown on the next table.

TABLE I
CONTROLLABLE AND UNCONTROLLABLE FACTORS

Controllable Factors	unit	Level 1	Level 2
Nozzle diameter (A)	cm	80	70
Nozzle pressure (B)	bar	3	2.5
Supporting Rail Speed (C)	rpm	500	400
Temperature Increment (D)	^{o}C/min	1	0.5
Material Quantity (E)	kg	250	200
Uncontrollable Factors	Level 1	Level 2	Level 3
Operator	*Shift* 1	*Shift* 2	*Shift* 3

Not all controllable factors interact with one another. The interactions observed are between:

1. nozzle diameter and nozzle pressure (AXB)
2. nozzle pressure and supporting rail speed (BXC)
3. nozzle pressure and material quantity (BXE)
4. nozzle pressure and temperature increment (BXD)
5. nozzle diameter and supporting rail speed (AXC)
6. nozzle diameter and material quantity (AXE)
7. supporting rail speed and material quantity (CXD)
8. supporting rail speed and temperature increment (CXE)

ISBN : 978-602-97809-0-1

IV. Orthogonal Array (OA) Selection

Orthogonal Array is a matrix containing possible combinations of treatment factors that may generate various experimental designs [2]. Orthogonal array L_{16} is selected because the inequality Vln > Vp must be satisfied. Vln equals to the toal degree of freedom, which is obtained by summing the degree of freedom for factors and degree of freedom for interactions [3].

As stated previously, there are 5 uncontrollable factors – each having 2 levels, and 8 interactions among them. The placement of those factors and the interactions in the OA L_{16} is accomplished by the linear graphs method. The method is applied with the following steps [3,4].

1. draw a linear graph depicting the relationship between factors and their interactions.

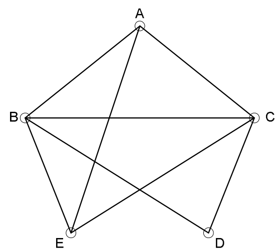

Fig. 4 Initial linear graph

2. draw the standard linear graph L_{16}.

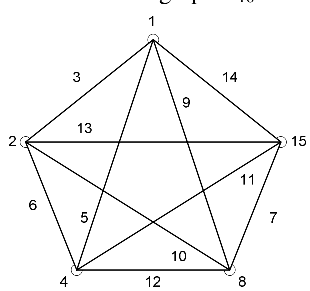

Fig. 5 Standard linear graph L_{16}.

3. adjust the initial graph with the standard one, then place the factors and their interactions on the adjusted graph.

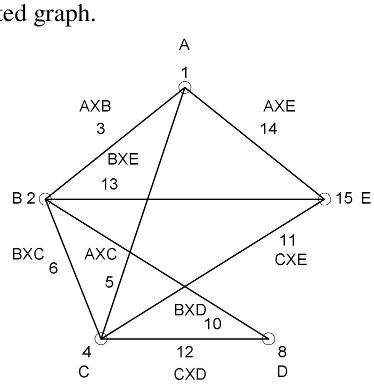

Fig. 6 Complete adjusted linear graph

V. Determining Significant Factors

ANOVA is applied to determine which factor(s) affects the average number of defects significantly [5]. The result is presented on Table II. It is also used to determine which factor(s) affects the variance of number of defects. The result is presented on Table III.

TABLE II
SIGNIFICANT FACTORS AFFECTING AVERAGE NUMBER OF DEFECTS

Source	df	SS	MS	F test	F table	Conclusion
A	1	15.698	15.698	58.335	3.861	significant
B	1	2.063	2.063	7.665	3.861	significant
C	1	6.128	6.128	22.770	3.861	significant
D	1	1.783	1.783	6.624	3.861	significant
(AXB)	1	1.317	1.317	4.893	3.861	significant
(AXC)	1	15.470	15.470	57.488	3.861	significant
(AXE)	1	5.367	5.367	19.943	3.861	significant
(BXC)	1	4.656	4.656	17.303	3.861	significant
(BXE)	1	1.125	1.125	4.182	3.861	significant
(CXD)	1	4.533	4.533	16.843	3.861	significant
(CXE)	1	9.319	9.319	34.631	3.861	significant
F	2	3.016	1.508	5.604	3.011	significant
AF	2	2.641	1.320	4.907	3.011	significant
(BXC)F	2	1.688	0.844	3.022	3.011	significant
(CXE)F	2	1.942	0.971	3.608	3.011	significant

TABLE III
SIGNIFICANT FACTORS AFFECTING THE VARIANCE OF NUMBER OF DEFECTS

Sumber	df	SS	MS	F test	F table	Conclusion
A	1	15.698	15.698	58.335	3.861	significant
B	1	2.063	2.063	7.665	3.861	significant
C	1	6.128	6.128	22.770	3.861	significant
D	1	1.783	1.783	6.624	3.861	significant
(AXB)	1	1.317	1.317	4.893	3.861	significant
(AXC)	1	15.470	15.470	57.488	3.861	significant
(AXE)	1	5.367	5.367	19.943	3.861	significant
(BXC)	1	4.656	4.656	17.303	3.861	significant
(BXE)	1	1.125	1.125	4.182	3.861	significant
(CXD)	1	4.533	4.533	16.843	3.861	significant
(CXE)	1	9.319	9.319	34.631	3.861	significant
F	2	3.016	1.508	5.604	3.011	significant
AF	2	2.641	1.320	4.907	3.011	significant
(BXC)F	2	1.688	0.844	3.022	3.011	significant
(CXE)F	2	1.942	0.971	3.608	3.011	significant

Factors A, B, C, D are found to affect both the average and variance of the number of defects. Through the plots for the average number of defects, it may be seen that the best level for each factors are:

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Factor A: level 1 (nozzle pressure = 3bar)

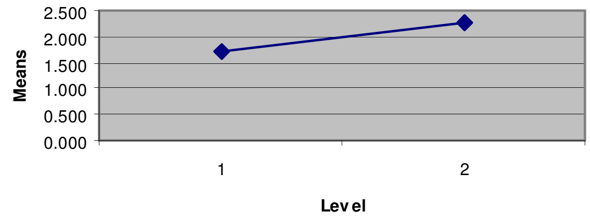

Fig. 7 Plot for Factor A

Factor B: level 1 (nozzle diameter = 80cm)

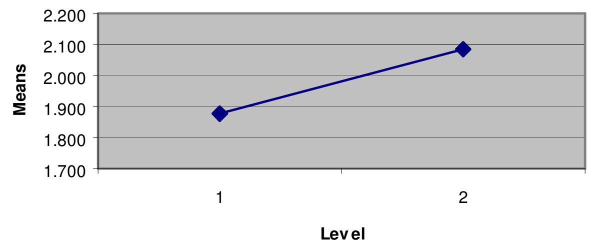

Fig. 8 Plot for Factor B

Factor C: level 1 (supporting rail speed = 500rpm)

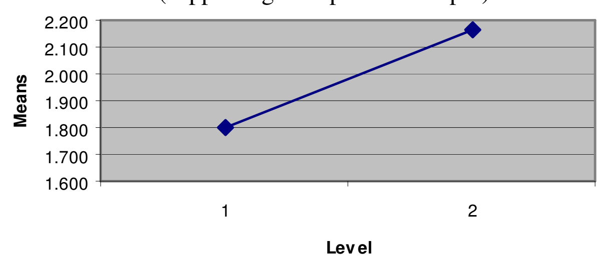

Fig. 9 Plot for Factor C

Factor D: level 2 (temperature increment = 0.5^{o}C/min)

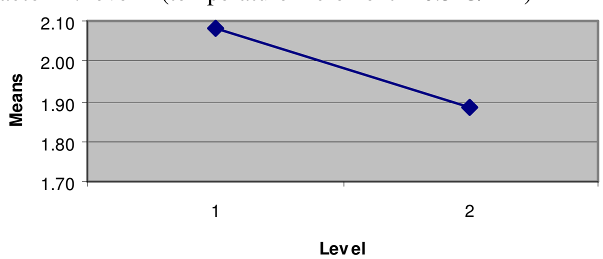

Fig. 10 Plot for Factor D

VI. Confirmatory Experiment

The suggested level for each factor is confirmed through the confirmatory experiment. The purpose is to know how much the suggested levels may decrease the number of defects for colored cloth type 4033. The experiment is done by comparing the length of defective cloth for the existing level setting and the new levels of parameters. For each level of the uncontrollable level, 15 trials are done. The result is shown on the next table.

TABLE IV
THE AVERAGE NUMBER OF DEFECTS FOR SUGGESTED LEVELS OF PARAMETERS

Trial	Level 1	Level 2	Level 3	Total
1	1.1	1.5	0.8	3.4
2	0.3	0.5	0.9	1.7
3	1.1	0.9	1.9	3.9
4	0.4	0.6	0.7	1.7
5	2.1	1.2	1.7	5.0
6	0.7	0.8	0.3	1.8
7	1.1	1.6	1.5	4.2
8	0.6	1.3	1.8	3.7
9	0.8	1.2	1.7	3.7
10	1.0	0.6	0.4	2.0
11	1.7	1.3	0.8	3.8
12	2.2	2.0	2.5	6.7
13	2.1	1.5	1.8	5.4
14	1.3	0.5	0.8	2.6
15	0.3	0.1	0.5	0.9
			Total	50.5
			Average	1.122

The average and standard deviation number of defects comparison between the existing level setting and the suggested levels of parameters are shown on the next table.

TABLE V
THE AVERAGE NUMBER OF DEFECTS COMPARISON

	Average	Standard Deviation
Existing Level Setting	1.983	0.813
Suggested Levels	1.122	0.605

VII. Conclusion

Based on the research done, it may be concluded:

1. The factors, both controllable and uncontrollable, affect the number of defects of colored cloth type 4033 are:
   - Nozzle diameter
   - Nozzle pressure
   - Supporting rail speed
   - Temperature increment
   - Material quantity
   - Operator
2. The factors affecting the number of defects significantly are:
   - Nozzle diameter
   - Nozzle pressure
   - Supporting rail speed
   - Temperature increment
   - Operator

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3. The most significant effect to the difference in number of defects is given by nozzle pressure and supporting rail speed.
4. The suggested levels for the parameters are:
   - nozzle pressure = 3bar
   - nozzle diameter = 80cm
   - supporting rail speed = 500rpm
   - temperature increment = $0.5^oC/min$
5. Based on the confirmatory research, the suggested levels of parameters may reduce the number of defects for colored cloth type 4033.

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

Production Yield Improvement Using Six Sigma DMAIC Methodology

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The purpose of this paper has been to better understand how is Six Sigma can be apply successfully in an improvement project. A case study on Six Sigma implementation has been performed at one manufacturing company located at Prai, Penang. There are 2 types of data involved in this project which are attribute data and variable data. For attribute data the hypothesis test required are 1-proportional test, 2-proportional test, and Chi square test. Meanwhile, for variable data, the hypothesis test required is 1-sample t-test. Six Sigma projects of continuous process improvements are led, from concept to completion, through five phases called DMAIC (Define, Measure, Analyze, Improve, Control).

***Keywords* — DMAIC, Six Sigma tools**

I. INTRODUCTION

Joplin antenna (hand phone antenna) is one of the products that are produced in one of the manufacturing company located at Prai, Penang. The production yield of the Joplin Antenna process is very low. It is just about 65.12% although the process had been setup after two years. The reject rate of the product is very high. Subsequently, the productivity of the Joplin process is low. The net profit of this product is very low although the company gain a high demand on this product. Scrap and rework cost a lot for the company. Many improvements had tried but the production yield is still the same.

In this project, there are three defects that been investigated and analyzed. They are sheath scratches, anchor dented and side contact out of specification. Since Six Sigma provides the systematic way to investigate and analyses the root cause and currently, there no systematic quality tool applied in this line yet, so that, Six Sigma will be the best approach to reduce the reject and improve the production yield as well. The relevant tools of Six Sigma that been used in order to do this project are Failure Mode and Effects Analysis, SIPOC diagram, Cause and Effect Matrix and Cause and Effect Diagram.

This project is carried out by aiming the following the main objective which is:

- To apply the Six Sigma DMAIC methodology and its relevant tools to improving production yield for Joplin Antenna production line.

There are several sub objectives that was aimed in order to achieve the main objective. They are:

- To construct SIPOC diagram to understand the various player and their contribution to the process.
- To develop Failure Mode and Effect Analysis to identify the process problem.
- To identify the relationship between input variable and output variable using hypothesis tests.

II. LITERATURE REVIEW

Sigma (σ) is a letter in the Greek alphabet that has become the statistical symbol and metric of process variation. The sigma scale of measure is perfectly correlated to such characteristics as defect-per-unit, parts-per-million defectives, and the probability of a failure. Meanwhile, six is the number of sigma measured in a process, when the variation around the target is such that only 3.4 outputs out of one million are defects under the assumption that the process average may drift over the long term by as much as 1.5 standards deviations (Park, 2003).

Six Sigma may be defined in several ways. Sokovic, Pavletic and Fakin (2005) defines Six Sigma as a “quality improvement program that aims to reduce the number of defects to as low as 3.4 parts per million that uses the normal distribution and strong relationship between product nonconformities, or defects, and product yield, reliability, cycle time, inventory, schedule, etc”.

Goffnett (2004), due to his research said that many scholars and practitioners concluded that “there are at least three definitions of Six Sigma: Six Sigma can be viewed as a metric, a mindset, and a methodology”. First, the lowercase Greek symbol (σ) is the metric or fundamental statistical concept that denotes a population’s standard deviation and is a measure of variation or dispersion about a mean. As a second definition, Six Sigma is considered an organizational mindset that emphasizes customer focus and creative process improvement.

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As a third definition, Six Sigma is viewed as a strategic improvement methodology termed DMAIC. Goffnett (2004), mention that DMAIC is an abbreviation of the five systematic steps in the Six Sigma methodology. The steps used for breakthrough thinking and improvements are: define, measure, analyze, improve and control.

Kwak and Anbari (2004) in their research define Six Sigma in two perspectives: statistical viewpoint and business viewpoint. In statistical point of view, the term Six Sigma is defined as having neither less than 3.4 defects per million opportunities or a success rate of 99.9997% where sigma is a term used to represent the variation about the process average. In business viewpoint, Six Sigma is defined as a 'business strategy used to improve business profitability, to improve the effectiveness and efficiency of all operations to meet or exceed customer's needs and expectations.

Snee, (2004), also define Six Sigma in two perspectives: Six Sigma as a business improvement and as a measure of process performance. First, Six Sigma is a business improvement approach that seeks to find and eliminate causes of mistakes or defects in business processes by focusing on process outputs that are of critical importance to customers. Six Sigma projects also often focus on improving productivity, process yields, production rates and process downtime. As a result, process performance is enhanced, customer satisfaction is improved, and the bottomline is impacted through savings and increased revenue. Six Sigma is a strategic approach that works across all processes, products and industries. Second, Six Sigma is also a measure of process performance. The methodology utilizes 'process sigma' as a measure of process capability with a 6σ process having a defect level of 3.4 parts-per-million opportunities and a 3σ process having a defect level of 66,807 part-per-million.

In an attempt to develop the concepts and principles underlying Six Sigma, Linderman et. al., (2003) define Six Sigma as "an organized and systematic method for strategic process improvement and new product and service development that relies on statistical methods and the scientific method to make dramatic reductions in customer defined defect rates".

III. METHODOLOGY

In order to visualize this project, the flow for the whole project has been developed essentially as Fig. 1. The project starts with topic selection by review the business performance of the company in particular product. Once the topic has been selected, application of DMAIC been performed according to the sequence.

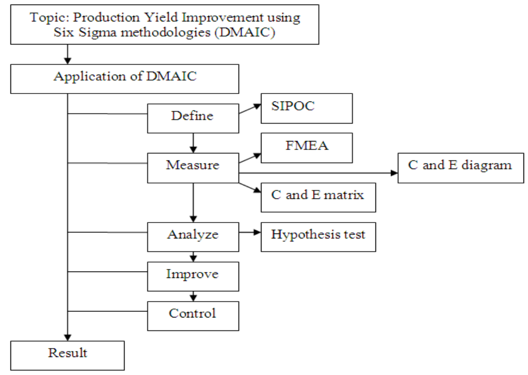

Fig. 1 Project Flow

A. *Application of DMAIC (Define, Measure, Analyse, Improve, Control)*

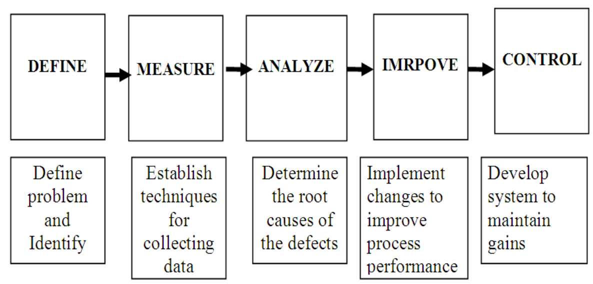

Fig. 2 DMAIC project flow

This part mention about the tools those are relevant for this project. All the five phases had own tools that can be used in order to complete the project. The relevant tools have been selected and the theories of the tools have been explained. This chapter also explains the step how the project will be conducted in a proper manner.

There are total 5 phases in the methodology which is define, measure, analyze, improve and control phase. The DMAIC road map starts with define phase. The define phase clarifies what problem needs to be solved. The customer's input is considered in understanding the effects and scope of the problem. A team is formed for a better effect. At the end of the define phase, a SIPOC (Supplier, Input, Process, Output and Customer) analysis is constructed better understanding of the whole process.

The measure phase enables to establish the baseline process capability. The baseline measures are used to prioritize areas of concern for further analysis. Failure mode and effects analysis (FMEA) helps to prioritize causes of problematic symptoms for the whole process. As a consequence, cause-and-effect matrix helps to filter out less important input variables. Cause-and-effect (C&E) or fishbone diagram helps to identify potential causes that need to be investigated. The analyze phase identifies sources of defects, problems or variation. Tools for analyze phase include multivariable analysis to reduce the variations and hypothesis test to evaluate the root causes.

After identifying the main causes of the problems, the improve phase offers a variety of statistical tools for establishing a better process. The intent of the improve phase is to achieve significant improvement through employee participation and innovation. Finally, the control phase is to sustain the gain and improve further. For a better understanding of the process, flow of this model is shown as in Fig 3.

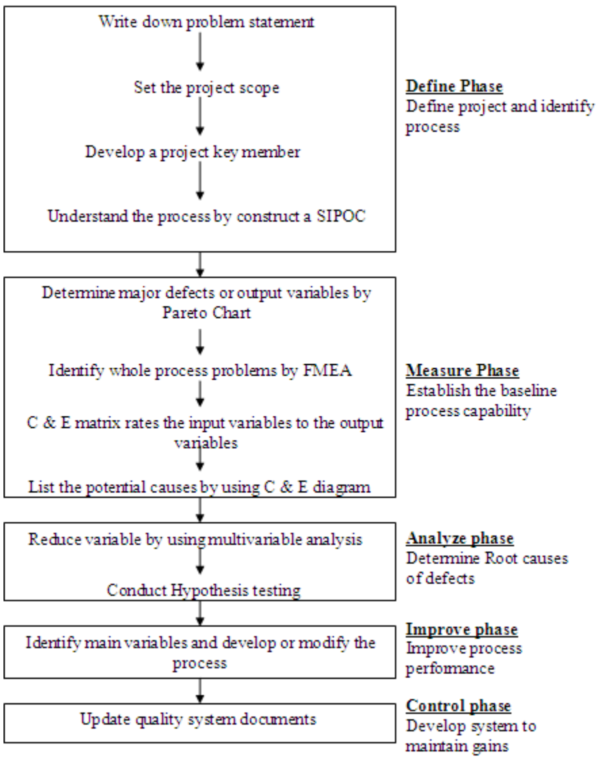

Fig. 3 DMAIC roadmap

IV. RESULTS AND DISCUSSION

A. Define Phase

The aim for this project is to achieve 80.0% of production yield and 95.0% of entitlement yield. The scope of the project is to focus on the Joplin antenna assembly process. Therefore it is important to understand the whole process of the Joplin antenna. SIPOC diagram is constructed to understand the whole process. Table 1 shows the SIPOC diagram that was constructed for the first operation which is install meander to A-core and B-core.

TABLE I
SIPOC FOR FIRST OPERATION

Supplier	Input	Process	Output	Customer
Incoming inspection (IQA)	• Operator operation method • Meander dimension • A core dimension • B core dimension • Meander appearance • A & B core appearance	Install meander to A-core and B-core	• Meander misalignment on A core • Meander misalignment on A & B core • Meander folded • Meander tang folded • Meander tang broken • Gap between A & B core • Meander ragged	Wrap meander

In developing SIPOC diagram, all the process involved need to be identify first. Output and input been defined by observing the operation and also by interviewing the expert in the line. The SIPOC diagram was a helpful tool in order to understand the process since it shows that a Joplin antenna production line have a lot of constraints which can contribute to the reject rate and production yield as well.

B. Measure Phase

From the Pareto Chart in Fig 4, it clearly displays the rejects for Joplin antenna process from September until November 2007. From the graph, it shows the rejects are electrical test fail, black dot, sheath scratches, white mark, white mark, short mold, and so on. To achieve the 95.0% of the entitlement yield of the project scope, eight rejects need to be considered for further improvement. These eight rejects are known as output variables (y). Electrical test fail (y1), black dot (y2), sheath scratches (y3), white mark (y4), short mold (y5), anchor dented (y6), sheath contamination (y7) and side contact out of spec (y8) are the eight output variables that will further the study to achieve the entitlement yield.

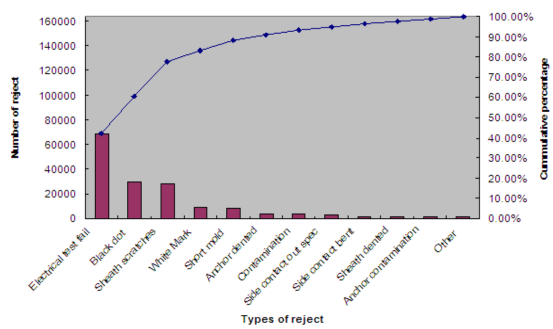

Fig. 4 Pareto Chart for Joplin Antenna

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Process function	Potential Failure Mode	Potential Effects of Failure	Severity	Potential Causes	Occur	Current process control	Detect	RPN
Trim gate	Sheath scratches	Cosmetic reject	8	Operator error	7	Control plan, prints, training, visual inspection, SOP, electrical verification, subsequent operation, in process inspection, first piece inspection, final audit inspection	3	168

Fig. 5 Part of FMEA

From the Fig 5, it shows the rating of the severity, occurrence and detect for each potential failure mode, effects of failure and causes. After understanding the failure mode, effect of failure and causes for each operation, there were some limitations in this project. The electrical test fail (y1) cannot be improved because it is caused by the design of the meander at main company in United States.

Besides, no improvement can be carried out on black dot (y2), white mark (y4), short mold (y5) and sheath contamination (y6). From the FMEA analysis, it shows that those rejects are caused by the content of the resin and the setting of the molding machine. The molding machine needs to operate all the time and no authority has given by head management to interrupt the process. As a result, no analysis and experiments can be carried out for those rejects.

Sheath scratches (y3), anchor dented (y6) and side contact out of specification (y8) do not involved in the molding machine process and the design of meander. Therefore, these three rejects were furthered the analysis and suitable improvement was carried out to solve the problems.

In order to make the analysis easier, the Y1, Y2, and Y3 will be used to represent the y3, y6 and y8 respectively. The representation of the defects that need to be analyzed has been summarizing in the Table 2.

TABLE 2
SUMMARY FOR DEFECTS THAT NEED TO BE ANALYZED

Output variable representation from Pareto Chart	Output variable representation for analyze
y3 (Sheath Scratches)	Y1
y6 (Anchor dented)	Y2
y8 (Side Contact out of specification)	Y3

By using FMEA, there are variable in the result that was gained since FMEA involving the commence sense and personal evaluation. Different people might have different view on the potential cause and also on the rating process. There are no rigid ways in determining the severity, occurrence and detection value.

TABLE 3
PART OF THE C&E MATRIX

Output variables (Y's)		Sheath scratches	Anchor dented	Side contact out of spec	
Output rating		10	9	8	
Process Step	Input Variables (X's)				Rank
Install anchor and side contact to crimped sub assembly	Operator handling method	0	9	9	153
Load sub assembly into pallet cavities	Operator handling method	0	9	9	153

For Cause and Effect matrix, the degree of the input variables (X) which affects the output variables (Y) had been rated by 0, 1, 3 and 9 according to its correlation. 0 is depute of no effect or correlation at all between X and Y. The value of 1 stands for small effect or weak correlation between X and Y. Meanwhile, 3 is representing the medium effect or medium correlation of X to the Y. Finally, 9 represent for strong effect or strong correlation of X to the Y.

From the Table 3, it shows that the operator handling method in install anchor and side contact to crimped sub assembly operations has a very strong effect on the anchor dented and side contact out of specification. Besides, operator handling method in install anchor and side contact to crimped sub assembly operations has no relation with sheath scratches.

From fishbone diagram that was developed, the operator handling method in install anchor and side contact to crimped sub assembly is the potential causes that caused anchor dented. It shows in detail that the loading method of the manpower in the crimping process, using one finger to support the anchor caused the anchor not seated properly on the crimping fixture while the crimping process is operated.

For the operator handling method in loading the sub assembly into pallet cavities caused anchor dented is due to the sharp edges of the molding cavities which easily caused the anchor dented while operator load the sub assemblies into the cavities. As a result, it is caused by the design of the mold and not the operator handling method.

Ejection machine in the 2nd half molding operation that is not enough air blows cannot totally eject the antennas from the cavities. Therefore, operator used the rod to unload the antennas from the cavities. Force is applied on the anchor to eject the antennas. This caused anchor dented.

From the Pareto chart and FMEA, the defects that need to work on for improvement had been identified which called output variables (Y). After that by developing the C and E matrix together with C and E diagram, the possible causes for the defects had been determined namely input variables (X).

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After completing all these tools, the most possible input variables to the output variable were listed as Table 4.

TABLE 4
MEASURE PHASE SUMMARY

Output Variable (Y)	Input Variable (X)
Y1= Sheath scratches	X1= Handling method in trim gate operation X2= Method in trim gate operation X3= Handling method in date code printing operation X4= Fixture design of date code printing operation
Y2= Anchor dented	X1= Method of crimping anchor and side contact to sub assembly X2= Mold design in the 2nd half molding operation X3= Ejection machine in the 2nd half molding operation X4= Unload Method in 2nd half molding operation
Y3= Side contact out of spec	X1= Handling method of crimping anchor and side contact to sub assembly X2= Handling method of install sub assembly to the molding cavity. X3= Handling method in verifying electrical test operation

C. *Analyse Phase*

Table 5 shows the hypothesis testing required in order to determine the relationships between KPOV and KPIV.

TABLE 5
HYPOTHESIS TESTING REQUIRED FOR ANCHOR DENTED

KPOV	DATA TYPE	KPIV	DATA TYPE	HYPO-THESIS TEST
Y2= anchor dented	Attribute	X1= Method of crimping anchor and side contact to sub assembly	Attribute	2-Proportion
		X2= Mold design in the 2nd half molding	Attribute	Chi-square
		X3= Ejection machine in the 2nd half molding operation	Attribute	1-Proportion
		X4= Unload method in 2nd half molding operation	Attribute	2-Proportion

Table 6 shows the relationship between KPOV and KPIV from the analysis of the hypothesis test for output variables, anchor dented.

TABLE 6
RELATIONSHIP BETWEEN KPOV AND KPIV

KPOV	DATA TYPE	KPIV	DATA TYPE	HYPOTHESIS TEST	RESULT
Y2= anchor dented	Attribute	X1= Method of crimping anchor and side contact to sub assembly	Attribute	Chi-square	Significant
		X2= Mold design in the 2nd half molding	Attribute	Chi-square	Significant
		X3= Ejection machine in the 2nd half molding operation	Attribute	1 Proportion	No Significant
		X4= Unload method in 2nd half molding operation	Attribute	2 Proportion	Significant

From the validation results, only 3 input variables which have significant effect on the output variable. They are crimping method, mold design, and unload method.

V. CONCLUSIONS

From this study, it is evident that applied tools detect a greater number of possible defect cause, so the defect in the product can be prevented as well as improve the production total yield. With the application of several Six Sigma tools such as FMEA, the time required is much longer than conventional process flow. However, FMEA always be efficient tools in failure modes detections. Besides, this study also can proved that the root cause of the defects can be identify and validate by conducting hypothesis testing.

After the improvement, the result draws an increment. Subsequently, the requirements of the customer were fulfilled through increased the antennas quality. Consequently, the net profit of the company increased. Even the yield shows an increment, but the yield still does not achieve the project target which is 80% production yield. The reason why the increment on the yield quite low is the improvement only done on the reject which contribute about 7.54% from the total input. But, after improvement, the contribution of these three reject on the total yield reduction only about 1.3%. So, even this project does not improve the total yield so much but it still can be considered as succeed since the project was improved the rejects that been analyzed. To make a breakthrough improvement on the production yield, the company have to improve the major rejects such as electrical fail and reject that caused by molding process as well. The team believe that all the other rejects also can be reduced using the same methodology if had an opportunity to do so.

ACKNOWLEDGMENT

Author wishes to acknowledge Section Manager of the company, Mr. Teoh Liang Long and other contributors for kindly providing an opportunity to implement Six Sigma methodology (DMAIC) in the company.

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ISBN : 978-602-97809-0-1

The Truths about the Implementation of Quality Management System in the Malaysian Construction Industry

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Abstract- **The main focus of the construction industry is to ensure that projects are completed within the stated period, with best quality and at minimum cost. In the era of globalization where economic competition is getting more intense, the implementation of a quality management system will be a good and sound business strategy to meet the international requirements. This study identifies the advantages of QMS implementation and problems faced by the Malaysian contactors in implementing the Quality Management System.**

Keywords- **Quality Management System, Malaysian Construction Industry**

I. INTRODUCTION

The 10-year Construction Industry Master Plan (CIMP) was introduced by the Malaysian government in August 2007. The CIMP blueprint is spearheading by 7 Strategic Thrusts. One of the aims of the strategic thrust is related to nurture the implementation of quality culture. The important strategy is to make ISO Quality Management System (QMS) certification mandatory for higher grade contractors; specifically grade G7 contractors. Comparatively, the number of ISO certified construction organizations are still relatively small when compared to the total number of construction organizations in Malaysia. Looking at the construction industry scenario in Malaysia, QMS implementation is crucial towards improving the quality of the Malaysian construction industry.

The contractors' organization should really understand the philosophy, concepts, procedures and other elements of the QMS. The design and implementation of an organization's QMS is influenced by varying needs, particular objectives, the products provided, the processes employed, the size and the structure of the organization. In addition to that, quality in construction related industries is still contemporary issues that require immediate action by all parties involved in the industry. As a result, the Malaysian Construction Industry Development Board (CIDB) has issued a circular in December 2006 to all G7 contractors which require them to be certified with ISO 9001:2000 by end of the Year 2008. This bold and laudable step by CIDB is to ensure Malaysian contractors adopt QMS principles in managing their respective projects; in attempting to deliver the desired quality in construction works. One of the key elements emphasized in QMS is quality performance measurement.

However, the prevalent question is; to what extent the problems of the construction firms in implementing the QMS concepts in their management system, the primary aim of this study is to explore the advantages and the extent of problems experienced by the construction related organization in implementing the quality management system concepts in their organizations

II. RESEARCH AIMS

The aim of this paper is to investigate the problems encountered by organizations in the implementation of Quality Management System in Malaysia. Therefore, the common problems encountered by organizations can be identified, and recommendations in many ways can improve the QMS implementation in Malaysia construction industry.

The objectives of this research are: (i) to study the scenario of QMS application, (ii) to identify the problems encountered by organizations in the Malaysian construction industry, and (iii) to recommend ways to improve the implementation of QMS in the Malaysian construction industry.

III. QUALITY MANAGEMENT SYSTEMS

A. *Quality Management System (QMS)*

Unlike other industries, the construction industry is characterized by activities which are discontinuous, dispersed, diverse and distinct, i.e. the four "D" as discussed by Tay [1].

According to Low and Tan [2], the implementation and sustainable improvement of quality management in the construction sector is difficult to achieve. However, the principle of continuous quality improvement is based on the belief that there is always room for improvement in any process and product. Therefore, continuous improvement, if implemented in a holistic manner in conjunction with other quality management techniques such as quality assurance systems, may maintain the competitive advantage of an organization.

According to Culp et al. [3], the failures of many quality management efforts have been due to the lack of a clear definition and quality measurement goals. Standards must be established beforehand to measure the quality goals and objectives. Therefore, an objective measurement quality performance assessment system is an essential prerequisite for contracting firms, wishing to achieve their quality goals, survive and compete in the current changing and competitive market.

Chan and Tam [5] stated that the need for quality of the finished product of the construction industry is no less than in any other industry. The high cost of building makes it necessary to ensure of quality products. Sommerville and Robertson [4] perceived TQM as not only a means of improving quality but also as an issue paramount in ensuring a competitive edge in a fiercely competitive market. Consequently, considerable benefits are seen as corollary to successful implementation of the TQM Programme, which includes:

- A quality product/service, without compromise
- Repeat and new business (due to product and service quality)
- A reduction of the cost of waste, with a clear shift in emphasis from waste cost build up, i.e. in inspection and failures (QC/QA), towards prevention (TQM); and
- Increased job security, through increased competitiveness, coupled with greater job-satisfaction through individual commitment to common goals.

B. The Application of ISO 9000 Quality Management System (QMS) in the Construction Industry

Chan and Tam [5] stated that quality and quality systems are topics which have been receiving increasing attention worldwide. The finished products of any industry must comply with a required standard, one which provides customer satisfaction and value for money. The high cost of building and infrastructure constructions makes it crucial to ensure quality of the finished products. In addition to that, Low and Omar [6] pointed that the incessant demand for quality necessitates the implementation of a QMS. The QMS helps to improve quality and productivity through the elimination of non conformance in every activity in a company. An effective QMS also allows the client's requirement to be understood and met first time, every time and at minimum cost.

Therefore, Low and Omar [6] further claimed that the implementation of ISO 9000 QMS should be able to achieve the following benefits:

- Common languages for communicating quality assurance;
- provide a general guideline for an organization in any industry to develop a QMS;
- facilitate and promote third-party auditing and certification;
- Increase clients' confidence;
- Time savings as the burden of assessment by clients is forgone;
- increases competition for better quality products and services;
- increased client satisfaction on quality;
- reduce corrective costs;
- Greater clientele base.

For the past decade, the Malaysian construction sector has been going through a radical change driven by the (ISO) quality policy of the Malaysian government. The number of Malaysian contractors obtaining certification of ISO 9001 QMS is gradually increased and beginning to implement the ISO 9000 Standard for their quality management system (QMS).

According to Low and Omar [6], an indication of an effectively maintained when there is indication of improvement in the quality of goods and services and an increase in the clients' satisfaction.

C. The Organization Problems in Implementing QMS

Chew and Chai (7) attributed the problems of implementing QMS to the traditional concept of quality control practiced by the organizations. Other reasons that can be attributed to the failure to achieve the requirements of the standards are as follows:

- Lack of Infrastructure necessary to establish and implement the system
- Lack of clear directions, i.e. absence of quality policy and quality objectives
- Lack of necessary documentation such as procedures, work instructions and records.
- Lack of clear lines of authority and responsibility
- Lack of suitably trained personnel

IV. RESEARCH METHODOLOGY

A First Stage (Research Design)

The first stage of the research involved studying and understanding of the topic area and to identify scope and

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objective of the research proposal. The study also employed the survey method by distributing questionnaires.

The questionnaires were distributed by the researcher to the top, medium and lower level management of the construction companies in central states of the Malaysian Peninsular (Selangor, Kuala Lumpur, Negeri Sembilan and Melaka).

B. Second Stage (Data Collection)

The purpose of the second stage of research is to identify project data and to conduct study for further details of the research. The sources of data are classified into prime sources and secondary sources. Prime sources provide original data and latest information for the research. A total number of 150 questionnaires were distributed to the respondents

C. Third Stage (Data Analysis)

All the data that are collected through the questionnaires will be analysed using SPSS Version 13 (Statistical Package for the Social Sciences) software.

D. Fourth Stage (Descriptive Analysis)

Descriptive analysis was conducted to describe and to interpret the data. The descriptive analysis used in this study was the frequency analysis to examine the respondents' demographic factor, mode and rank data Based on the frequency test, the advantages of QMS application, the rank of problems encountered by organization in the implementation of QMS and the recommendations for the problems solution was obtained and lastly, conclusion for the study could be made.

V. DATA ANALYSIS AND RESULTS

In this study, questionnaires are distributed to 150 respondents in top, medium and lower level management of the construction companies in the central states of Malaysia (Selangor, Kuala Lumpur, Negeri Sembilan and Melaka).

A. Analysis of the Advantages of QMS Application in Malaysia Construction Industry

Table 1 shows the ranking of the advantages of QMS implementation in Malaysia construction industry based on the order of mean values. Based on the literature reviews and respondents' opinion on the advantages of QMS application, there are eleven advantages of QMS to be analysed in this study. The analysis was based on the Likert scale 1 to 5, where `1' represents `strongly disagree', `2' represents `disagree', `3' represents `neutral', `4' represents `agree' and lastly, `5' represents `strongly agree'.

The analysis shows that the first ranking for the advantages of QMS application in Malaysia Construction firms is "Enhanced Image and Reputation of Organization", followed by "Performance Improvement and Increase Customer Satisfaction". The third ranking given by the respondents is "Establishing Clear Documented Procedures and Instruction" followed by "Consistency in Quality Services" and "Efficiency of Operations in Construction Site". The lowest ranking is "Project Completion within the Stated Period of Time". Therefore, based on the analysis, majority of the respondents opine that the main advantage of QMS implementation if for the enhanced image and reputation of the construction organization. Majority of the respondents also opine that "Project completion within the stated period of time" has the lowest ranking on the advantages of QMS implementation in the construction industry.

TABLE 1
The Ranking of the Advantages of QMS Application on Malaysia Based on the Mean Values

Ranking	List of Advantages	Mean
1	Enhanced image and reputation of organization	4.19
2	Performance improvement and increase customer satisfaction	4.16
3	Establishing clear documented procedures and instruction	4.15
4	Consistency in quality of services	4.15
5	Efficiency of operations in construction site	4.15
6	Reduction of Quality Cost	4.05
7	Prevention of errors at the earliest stage of the project	3.98
8	Clear line of duties	3.97
9	Increase chances to be award the tenders/contracts	3.89
10	Facilitates access to certain markets	3.87
11	Improved relationship and cooperation between clients, contractors, consultants and suppliers	3.84
12	Project completion within the stated period of time	3.66

B. Analysis of the Problems Encountered By Organization in the Implementation of QMS in Malaysia Construction Industry

Table 2 shows the ranking of problems encountered during the implementation of QMS in Malaysia construction firms based on the mean values. Based on the literature reviews and respondents' opinion on the problems of QMS application, there are eleven to be analysed in this study.

The result of the analysis in Table 2 shows that the first in ranking for the problems encountered by organization in the implementation of QMS in Malaysia construction industry is "Lack of Awareness in Benefits of QMS", this is as the majority of the respondents opine that "Lack of Awareness in

ISBN : 978-602-97809-0-1

Benefits of QMS" is the biggest hurdle in the application of QMS in the Malaysian construction industry. On another note, the majority of the respondents ranked "Lack of available Quality System documentations" as the least problem faced by the Malaysia construction in implementing the QMS.

TABLE 2
The Ranking of the Problems Encountered by Organization in the Implementation of QMS in the Malaysian Construction Industry

Ranking	List of Problems	Mean
1	Lack of awareness in benefits of QMS	3.83
2	Lack of QMS exposure among workers	3.79
3	Inadequate understanding in the QMS requirements	3.75
4	Insufficient continuous professional development (CPD)	3.73
5	Lack of understanding in the process requirement	3.71
6	Lack of planning to implement QMS	3.67
7	High cost to implement QMS	3.59
8	Inadequate time to implement QMS/Time Consuming	3.59
9	Inadequate documentations for suppliers, materials and services	3.53
10	Poor support from the top management	3.51
11	Insufficient quality systems documentation such as procedures, records construction period, work instruction and record	3.39

VI. CONCLUSIONS AND RECOMMENDATIONS

A. *CONCLUSIONS*

QMS application can enhance image and reputation of a construction firm. Based on the fact that QMS is a versatile and flexible management tool, an organization would be able to improve their goals, efficiency and profitability whereby the culture of continuous quality improvement (CQI) would be gradually practiced in the organization.

Organizations that lack of awareness on the benefits of QMS may be due to the top management failing in disseminating organization quality policy to all level of management. Furthermore, the organization also lack of competence skill for properly QMS implementation in the various levels of management. Another problem is the inadequate QMS monitoring, training and awareness in QMS standard requirements.

Some of the terms used in the standards could be vague, ambiguous and imprecise. This in turn will cause lack of QMS understanding in the organization. The poor guidance in the training programs affects the CPD for every level of management.

B. *RECOMMENDATIONS*

The recommendations to solve this problem are taken from respondents' and established organizations' suggestions. List of recommendations is shown in Table 3.

TABLE 3
Recommendations for the Problems Encountered by Organization In the Implementation of QMS in Malaysia Construction Industry

List of Problems	Recommendations
Lack of awareness in benefits of QMS	Organize talks on QMS benefits
Lack of QMS exposure among workers	Provide trainings on QMS application
Inadequate understanding in the QMS requirements	Provide trainings on QMS requirements
Insufficient continuous professional development	Trainings on the specific fields (CPD)
Lack of understanding in the process requirement	Workshops on the understanding of QMS requirements
Lack of planning to implement QMS	Increased top management efforts
High cost to implement QMS	Allocate certain budget on QMS planning/ Require top management commitments
Inadequate time to implement QMS/Time Consuming	Proper scheduling system/ CPM
Inadequate documentations for suppliers, materials and services	Ensure adequate documentations for suppliers, materials and services
Poor support from the top management	Increase top management participation and understanding
Insufficient quality systems documentation such as procedures, records construction period, work instruction and record	Ensure adequate documentations for QMS application. Provide e- documents

From the results of the questionnaires and analysis using SPSS 13.0 Software, majority of the respondents were in the opinion that the main advantages of implementation of QMS is "Enhanced Image and Reputation of Organization", while the least significant advantage is "Performance Improvement and Increase Customer Satisfaction".

It is clear from the analysis that majority of the respondents also opine that the first ranking for the problems encountered by organization in the implementation of QMS in Malaysia Construction Industry is "Lack of Awareness in Benefits of QMS" while the least significant problem is "Lack of QMS exposure among workers". Recommendations shown in Table 3 are some examples that can be applied in the construction industry to solve the problems of QMS implementation.

In order to realize the successful implementation of QMS in the Malaysian construction industry, optimum participation and effort of the organization top management in the QMS implementation processes are required and; subsequently, everything else will follow and continual quality improvement will become a culture in the organization.

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

Benchmarking Best Practices through Quality Management Systems among Contractors in Malaysia

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Abstract - **This paper aims to identify the current trend of QMS implementation, improvement methods and benchmarking best practices. This research employs the methodology of literature review to identify practices arising from use of QMS, which then; a questionnaire survey was conducted to benchmark best practices. The analysis was conducted via use of Statistical Package for Social Sciences (SPSS) version 17. The results revealed best practices from four different perspectives, where; (i) organization & people has the best practice oriented on QMS to having an integrated project management system; (ii) quality and construction has the best practice oriented on using QMS to execute a form of quality control in construction; (iii) competitive advantage and clientele satisfaction has the best practice oriented on QMS as a mean to be more competitive and; (iv) profits and cost savings has the best practice oriented on implementing QMS to achieve QA. The findings from this research could be used as a guide for companies to achieve their goal in the desired perspective.**

Keywords - **Quality Management System, Best Practices, Malaysian Contractor**

I. INTRODUCTION

The Malaysian Government has over the years, introduced the (ISO) quality policy to be implemented to all major industries in the nation and construction included as well. As a result, the construction industry has gone thru various changes. The number of contractors obtaining certification of ISO 9000 Quality Management System (QMS) is ever increasing. With the demand from the end user which requires contractors to be ISO certified, has in a way put on external pressure for construction companies to adopt and implement the ISO Quality Management Systems. This may have led to a system thinking of, 'If a company is ISO acclaimed, it would be successful'. However, with insufficient experience on ISO quality implementation within the Malaysian environment, the construction participants are staggered with several performance-related problems [1].

With the scenario of implementing Quality management systems, it opens up doors to having best practices. Therefore this research attempts to benchmark the best practices through quality management systems practiced by Malaysian contractors. The benchmarking could identify the highest standards of excellence (with the implementation of QMS) and then making the improvements necessary to produce the best among best practices.

II. RESEARCH OBJECTIVE

The research aims are to:

1. Identify the current trend of QMS employed by the Malaysian Contractor.
2. Identify the method of improving performance through benchmarking best practices.

III. BENCHMARKING BEST PRACTICES AND QUALITY MANAGEMENT

Benchmarking Best Practices

Benchmarking is different from other forms of management techniques as comparison forms the thrust of the concept. Benchmarking comparisons are not only within internal factors of environments, it also encompasses the external environment as well [2]. Regardless internal or external benchmarking it is important to note that, besides the obvious comparisons between the parts of an organization, performance of internal processes or transactions which result in various customer-provider relationships within an entity also need to be monitored and evaluated. This will enable identification of superior practices, which can be standardized, as well as those operations which exhibit a scope for improvement.

Benchmarking is a systematic process of measuring performance against recognized leaders for the purpose of determining best practices that lead to superior performance when adopted and utilized. It is a part of the construction industry's continuous improvement process and involves the indirect transfer of ideas from the Best-in-Class organizations to those seeking to improve [3].

Benchmarking has been said to be a performance accelerator of organizations. In other words, benchmarking brings forward the relevant and best practices, in which when implemented will improve the results of the entity. It was identified in the literature review that Benchmarking first originated in the manufacturing industry and it was later adapted into construction. Despite the variations and the types of benchmarking present, essentially they contain the same essence. In the construction context, it would be practical to adapt the core of benchmarking procedures. Chan [7] proposed a nine-step benchmarking approach to be used for benchmarking best practices in the construction industry.

Quality Management Systems in Construction

ISBN : 978-602-97809-0-1

Due to the nature of the construction industry, quality management has to be viewed differently. This is owing to the fact that a project comprises of various stakeholders, each with their own vested interest in the project. Therefore, the examination of quality should be further expounded to cover the following: (i) from the market point of view; (ii) from the technical-technological point of view and; (iii) from the economic point of view [4]. At this juncture, it can be implied that in construction, QMS is the interaction of people, processes and documentation to meet both customers stated and implied needs.

QMS are aimed at linking the various project parameters to engender synergy where; the interaction of different entities so that their combined effect is greater than the sum of individual efforts. Quality management involves all aspects of a project and needs to be incorporated as an integral part of the management function within a general contractor organization [5].

In reality there is no such term as "Project- based QMS" as ISO 9000, TQM or any quality programmes are organization based [1]. Therefore, it is implied that the scenario of QMS implementation in the construction industry is quite similar to benchmarking, in which the implementation is only possible in the business process or in the organizational level. Proper comprehension of QMS is required to ensure a successful implementation. Successful implementation of QMS shows in the functional fitness of the project, economy, safety level in the project, and work performance by parties involve in the construction industry.

The existing literature has highlighted that over the years, the construction industry has become synonymous with poor quality and non conformances [1]. Aside from poor quality issues in building products, the construction procurement process also faced quality failure issues [6]. To date, Quality and quality systems are topics which have received increasing attention worldwide [7-10] and thus QMS is seen as a panacea for the matter at hand. This has prompted many governments worldwide to impose QMS prerequisites in construction related projects. Given the benefits that QMS brings, it makes perfect sense to adopt to raise quality as well as standards of the construction industry.

The implementation of QMS has to be carefully administered due to the linkages the construction industry has. Though construction contributes less than 10% of the national GDP, it is still the major building bulk of the country's economy as it provides infrastructures for other industries and a platform for other support industries. Therefore, a QMS needs to be flexible in order to meet social and economic changes within the construction environment [11] and needs to be integrated within every management aspect of the organizations structure, functions, tasks and daily procurement [12].

Best Practices: The Malaysian Contractor

Best practices are divided into technical and people best practices [13]. However, the researcher has segregated the best practices based on the benefit group that they belong to.

Organization & People

Organizational factors have a critical role in mediating project outcomes, success and failure, and the potential to be a best practices project organization [13]. This leads to the fact that application of ISO systems are usually done in the organizational level. Taking for example, once ISO 9000 certifications are awarded to general contractors, the organizational performance is enhanced and augmented [14]. This approach is likely to generate a very significant leap in the performance even if the company has to radically changes some of its practices [15].

On another note, the foundation of a QMS is to ensure the monitoring of key processes. By looking into key processes, the implementation of QMS may serve as the foundation for training and education implementation relative to new employees and re-training of current employees [16]. With the benefits from training and the monitoring of key processes, accidents and injuries can be reduced and prevented, thus improving construction employee health and safety.

QMS are a critical component relative to the successful management of construction project [5, 17] and result in conformity to all procedures. Conformity in all procedures is brought about by consistency; a byproduct of a well documented QMS effectively incorporates Quality Assurance (QA), Quality Control (QC) and quality improvement [18].

From the excerpts of the literature, it is identified that the practices in the subject of Organization and people are; (i) Having an integrated project management system [13]; (ii) Consistency in documentation; (iii) QMS to reduce conflicts resulting from contracts; (iv) QMS as a foundation to train new employees; (v) Effective project planning, scheduling, and controlling [13]; (vi) Having high-caliber project teams [13]; (vii) Effective communication within teams and externally [13].

Quality & Construction

The absence of QMS such as QA or QC contributes towards the incidence of rework/ non-conformances during construction projects and the top four ranked cause of defects are due to construction [19, 20]. It is implied here that the non conformance issues will have a direct negative impact on quality, client satisfaction and project parameters. QMS results in a synergy which exists between QA and project parameters. This aids in identifying defects at an early stage, eliminating the need and cause for rework to occur, resulting in increased profits and competitiveness [21]. Thus, supporting the claim that GCs who implemented a QMS experienced a significant reduction in rework and a competitive superiority among client stakeholders [22].

A successful adoption of QMS by Contractors could indicated the removal of external quality controls, i.e. inspection and testing by consultants [23]. Also, the implementation of QMS in the GC will lead to a higher quality requirement scenario where third party certification of product or services are to the optimal level of quality required in a project [6]. On another note, QMSs enable GC organizations to improve productivity levels [24, 25] The QMS provides a platform for various ISOs to be integrated. ISO 9000 QMSs and ISO 14001 environmental management systems can be integrated within a GC organization to improve GC performance [26].

Here, it is identified that the practices in the subject of Quality and Construction are; (i) QMS as a mean to ensure quality in third part supplies/ services; (ii) using QMS to boost productivity levels in construction; (iii) Using QMS to prevent incidence of rework/ non-conformances; (iv) Using QMS to achieve quality assurance in construction work; (v) Using QMS to execute a form of quality control in construction; (vi) QMS as a training platform to have in house QA QC personnel and; (vii) QMS as common ground to integrate various ISO systems

Competitive Advantage & Client Satisfaction

QMS certifications such as ISO 9000, is believed to give companies an advantage over others and provide competitive superiority in the highly competitive international markets [22, 27]. Quality, being the core of QMS will result in regaining previous clientele, leading to organizational sustainability in acquiring jobs. This claim is backed up for the fact that high levels of client satisfaction create the opportunity for a GC to remain a client's preferred selection [28]. When it comes to the procurement process, QMS improves productivity through the elimination of non conformances within the construction procurement process [11] and at the same time, decreases procurement costs. Also, QMS contributes to reduced contract conflicts, which has always been regarded as the most damaging tribulations within the construction industry [29].

The practices in the subject of Competitive advantage & client satisfaction are identified as; (i) Using QMS to acquire client satisfaction, perception and trust; (ii) QMS to ensure organization sustainability; (iii) Having stakeholder participation [13]; (iv) Effective contract management by the use of QMS [13]; (v) Implementing QMS as means to get into international markets and; (vi) QMS as a means to be more competitive

Profit and Cost savings

QMS alone contribute to reduced building costs [6]. Also, QMS implementation realizes the application of QA. With QA measures, quality will be increased, thus resulting in a decrease in superfluous costs [2] and a reduction in surplus construction costs. Also, QMS enable GCs to become more competitive and to reap greater augmented profits.

QMS programmes such as ISO 9000, when implemented will lead to an effective implementation of QA. The set of working procedures present in QA subsequently leads to less construction waste [11, 30] standardize quality system specification. With the same quality standard specification used between the supplier and contractor the need to formulate a new system will be rendered obsolete and the contractor could reduce the costs of doing business [31].

From the excerpts of the literature, it is identified that the practices in the subject of Profits and cost savings are; (i) Implementing QMS to reduce business cost between supplier and contractor; (ii) Implementing QMS to achieving savings in contract sum due to lower reworks costs; (iii) Implement QMS to achieve QA, which will reduce superfluous costs; (iv) QMS implementation as a strategy to reap more profit and; (v) QMS as a platform to reduce waste.

IV. RESEARCH METHODOLOGY

The literature review was conducted to ensure that no important variable was ignored in the purposed of this research as well as to set up a basic framework for this research. The research adopts the probability sampling design where the representativeness of the sample is of importance in the interest of wider "generalisability" [32]. To conduct a survey to the entire population would be close to impossible, hence, the need for a stratified random sampling. This research focuses on the stratification of the population being registered grade G04 to grade G07 contractors and then is subsequently followed by a random selection of subjects for the questionnaire survey. Raw data from the questionnaires will be analyzed via frequency analysis, using the Statistical Packages for Social Science SPSS 17 software. Microsoft Excel 2007 was used to generate graphical data.

The sample size of 60 was chosen out of the total population of 750 contractors in Penang, Malaysia. Sample sizes larger than 30 and smaller than 500 are appropriate for most research [32-34]. The sample fulfill the stratified criteria set by the researcher where; (i) Having a high probability of implementing Quality Management Systems; (ii) Contractors within Peninsular Malaysia; (iii) Within the grades 4 to 7; (iv) Registered contractors to the Malaysian Construction Industry Development Board (CIDB).

V. RESULTS AND FINDINGS

Deployment of Quality Management System

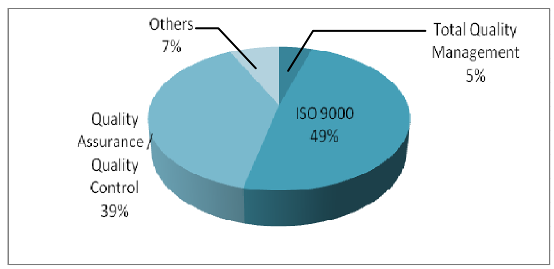

Fig. 1 Distribution of Quality Management Systems used.

ISO 9000 standard was found to be the most favorable QMS adopted by the surveyed companies. This scenario may be due to the emphasis of the standard on quality assurance via the preventive actions instead of reactive measures. Also, it is most likely due to the fact that it is a well established ISO system since 1994. The other forms of QMS deployed include; ISO 9001:2000 and CONCOURS. The deployments of other QMS are perhaps due to individual clientele need; where these scenarios are common for projects initiated by foreign companies. Also, the ISO 9001 standard are fairly new in the industry and not many have adopted this standard which was established in the year 2000. Though it has been going for 10 years, yet, many of the companies are established well before the year 2000, hence the adoption of the ISO 9000 standard.

Methods used to measure company improvements towards continuous Quality

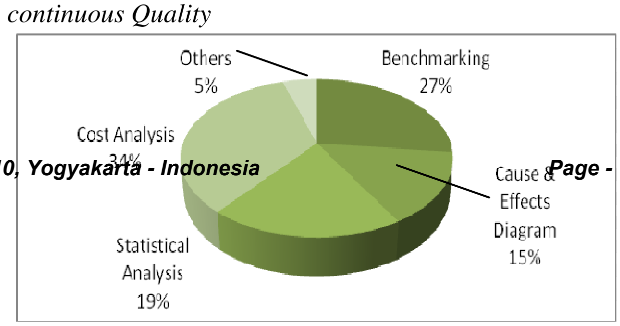

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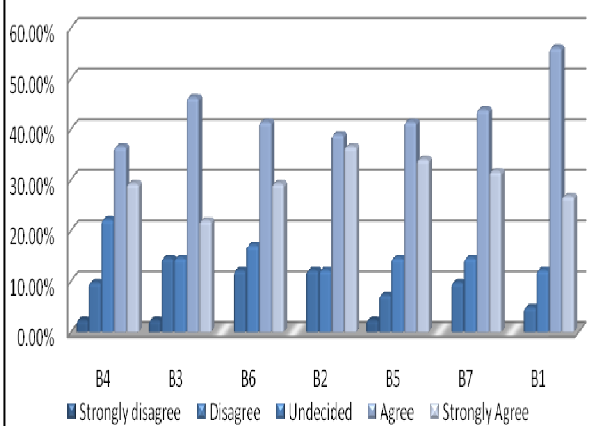
Fig. 21 Distribution of improvement methods used

It can be seen that cost analysis is the most favorable method to gauge company improvement. This point to the fact that cost is an important element as it involves the profit gained by the company as a result of improvising. In other words, it could be said that performance has a directly proportional relationship to cost. Several of the companies which denote the 5% (of ‘others’) adopt the use of Non Compliance Records (NCR). The use of NCRs in normal circumstances reflects a ‘reactive’ system; which is to say, when an error or non compliance occurs, it is noted and subsequently corrective countermeasures are employed to solve the issue.

Best practices from the perspectives of Organization & People

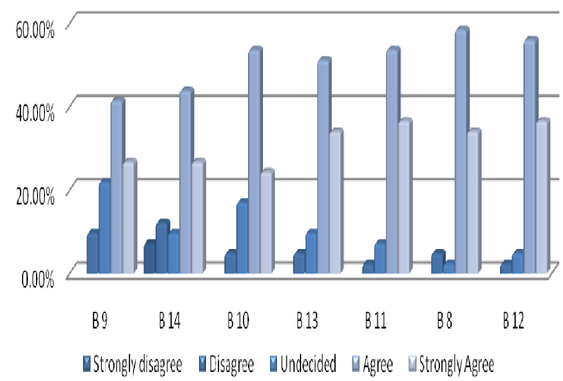


B1: Having an integrated project management system
B2: Consistency in documentation
B3: QMS to reduce conflicts resulting from contracts
B4: QMS as a foundation to train new employees
B5: Effective project planning, scheduling, and controlling
B6: Having high-caliber project teams
B7: Effective communication within teams and externally

Fig. 3 Comparative analysis of best practices from the perspective of Organization & People.

From the comparative graphical analysis, it was revealed that ‘QMS leads to having an integrated project management system’; has the highest rate of agreement from the respondents, with the agreement rate of 56.1%. This may be due to the fact that by adopting QMS, companies may have an integrated project management system which incorporates quality as the truss of operations. From the people’s point of view, a comprehensive management system which encompasses a whole lot of the company will provide a better footing in propelling the company to greater heights. That is to say, with proper staff management (acquired via QMS), and then only it is possible to have significant improvements within company operations.

Best practices from the perspectives of Quality & Construction

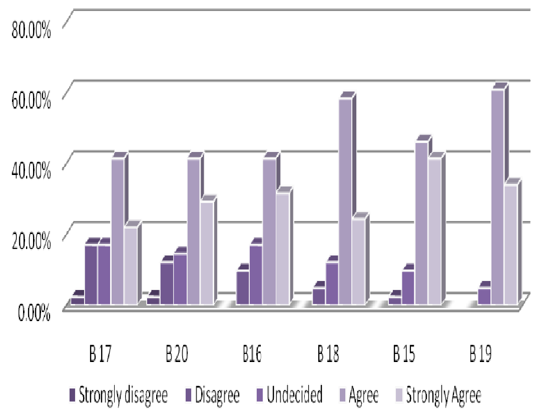


B 8: QMS to ensure quality in third party supplies/ services
B 9: Using QMS to boost productivity levels in construction personnel
B 10: QMS to prevent incidence of rework/ non-conformances
B 11: Using QMS to achieve quality assurance in construction work
B 12: QMS to execute quality control in construction
B 13: QMS as a training platform to have in house QA QC
B 14: QMS as common ground to integrate various SO systems

Fig. 4 Comparative analysis of best practices from the perspective of Quality & construction.

From the comparative graphical analysis, it was revealed grossly that ‘QMS as a mean to ensure quality in third party supplies/ services’; has the highest rate of agreement from the respondents, with the agreement rate of 58.5 %. However, a further cumulative analysis, detected that ‘Using QMS to execute a form of quality control in construction’ has the highest rate of cumulative positive agreement from the respondents, with the agreement rate of 56.1% and 36.6% for ‘agree’ and ‘strongly agree’ respectively. The implication arising from this finding is that quality is an important element in construction. It can also be said that quality is a key element in driving construction activities as it is the final product which is often seen by the end user. Subsequently the evaluation of the end product will directly impact the contractor who undertook the task. QMS is also seen as a favorable method for contractor firms to set the baseline to have quality control in their operations.

Best practices from the perspectives of Competitive advantage and Clientele satisfaction



B 15: Using QMS to acquire client satisfaction, perception and trust

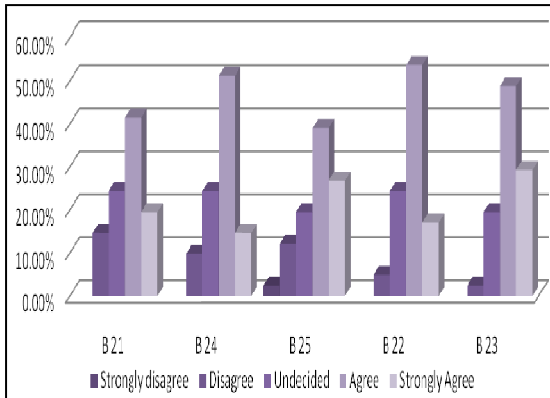
B16: QMS to ensure organization sustainability (ability to get contracts)

B17: Effective contract management by the use of QMS
B 18: Implementing QMS as means to get into international Markets
B 19: QMS as a means to be more competitive
B 20: A better project stakeholder participation

Fig. 5 Comparative analysis of best practices from the perspective of competitive advantage & clientele satisfaction

The frequency (percentage) analysis indicated three categories having the same percentage of agreements (41.5%) for *'QMS to ensure organization sustainability (ability to get contracts)', 'Effective contract management by the use of QMS'* and *'A better project stakeholder participation'*. Therefore, the cumulative of agree and strongly agree are summed to make the comparison. It was then revealed that *'QMS as a mean to be more competitive'*; has the highest rate of agreement from the respondents, with the agreement rate of 61% and 34.1% for 'agree' and 'strongly agree' respectively. Deductions on the nature of the industry could be made based on the results. It could be seen that the competitiveness within the industry has led to contractors looking for an edge over the rest. It is sufficed to say that in order to have a competitive advantage over another; QMS is seen as the avenue towards achieving the competitive advantage. Another implication that may be drawn here is that QMS has already been established as method favored for contractor firms to equip as a vital tool to take on competition.

Best practices from the perspectives of Profits & Cost savings



B 21: Implementing QMS to reduce business cost (supplier and contractor)
B 22: Implementing QMS to achieving savings in contract sum (due to lower reworks costs)
B 23: Implement QMS to achieve QA, which will reduce superfluous costs
B 24: QMS implementation as a strategy to reap more profit
B 25: QMS as a platform to reduce waste

Fig. 2 Comparative analysis of best practices from the perspective of profits & cost savings

From the comparative graphical analysis, it was revealed that 'Implement QMS to achieve QA, which will reduce superfluous cost'; has the highest rate of agreement from the respondents, with the agreement rate of 48.8% and 29.3% for 'agree' and 'strongly agree' respectively. The implication here can be correlated to another field of knowledge, which is lean construction. Reducing superfluous cost is seen as an objective of lean construction; where the reduction of unnecessary cost is often the prime goal. In this context, the application of QMS could bring upon the reduction in superfluous cost; which means (i) a reduction in unnecessary cost and (ii) more profit for the contractor firm.

VI. CONCLUSIONS AND RECOMMENDATIONS

In the construction industry, the end product, i.e. buildings, are the representation of the image and workmanship of building contractors executing the task. As such, quality, which is the primary personification of workmanship, is an essential element in construction. All in all, quality also has it linkages and effects towards other matters such as cost, reputation, etc. Integrating the context of benchmarking and quality, benchmarking best practices here has been used as a method to adapt quality systems to fit managerial inclinations in a construction contractor's firm, i.e. being the four perspectives featured in this research.

The practices identified were then benchmarked. A general opinion concerning the practices arising from Quality management systems has been obtained through this research. The research was able to chart the best practices from four different perspective where; (i) *Organization & people* has the best practice oriented on QMS to having an integrated project

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management system; (ii) *Quality & construction* has the best practice oriented on using QMS to execute a form of quality control in construction; (iii) *Competitive advantage and Clientele satisfaction* has the best practice oriented on QMS as a mean to be more competitive and; (iv) *Profits & Cost savings* has the best practice oriented on implementing QMS to achieve QA.

In conclusion, this research has employed benchmarking as a method to identify the best practices with the implementation of QMS. The findings from this research could be used as a guide for companies which seek improvements as the findings has identified the best practice in order to achieve the best in their desired perspectives. It is believed that companies which employ the best practices highlighted here will have advantages over other companies within the industry. However, it is vital to note that benchmarks go out of date in due time and it is best to have continuous future researches to improvise and improve on existing benchmarks. In conducting the questionnaires surveys, some of the respondents were bound by confidentiality laws which inhibits them from providing either or combinations of; the company stamp, name, designation and company address. The targeted group of respondents in future researchers could be expanded to include construction players in east Malaysia in order to provide a more holistic approach towards benchmarking and a more comprehensive finding.

Future research headings could consider having to benchmark more practices from different perspectives which can be correlated to other field other than the Malaysian contractor, i.e. cost consultants, developers, design consultants, engineering consultants and foreign contractors firms operating within Malaysia. Presently in this research the samples covers only contractors in Peninsular Malaysia.

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

The Conceptualization and Development of Safety Culture in the Construction Industry

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Abstract - This paper reviews the issues in developing safety culture in construction industry. It argues that accidents at the construction sites are evident that the construction industry is unique in nature but also the cause of safety problems. As buildings become higher and larger, the frequency of accidents also increases. The objectives of this paper are to identify causes of safety problems and provide a conceptual framework to develop safety culture in the construction industry. The factors that influence accidents include human behaviour, different construction sites, complexity of work, lack of safety culture, unsafe use of machinery and equipment, and noncompliance with various sets of procedures. Studies show that accident and injuries at the worksite are often the result of workers' behaviour and safety culture. Safety culture is more related to workers' safety practices. This paper suggests that an efficient safety management system creates safety awareness that leads to a culture in the construction industry. Efficient safety culture should be demonstrated to the public as a good value business. Finally, this paper proposes ten best practices that may influence safety culture development in the construction industry.

Keywords - **Behaviour, Construction Industry, Safety, Safety Culture, Organizational Culture**

I. INTRODUCTION

The construction industry is unique as construction activities are often performed under conditions that are conducive for safety and health. Workers at the construction sites have to face constant changes in the nature, location of work and at the same time to work with new workers. Most of the people tend to relate construction industry to a high-risk working environment as compared to other industries. The reputation of the construction industry relies on the skills in implementing and managing safety, while meeting the consumer's requirements [17, 25, 23]. Although there are attempts to find reasonable and efficient safety supervision system, these systems seem to be not comprehensive enough and lack preventive measures. The safety supervision systems adopted by most new companies also are reported to be inefficient. The construction sites are constantly exposed to safety risk and that such risks are hard to manage by supervisors alone. Therefore, it is necessary to prioritize such risk and manage them accordingly.

One of the measures to develop a good or better image of construction industry is to provide safe working environmentm [26]. High rate of accidents occured in the construction industry causes loss, both to health and safety of workforce, and too much amount of money worth of properties every year in the country [2, 42]. Should these situations and phenoma are not rectified, it hinders the country's economic growth in becoming a developed country in the year 2020 [6]. Therefore, this paper attempts to conceptualize the term safety culture and the culture of safety in proposing a conceptual framework to nurture safety culture among construction players in the construction industry.

II. OBJECTIVES OF THE RESEARCH

This paper aims to develop a conceptual framework for implementating safety culture in the construction industry in Malaysia. The best practices on safety factors will be identified as these factors serve as a guide to understand the issues and problems related to safety culture in the construction industry.

Accident, Safety and Culture

Quality and safety are key issues in the present construction industry. ISO 9000 has been promoted in the construction industry to ensure the quality of construction work done by the contractors. Besides, a safe work environment is very to avoid the high risk image that is closely associated with the construction industry [29]. Safe work environment may also be referred to as construction safety which is a standard of quality that is indicated in the contract and required by the client [2]. Often, projects are becoming more complex, and safety has become the main focus in ensuring the safety of the construction personel and properties. The developed countries such as the UK and Australia had enforced safety rules to contractors' works on site. The revolutions and changes in safety system management have become a mandate in practicing safety action that can be managed interminably [24]. The construction industry is labour intensive based on wet trades. This factor contributes to the low quality of work due to the workers' lack of expertise and training, while at the same time exposes them to accidents easily [29].

The accident theory on human factors shows that there is a chain of events which are caused by human faults. In this theory, there are three general factors causing human faults, namely; overload, irrelevant response, and irrelevant activities. Furthermore, according to Heinrich Theory, accidents are caused by main factors that can be predicted such as human faults, unsafe environment, or unsafe use of machineries [16]. Accidents and injuries can be avoided by eliminating these factors. Changes need to be undertaken by the construction industry by establishing the paradigm of safety and health culture; which may improve the safety and health level in line with the requirements of safety and health in the construction industry [28].

Definition of Safety Culture

Culture involves learned and shared behaviours, norms, values, and material objects. It encompasses what people create to express values, attitudes, and norms. Culture is largely undiscussed by the members who share it. Edward Hall, a key researcher into cultures, in Varner and Beamer [43] stated: "*Culture [is] those deep, common, unstated experiences which members of a given culture share, which they communicate without knowing, and which form the backdrop against which all other events are judged*". It seems to imply that culture is a 'social culture'. Similarly to social culture, each organization has its own culture dominated by its values and behaviour. This is known as 'organizational culture', of which safety culture is an instance.

According to Booth [4], the term safety culture was introduced to the nuclear safety debate by the International Nuclear Safety Advisory Group of International Automatic Energy Agency (IAEA) in their analysis of the Chernobyl disaster. IAEA [21] defined safety culture of an organisation as the product of individual and group values, attitudes, competencies and patterns of behaviour that determined the commitment, and the style and proficiency of an organization's health and safety programmes. It seems to suggest that safety culture can be described as a set of beliefs, norms attitudes and social technical practices that are concerned with minimizing the exposure of individuals, within and beyond an organization, to conditions considered dangerous or injurious [30].

Cooper [7] considered safety culture as a sub-facet of organizational culture, which is thought to affect member's attitudes and behavior in relation to an organization's ongoing health and safety performance. He argued that defining the product of safety culture is very important to clarify what safety culture should look like in an organization. He added that this also could help to determine the functional strategies required to developing this product, and it provides an outcome measure to assess the degree to which organisations might or might not possess a 'good' safety culture. This outcome has been severely lacking in the construction industry.

Cox and Cox [8] (in industrial gases, European) on the other hand defined safety culture as one which reflects the attitude, beliefs, perceptions, and values that employees share in relation to safety. A definition of safety culture adopted by many researchers is: "*the product of individual and group values, attitudes, perceptions, competencies and patterns of behaviour that determine the commitment to, and the style and proficiency of an organisation's health and safety management characterised by communications founded on mutual trust, shared perceptions of the importance of safety and by confidence in the efficacy of preventative measures*" [1].

Issues and Problems in Safety Culture

Certain guidelines concerning management in the construction industry are needed to ensure that safety culture in the industry would be improved. The guidelines should govern the safety management of plant, equipment and workforce. To prevent accidents in work-place, human attitude that is "reactive and bad attitudes, generally a norm, should be changed to positive and proactive culture" [28].

Two fairly distinct approaches to managing workplace safety have competed for attention and have generated a considerable amount of debate and controversy in the past decade. The first approach, i.e. behavior-based safety, focuses on the identification and modification of critical safety behaviour, and emphasizes how such behaviors are linked to workplace injuries and losses. The second approach, in contrast, emphasizes the fundamental importance of the organization's safety culture and how it shapes and influences safety behaviors and safety program effectiveness. Adding to this mix, each movement has recruited its own persuasive proponents and vocal detractors. On the surface, at least, the two approaches appear to be indirect opposition to each other and represent two entirely different world views of injury causation and safety management [11].

Cultural Influences

Businesses are embedded within given institutional and social setting, thus making them susceptible to the influence of national culture. This influence is reflected in the general definition of safety culture offered by Waring [44] as 'aspects of culture that affect safety'. The results of the study corroborate the evidence provided by other studies of the influence of national culture on health and safety. A comparative study conducted by Peckitt *et al.* [36, 35] on safety culture of the construction industry of Britain and the Caribbean illuminates the relationship between cultural values and construction site safety. The Caribbean site workers viewed values of freedom, love and social interactions as having impact on site safety, whereas, the British workers rated these values as having a lower impact. The relationship between workplace health and safety and cultural values is supported by data of the current study. Owner/managers perceptions and attitudes to health and safety are bound together with the extended family system and a collectivist view of life characterized by upholding and providing for the social needs including health and safety of workers.

The Influence of Culture on Organizational Practices

Given the importance of the external environment of businesses in developing countries, research into health and safety should not only focus more on it alone, but also the workplace. There is a link between culture and the external environment. Culture is the interactive aggregate of common characteristics that influence a human group's response to its environment [20]. Studies conducted by sociologists such as Hofstede [19] and Schein [41] show that organizations are culture-bound. This supports the view that the cultural environment is an important aspect which cannot be overlooked when developing ways to improve workplace practices including health and safety.

 ISBN : 978-602-97809-0-1

Culture is defined as those practices common to a group of people. In this context, safety can be expressed in simple direct terms as behavior affected by culture. Note that this topic encompasses both management behavior (action or inaction) and employee behavior [13]. Culture is further defined as missions interacting with work processes and corporate values to generate behavior [13].

Organizational or corporate culture as defined by Handy [18] is the '*pervasive way of life or set of norms and values that evolve in an organization over a period of time'*. Norms are unwritten but accepted rules which tell people in organizations how they are expected to behave. They may be concerned with such things as how managers deal with their staff (management style), how people work together, how hard people should work or the extent to which relationships should be formal or informal. Values are beliefs on how people should behave with regard to such matters as care and consideration for colleagues, customer service, the achievement of high performance and quality, and innovation.

There are also some debates, initiated by Hofstede [19], and revived by Reason [38], about the ownership of culture. Some theorists argue that the organization has culture, whereas others argue that the organization is culture. Like organizational culture, safety culture is assumed to be a relatively stable construct, similar to personality, and resilient to change in the face of immediate and transient issues. Safety culture is often seen as a subset of organizational culture, where the beliefs and values refer specifically to matters of health and safety [5].

It should be noted that the proposed definition of safety culture is stated in neutral terms. As such, the definition implies that organizational culture exists on a continuum and that organizations can have either a good or poor safety culture. However, not all definitions in the literature make this assumption. Some suggest that safety culture is either present or absent within an organization. Nevertheless, it is clear from the initial introduction of the term within various operational environments that safety culture is assumed to be a component of an organization that can be improved rather than simply instilled [21, 10]. Obviously, such a distinction is important when it comes to both measuring and changing safety cultures within organizations. More specifically, safety culture is seen as a subfacet of organizational culture and exists at a higher level of abstraction than safety climate. It seems plausible that safety culture and safety climate are not reflective of a unitary concept, rather, they are complementary independent concepts [7].

Cultural Change

Misnan and Mohammed [31] state that organizational culture conveys a sense of identity and unity of purpose to the members of an organization, facilitates the generation of commitment and helps shape behaviour by providing guidance on what is expected. This can work against an organization.

Cultural change aims to change the existing of the values organizational system (what is regarded as important in organizational and individual behaviour) and accepted ways of behaviour (norms) which strongly influence 'the way things are done around organization' [30]. It can work against an organization by encouraging unproductive behaviour. Strong cultures may be formed over a considerable period of time and have more widely shared and more deeply held beliefs. But, strong cultures are only appropriate if they promote desirable behaviour. If they do not, they are inappropriate and must be changed [3].

III. A CONCEPTUAL FRAMEWORK OF THE SAFETY CULTURE

Glendon and McKenna [15] stated that effective safety management is both functional (involving management control, monitoring, executive and communication subsystems) and human (involving leadership, political and has safety culture sub-systems paramount to safety culture). This is so, because the concept of safety culture has emerged from the earlier ideas of organisational climate, organisational culture and safety climate. They described safety culture as the embodiment of a set of principles, which loosely defines what organisation is like in terms of health and safety.

Safety is looked into from the cultural point of view as shared characteristics of a group dynamic relating to a system (e.g. group, community, race, nation, religion), which include beliefs, values, attitudes, opinions and motivations. Glendon and McKenna [15] pointed out that organisations with good safety cultures have employees with positive patterns of attitudes towards safety practice. These organisations have mechanisms in place to gather safety-related information, measure safety performance and bring people together to learn how to work more safely. Ostrom *et al.* [34] looked at the employees' perceptions of safety culture as follows:

- management attitudes towards safety;
- perceived level of risk;
- effects of work pace;
- management actions towards safety;
- status of safety adviser and safety committee;
- importance of health and safety training; and
- social status of safety and promotion.

Creating a culture of safety means that the employees are constantly aware of hazards in the workplace, including the ones that they create themselves. It becomes second nature to the employees to take steps to improve safety. The responsibility is on everyone, not just the management. However, this is a long process to get to that point [12].

Safety and health culture within a company is closely linked to the workforce's attitudes in respect to safety. They share the company's risk, accidents and incidents. The role of management and the involvement of all employees as important key players in safety and health culture are important in order to cultivate the positive beliefs, practices, norms and attitudes among all in the company. Glendon and McKenna [15] also identified four critical indicators of safety culture. They are:

i. Effective communication, which leads to commonly understood goals and means to achieve them at all levels.
ii. Good organizational learning, whereby organizations are able to identify and respond appropriately to changes.
iii. Organizational focus upon health and safety, that is, how much time and attention is essentially paid to health and safety.
iv. External factors, including the financial health of the organization, the prevailing economic climate and impact of regulation and how well these are managed.

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The theoretical and empirical development of safety culture and climate has followed the pattern set by organizational culture and climate, although to a lesser extent. As stated previously, most efforts have focused on the empirical issues surrounding safety climate although it is possible to identify theoretical development of concepts within the safety culture literature. Also, the terms safety culture and safety climate have been used interchangeably in the literature [10]. Cox and Cox [9] also demonstrated this point by likening culture to personality, and climate to mood. Conducting a survey will assess the current mood state of an individual. Some responses may be indicative of the individual's stable underlying beliefs, constructs and personality but overall, the survey will reflect how the individual feels at that point in time. The comparison between culture and personality seems attractive because personality is relatively stable over time whereas climate and mood can be susceptible to short-term fluctuations [37]. In relation to occupational safety, the workers must be able to automatically correct a hazardous act or eliminate a hazardous condition. In terms of occupational health, they ought to automatically undertake measures to ensure protection from health hazards at the workplace using personal protective equipment without having to be told repeatedly to do so [29].

Conceptual Framework of Safety Culture in Construction Industry

For a long time, the construction industry has been labelled with poor occupational safety and health culture. Efforts to improve occupational safety and health performance will not be effective until the occupational safety and health culture is improved [30]. As a result, there is a need for a major paradigm shift regarding attitudes on occupational safety and health in construction sites. Widening the understanding of behaviour increases insights into possible targets for improvements, for example better planning, more effective job design, or more comfortable personal protection. Therefore, this root problem must be solved effectively [33].

The best practices elements that influence the development of safety culture are [32]:

i. Leadership - Improved safety culture can be achieved through close cooperations between leaders and the workers;
ii. Involvement - An important indicator to a positive safety culture in an organization is the involvement of the leaders and the workers in safety management.
iii. Recognition systems and acknowledgement - The recognition received would only be effective if it is meaningful and given as an acknowledgement to the work produced.;
iv. Training and education - Training has always been a high priority, and the effectiveness of safety training has been proven to increase knowledge and awareness of workers on safe working culture;
v. Communication - Communication involves all aspects of work in an organization and is able to connect all entities at all levels on safety aspects;
vi. Teamwork - Team members are involved in conveying their opinions on works that they do and strategies to solve problems;
vii. Motivation - Leaders that consider the ideas of the workers and sensitive to their needs will be able to elevate the motivation level of the workers to produce work of better quality;
viii. Safety and Healty Committee - Functions to improve certain aspect of the work environment and develop safety values in everyday work practice, and establishing safety as the main goal to be achieved by the committee;
ix. Work environment - The work environment should conform to the standard of safety and health at all times;
x. Policy and safety planning - Policy pertains to the principle that supports behaviour towards safety, as in making safety policies as a marketing advantage for the organization.

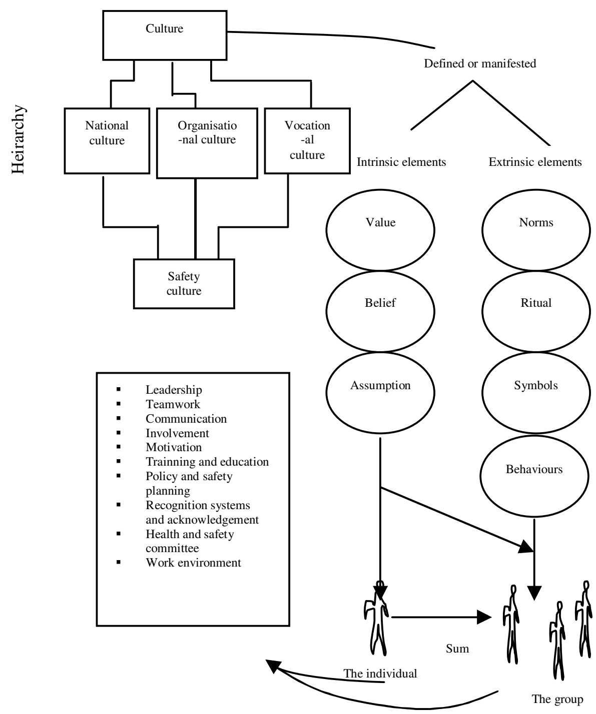

Figure. 1 : Conceptual framework of safety culture development

Figure 1.0 shows the conceptual framework of safety culture development. The development of safety culture as depicted in the framework views that both individual and groups are responsible for developing the total value of safety culture which in turn supports the organisational culture. Everyone must play a part in the organisational culture to ensure correct understanding of the importance of safety and changing the attitude and behaviour through the instrinsic and extrinsic element of the culture. Organisational culture will be transmitted to all organisation activities which involve intrinsic and extrinsic elements of the organisation. This will in turn be transmitted to every member in the organisation. All instrinsic and extrinsic elements of culture will affect the organisation culture throughout the development of safety culture. Consequently, it makes the concept of safety culture more acceptable to wider attention. It does not mean that the safety system, nowadays, is not relevant for practices, but this system will function well when the organization has developed safety culture. The reason could be seen from different perspective but the barrier in implementing the safety system could be minimised if the organization develops a strong safety culture.

ISBN : 978-602-97809-0-1

The safety and health legislations have changed over the years with more emphasis on safety at work. The rules and regulations were improved to make the working environment safe. Besides, the effect of laws, many factors related to safety activism also influence the decision of modern managers regarding health and safety such as the active role of the trade unions, consumerism and the legal battle by accident/incident victims. All these factors are forcing managers to change their attitudes towards safety.

IV. CONCLUSION

In summary, there appears to be a considerable evidence suggesting that organizational and contextual factors are important in achieving workplace safety. However, current definitions of safety culture remain rather vague and variable, and current knowledge does not permit precise statements about which factors are most important in a given organization or situation. Also, systematic studies evaluating field-based interventions specifically targeted to safety culture change are conspicuous in their absence. But this is perhaps not that surprising given current conceptual and measurement limitations. It is also worth noting that intervening into the culture of an organization is difficult under the best of circumstances, because it requires that the organization be willing to look at itself and make fundamental changes in the way it pursues its core activities. These limitations, withstanding not, the importance and usefulness of organizational culture as they pertain to workplace safety appears to be broadly accepted by researchers and practitioners alike.

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ISBN : 978-602-97809-0-1

Developing prototype of Seat Belt Reminder Systems for Indonesian Used Car

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***Abstract* - In Indonesia, the number of accidents occurred in 2009 increased to 19 thousand cases. Many efforts to minimize the number of deaths and injury rates caused by traffic accidents have been initiated, one of which is adopting a seatbelt reminder system (SBR) on passenger cars. This paper aims to develop SBR prototype for Indonesian used car, instead of new car, considering magnificent number of used car in Indonesia. The research began with the study of the use of seat belts and SBR in Indonesia, the willingness to pay (WTP) for the SBR and the willingness to use of the SBR. SBR prototype is developed using Quality Function Deployment (QFD) method.**

***Keywords* - seatbelt reminder system, used car, quality function deployment, willingness to use, willingness to pay**

I. INTRODUCTION

According to WHO report, the number of road transport accidents in the world has now reached 1.2 million victims died and more than 30 million victims injured per year (2739 people died and 63,013 people were injured per day). The 85% of victims who died from these accidents occur in developing countries, in which the number of vehicles is only 32% of the total vehicles in the world. The number of road transport accidents in the Asia Pacific region, including Indonesia, contributed 44% of the total accidents in the world [9].

In Indonesia, the number of accidents that occurred in 2009 increased to 19 thousand [10]. In fact, according to the calculation of the ASEAN Development Bank, the number of accidents in Indonesia has reached 30 thousand cases per year. The results of study by the Center for Transportation and Logistics Studies, Gadjah Mada University (PUSTRAL UGM) and the Faculty of Economics, University of Indonesia (FE UI) state that estimate of economic losses caused by traffic accidents in 2002 was reaching 41 trillion rupiah, or about 2.91% of Gross Domestic Product (GDP) [10].

In a related statement of transport policy, the European Commission mentioned that there are three main pillars in transportation safety, the design of network transport (horizontal and vertical road profile), the condition of the vehicle (including safety devices that are passive and active), as well as the driver behavioral (habit of alcohol consumption), the awareness for the use of seat belts, and so forth [6].

In his research report [6], Lapparent specifically states that seat belt usage is very influential on decreasing the level of injuries or even death rates due to accidents. However, the use of seat belts is still not optimal yet because of various reasons.

Seat belt is a device designed to restrain a passenger car or other vehicle to remain in place in case of collision, or, more commonly happens, when the vehicle stops suddenly [6]. It works by distributing the seat belts pressure due to collisions or pull through the thigh, chest and shoulders. Seat belts intended to prevent passengers hit a hard interior or thrown from the car. Seat belts also prevent rear passengers hit the front seat.

In Indonesia, there is a government regulation concerning the obligation to use seat belts, Law No. 14 Year 1992. Unfortunately, the facts show that the rate of seat belt usage in Indonesia is still very low at less than 20% [5]. This is caused by the application of rules which is still not effective. The reason why people is reluctant or do not use seat belts is vary and including a combination of situational, behavioral, motivational, and design aspects of safety belts [4]. Existing position of seatbelt can be seen in figure 1.

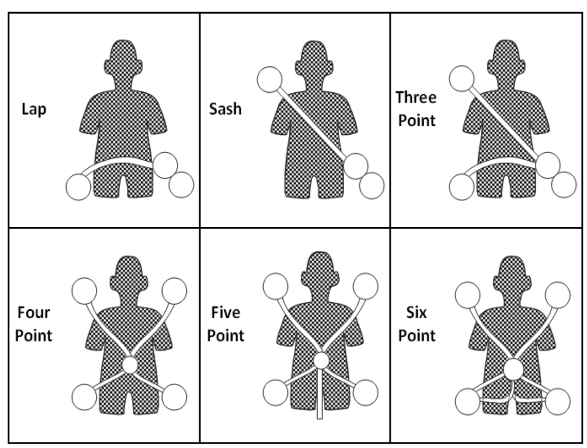

Figure 1 Types of seat belts

Effectiveness of safety belts used is supported by the seat belt reminder system (SBR system). SBR is a warning system in the form of sound or visual indicator to the driver when not using seat belts. The aim of SBR is to remind the people while they were not using seat belts [2]. Various result of studies show that the use of SBR increases seat belt usage by more than 80% [8]. The number of cars with SBR also increased rapidly in many countries with coverage of 88% of the total drivers.

Along with increasing number of used car in Indonesia, this research focus on developing prototype for used car' SBR, which is in the end expected to be reducing the number of injury rate caused by car accident in Indonesia.

II. Method

The research began with the study of the use of seat belts and SBR in Indonesia, the willingness to pay (WTP) for the SBR and the willingness to use (WTU) of the SBR. SBR prototype is developed using Quality Function Deployment (QFD) method.

Survey were conducted in 12 cities in Indonesia based on cities categorization published by Indonesian Bureau Statistic (BPS), that are to say : Jakarta, Bandung, and Semarang as representatives of metropolitan cities; Denpasar, Bogor, Cimahi, Surakarta, and Bandarlampung as representatives of big cities; Jogjakarta as representatives of middle cities; and Metro as representatives as small cities. 775 respondents were included in this study. In the end, only 719 respondent's data were included for further analysis.

Willingness to use (WTU) questionnaire was used to determine whether the design of a product may be accepted by the target or not [1]. The approach taken is behavioral approaches in assessing factors related to using car; include the factor of willingness and unwillingness to use seat belts.

Willingness to pay (WTP) is the maximum amount of money to be someone use to get a good or service. WTP calculations are used as basic information for estimating the economic sustainability of a plan, the determination of affordable tariffs for certain goods or services, evaluation of alternative policies, the review of financial aspects in an integrated, up to a reasonable subsidy planning.

Quality Function Deployment (QFD) is one technique used to translate customer requirements into product characteristics and also considers the company's ability to accomplish. Conformity between the specifications and quality parameters of products with consumer desires is an important consideration in designing the product [7].

III. Result and Analysis

Based on the composition of age groups, most respondents are from the 21-25 year old, about 33.23%; followed by the second most are respondents aged over 50 years, about 23.04%.

TABLE I
PERCENTAGE USE OF SBR BASED ON AGE CLASSIFICATION

Age category	Know the Law	Know the function of SBR	SBR is useful
<21 years	61.80%	87,64%	96,63%
21-25 years	69.70%	90,15%	93,56%
26-30 years	77.78%	89,74%	97,44%
31-35 years	65.56%	92,22%	98,89%
36-40 years	66.67%	95,00%	100,00%
41-45 year	85.42%	87,50%	97,92%
46-50 years	66.67%	85,19%	100,00%
> 50 years	83.33%	79,17%	95,83%

The age group 41-45 years showed the highest percentage for any questions about the knowledge of the Law No.14 Year 1992, i.e. 85.42% answered "know". Respondents aged 36-40 years showed the highest result (95%) for knowing the function of SBR than other age groups. Whether the SBR helpful or not, the age of 31-50 years shows a very high result, which is more than 97.50% SBR consider that SBR is useful. These results might be due to mature age, people tend to be more concerned about safety issues. However, this argument is less convincing. Furthermore, most of respondents already know the importance of seat belt usage. It is based on the high number of respondents who know about the Law No.14 Year 1992 about seat belts. About 70.37% of respondents having knowledment about this law.

A. *Willingness to use (WTU)*

Results of the willingness to use (WTU) questionnaire is quite good. For each category of the city, WTU is 77.55% for metropolitan cities, 75.38% for large cities, 73.95% for moderate town and 82.56% for small towns. In general, 76.91% of the respondents have a willingness to use the SBR.

Based on the questionnaire results, the main reason for the reluctance to use SBR is a thought that SBR is unnecessary. This could be caused by condition that people are not familiar with SBR technology. Although considered to be beneficial, the implementation of the existing SBR has not shown significant differences in increasing seat belt usage. The second reason people are reluctant to use the SBR is because there are no binding rules and force to install the SBR in the car. The next reason is deemed inconvenient SBR. As 15% of respondents think that the use of SBR unpleasant and not comparable to benefits provided. For this reason, the steps that need to be done are to create an ergonomic design of the SBR. Thus, the SBR was created to not too much trouble or disrupt the activity of driving, while still effective in providing warnings.

For effective implementation of the SBR, the rate of use or the willingness to use the SBR must be high. The reasons why people are reluctant to use the SBR must be tackled. The design is made must also consider the cost of production. As mentioned in previous chapters, the target of this SBR design is a society that has a car without SBR. Respondents who have cars with SBR facility are a respondent who spend on over IDR 10 million per month, which is as much as 70%. Among

ISBN : 978-602-97809-0-1

respondents with a monthly spending less than IDR 5 million, less than 50% have cars with SBR system facilities.

B. Willingness to pay (WTP)

Result of uniformity test of data is as follows : a fair price for SBR is ranged IDR 0.00 to IDR 1,000,000.00 with an average = IDR 282,848.84 and the standard deviation = IDR 280,866.93; the maximum price is IDR 0.00 to IDR 1,500,000.00 with an average = IDR 416,014.26 and the standard deviation = IDR 382,622.44. These results indicated that despite a price range that large enough, from Rp.0.00 to IDR 1,000,000.00 or IDR 0.00 to IDR 1,500,000.00, some communities have a WTP below the midpoint of that range. This indicates that most respondents wanted an affordable price SBR. This is also in accordance to the conditions of the respondents who do not have the SBR is a respondent who earn money less than IDR 2,000,000.00 per month.

For the lowest price is IDR 0 or free. This is also caused by the respondents thought that if the use of SBR is a must, then the cost incurred is the responsibility of government, not the vehicle owners. Meanwhile, the most expensive price is IDR 50,000,000. With the desired height value for a SBR, the respondents are well aware that safety is not something trivial and cheap.

C. House of Quality (HOQ)

Voice of customer was identified based on functionality, reliability, usefulness, efficiency, maintenance, and quality. After process of weighting using borda method, final result reveal the list of technical characteristics short by the most importance : indicator type, material used, sensor level, easiness to install, design, dimension, availability of the component, price, safety, and guidance book.

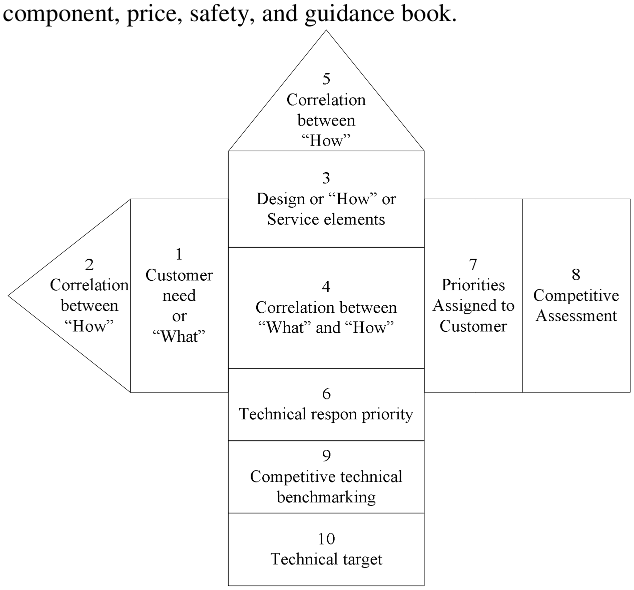

Figure 2 Structure of HOQ

In this paper, design of SBR prototype is limited to indicator type and sensor level. Other technical requirement, such as material used and instalation will not be discussed.

D. Preferred type of indicator

Indicator species that are listed are divided into two categories: audio and visual indicators. Most of respondents (73.81%) chose a combination of audio and visual indicators as appropriate indicators as a reminder. The indicator species for each category was divided into several types.

The following diagram shows the preference of respondents to the indicator species.

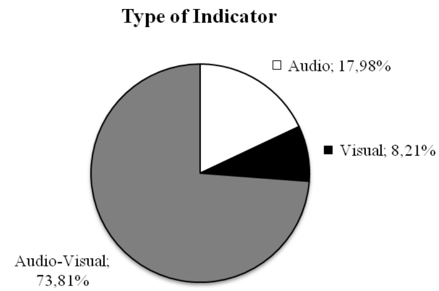

Figure 3 Preferred type of indicator

For a visual indicator, the most wanted indicators are indicators of representative pictures (40.61%).

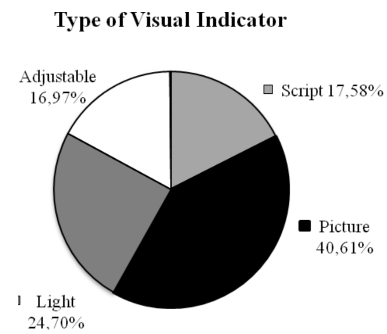

Figure 4 Preferred visual indicator type

For audio indicator, the most wanted indicators is a sound "beep" (44%) and a voice that can be replaceable according to the user wishes of SBR.

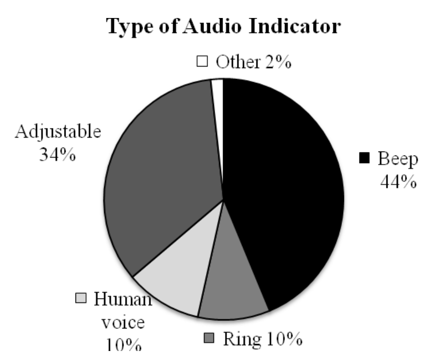

Figure 5 Preferred audio indicator type

E. Prototype Development

Prototype design divided into three levels of intelligence. The three different levels of intelligence were due to production process of SBR, in which there was a tradeoff between price, efficiency, effectiveness, and quality.

1) *SBR with Low Intelligence Level:* The indicator used is the audio-visual. Display images can be seen in the following figure. The visual indicator is enlighted by red lamp to give better notification to user. This device will be completed with audio sound "beep". SBR sensor will turn on when the ignition is attached. In the early ignition contact, a visual indicator will light up. Audio indicator will also light up at the same time. For the latest indicator, a warning signal that is used is the sound of *intermittent* (discontinuous) "*beep*" in *allegro* tempo.

Figure 6 Display of the standard for visual indicators on the SBR

2) SBR with Medium Intelligence Level: At this level of this intelligence, the SBR with low intelligence level is equipped with weight sensors / pressure on the seat. With the use of mass sensor, the SBR will work if the driver or passenger seats occupied. Although the car ignition is attached, if the sensor does not detect any pressure from the people who sat, the indicator will not light SBR. Indicators used in this system similar to those used in the SBR system with low intelligence level.

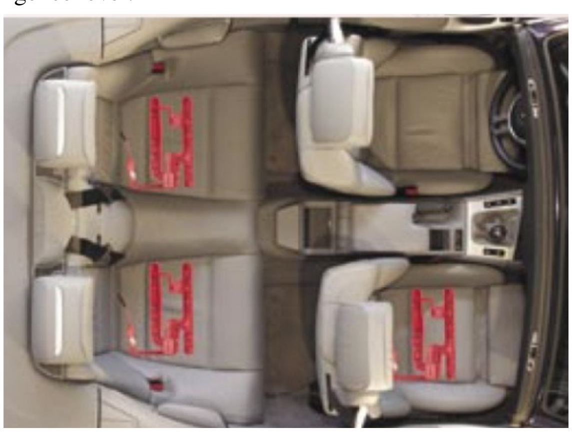

Figure 7 Position of seat sensors

3) *SBR with High Intelligence Level:* At this intelligence level, the SBR system equipped with an infrared ray sensor on the dashboard. The sensor is placed at a certain height so that was directly in front of user's body. The mechanism of SBR begins when the ignition is mounted and the pressure sensor detects the driver/passenger seat. The aim of infrared sensors is to ensure that seat belts actually installed properly by the driver / passenger car.

IV. Research Implications

Results from this research will impact upon society, either directly or indirectly. Stakeholder who will get the advantages of this research include government, local authorities, industry, automotive, industrial electronics device assemblies, workshops, academics/researchers, car dealerships, health and public safety organizations, and so forth.

A. Automotive Industry

Referred to the automotive industry here is a small industry that produces only an electronic device assembly as well as the automotive industry large-scale production.

For small industries, development of SBR in the *Used Car* opened a separate business opportunities. Such industries are generally making a simple electronic device assembly in accordance to customer orders. People working in this industry sector can play a role as a producer and distributor of SBR device. The electronics assembly industry practitioners can easily create a SBR because of electronic components is the main raw material in the industry. Disadvantages of this industry are in terms of price and production time.

One alternative to overcome the problems of cost and production time is to involve large-scale industry. In addition to having the advantage of time efficiency and cost of production, involving the automotive industry in the implementation of the SBR provides other value-added. Automotive companies can play a role in the socialization of the functions and benefits of SBR, provision of spare parts, facilitate maintenance, and so forth. For the automotive industry, participation in the development and implementation of the SBR can enhance the company image. Consumers of course will choose the car manufacturer that offers the facility a better safety protection.

B. Government and other authorities

What is meant by the government and the authorities here are ministries, policy makers, the police, to legal entities. As comparison, the Japanese government has set a mandatory system of SBR as a device in the car since 2005 [3]. That obligatory were effective to make people not forget to wear a seat belt. In addition to issuing a similar assessment, the government can also make another attempt, for example:

1) Examine existing conditions of the manufacturing belt and SBR comprehensively. The things that must be considered among other applicable standards and guidelines, the level of usage, and so forth. Checking standards and guidelines made to see if there are standards that need improvement or even just need to develop new standards. To launch this effort, it is necessary to have good communication between the government and automotive companies.

2) SBR program development usage with a target and a realistic time period. This option can be done for example by adapting the United Nations Economic Commission for Europe (UNECE)'s Regulations 14, 16, and 44. These regulations contain guidelines for the manufacture of safe vehicles (safe car). One of the concrete forms of application of this regulation is to pass a law that cars manufactured by automotive companies must be equipped with a SBR system. Thus, the SBR system usage rate in Indonesia would be higher.
3) Supervision of SBR usage. One of the characteristics of Indonesian people is the need of supervision. It can be seen from the new seat belt usage increased significantly when the Law No.12 Year 1992 confirmed. The same could apply to the implementation of the SBR system. With monitoring process, the implementation of the SBR system can be more controllable and effective.

C. *Academics*

Results from this study can be used as preliminary description of the use of safety belts, SBR, WTU and WTP, and design preferences of SBR for Indonesian people.

However, further research could be done, among others:

1) Proving the hypothesis concerning the relationship between the factors that influence the implementation of the SBR in Indonesia.
2) Research in cooperation with automotive companies about product benchmarking.
3) Research on the economic feasibility analysis of the implementation of the SBR.

Research on influence of SBR implementation on rate of deatch and injuries due to accidents in Indonesia.

V. CONCLUSIONS

This study indicated that Indonesian cars equipped with SBR are still low, less than 50%. This fact is caused by many factors, among other things: forget and unwillingness to use seat belt reminder. This indicates there is still a huge opportunity in the design and implementation of the SBR for Used Car. The reluctant to use the SBR is because people feel the SBR is not required no binding rules and forces someone to put on his car SBR, SBR cumbersome, and so on.

Based on respondent's preference for SBR, we proposed three prototypes design, based on the level of intelligence. The distribution of intelligence level prototype design conducted because a tradeoff between price, efficiency, effectiveness, and quality.

SBR application needs the cooperation of various parties such as governments, policy makers on transportation, automotive companies, and also academics.

ACKNOWLEDGMENT

This study supported by the Directorate General of High Education Department of National Education, Republic Indonesia, Competitive Research Grant Program by the National Priority.

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

Key Elements of a Lean Six Sigma Framework for Indonesian SMEs

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***Abstract* – This paper describes the development and structure of a framework for the implementation of Lean Six Sigma into Indonesian small and medium sized organisations (SMES). The framework was developed from literature and research conducted with Indonesian SMEs competing in the metal sector. The elements of the framework are owner/manager commitment and involvement, training, employee involvement, culture change and external support. Appropriate external support was found to be particularly important factor for Indonesian SMEs for successful adoption of innovations.**

***Keywords* – Indonesia, Lean Six Sigma, SMEs**

I. INTRODUCTION

This paper describes the development and structure of a framework for the implementation of Lean Six Sigma into Indonesian small and medium sized organisations (SMES). The framework was developed from research into Indonesian SMEs competing in the metal sector and relevant literature. The research methodology for the project consisted of a questionnaire survey of a sample of SMEs operating in the metal sector and interviews with stakeholders with an interest in SME development. For example, interviews were carried out with representatives from a non-Government agency who provide support for SMEs, with SME owners and with customers of SMEs. The key results of the questionnaire survey and interview reported here was to gather information needed to contribute to the design of an effective implementation framework.

The paper first presents a literature review on Indonesian SMEs, Six Sigma and Roger's work on diffusion of innovations [20]. This is followed by an explanation of the methods, key results a discussion of framework's elements and conclusions.

II. LITERATURE REVIEW

Indonesian SMEs

Research has identified that SMEs have some characteristics that in general differentiate them from large organisations e.g. [12]. For example, the organisational structure of SMEs is usually much simpler than that of large organisations. Both day-to-day and strategic decisions in SMEs are more likely than in large organisations to be made by the leader, who is often the business owner. The structure and leadership of SMEs can provide them with better agility than large organisations to respond to change. However SMEs often lack the resources and the organisational slack of large organisations and this can impede their competitive development, particularly business improvement and the adoption of innovations.

In Indonesia, SMEs play a vital role in the economy, and employ a substantial proportion of the workforce [6]. However, their export contribution is small compared to ASEAN (Association of Southeast Asian Nations) countries such as Singapore and Malaysia [24]. There is also concern that SMEs operating in the metal sector need to be more competitive on price, quality and delivery performance in order to compete effectively in their local market against strong foreign competitors such as China [25] [23].

Indonesian SMEs receive various forms of support, some internal and some external in the way of development aid projects. Indonesian government support has typically been in the form of training and financial loans. A summary of this support since 1969 has been made by Hayashi [15]. Non-government support comes from bodies such as universities, large organisations and is usually provided in the form of consultation, training and technical assistance [23].

Six sigma and lean six sigma

The Six Sigma concept was first introduced by Motorola Company in the mid 1980s. The central idea of this approach is to design processes, or improve existing processes, to obtain very high process capability and hence defect rates that are close to zero. A Six Sigma target defect rate of 3.4 defects per million components/incidents is often cited [9]. General Electric (GE), under the leadership of CEO Jack Welch did much to popularise the use of Six Sigma [19].

Since its inception a number of variants on the original concept have been developed, often combining Six Sigma with ideas from other improvement approaches [2] [5] [27]. Lean Six Sigma, perhaps the most popular variant of Six Sigma, integrates Six Sigma with Lean principles [16]. Lean Six Sigma is claimed to have some advantages over Six Sigma and is aimed at improving quality, reducing processing time and reducing production cost [3]. The Lean concept was first introduced by The Toyota Company [26] and is popular today particularly in some large organisations which have successfully integrated it with Six Sigma. According to advocates both concepts, Lean and Six Sigma, can be integrated to provide an agile approach in order to respond to the changes in customer wants, which have resulted from globalization pressures [3].

Six Sigma uses a systematic approach i.e. DMAIC (Define, Measure, Analyse, Improve and Control) to structure improvement projects. There are various analysis tools to aid in problem identification and improvement e.g. Pareto analysis and root cause analysis. A fascinating and successful development in Six Sigma has been the introduction of the ‘belt system’ used in training i.e. green belt, black belt and master black belt – presumably copied from martial arts. Recently, Harry and Crawford [14] introduced a ‘white belt’ designed to help small businesses by providing a more affordable alternative to the foundation green belt program. Six Sigma has attracted a moderate amount of attention from academics e.g. recently Schroeder et al. [22] have explored the theoretical basis of six sigma.

Information on four implementation frameworks specific to Six Sigma were found in the literature, these were by Chang [8], Park [18], Burton & Sams [5] and Furterer [11]. None of these frameworks specifically addressed Lean Six Sigma implementation in SMEs but were of use in guiding the research.

Diffusion of innovation theory

The work on diffusion of innovations by Rogers [20] was used as the theoretical framework for the research. Roger’s work on diffusion of innovations has been refined over many years and its application extended from focusing on adoption of new ideas by individuals to adoption of new ideas by organisations. Consideration of the culture, at national, local, industry and individual levels, into which an innovation is introduced is a strong aspect of the theory. Rogers [20] argues that to enable successful adoption, innovations that are being transferred from one cultural setting to a different cultural setting should be suitably modified to fit in with the new setting. To support further discussion, Roger’s core ideas on diffusion of innovation are now explained. Broadly speaking Rogers identifies two sets of variables related to the adoption and diffusion of innovations. The first set of variables relate to organisational innovativeness i.e. how receptive an individual organisation is towards the adoption of an innovation. The second set of variables relate to the rate of adoption of an innovation in a particular industry and cultural setting. It is evident that there is some linkage between the two sets of variables; they are not completely mutually exclusive.

The organisational innovativeness variables include the following:

a) Characteristics of the leader(s) in the organisation, especially their attitudes towards supporting new ideas in the organisation.
b) Characteristics related to the internal organisation structure: – *centralisation* according to Rogers [20, p.412] is ‘…the degree to which power and control in a system are concentrated in the hands of a relatively few individuals’ – *complexity* is ‘…the degree to which an organisations’ members possess a relatively high knowledge and expertise…’ – *formalisation* is ‘…the degree to which an organisation emphasises following the rules and procedures in the role performance of its members’ – *interconnectedness* is ‘…the degree to which the units in a social system are linked by interpersonal networks’ and *organisational slack* is ‘…the degree to which uncommitted resources are available to an organisation’.
c) Lastly, *systems openness* which is an external characteristic of the organisation ‘…the degree to which the members of a system are linked to other individuals who are external to the system’.

According to Rogers [20] there are five main constructs that combine to determine the adoption success innovations:

1. Perceived attributes of the innovation consisting of areas: relative advantage, compatibility, complexity, trialability and observability.

   Relative advantage is ‘the degree to which an innovation is perceived as better than the idea it supersedes’ [20, p.229]. Compatibility focuses on how compatible an innovation is with social and cultural values and beliefs, previously introduced ideas or client needs for the innovation. Complexity is ‘the degree to which an innovation is perceived as difficult to understand and use’ [20, p.257]. Trialability is ‘the degree to which an innovation may be experimented with on a limited basis’ [20, p.258]. Observability is ‘the degree to which the results of an innovation are visible to others’ [20, p.258]. Generally innovation have promising characteristic for diffusion when they are perceived as better than existing methods, are compatible with cultural values and beliefs in their intended setting, are not over complex, can be trial easily and where results can be made visible for scrutiny.

2. Type of innovation decisions; three types are identified by Rogers [20] namely individual-optional, collective and authority.

   The point here is that it is important to understand who makes decisions related to the adoption of an innovation and the authority that these decision makers have in actioning their decisions. Individuals, or groups in an organisation may be the key decision makers or support for an innovation may occur at government level through for example an industry support structure.

3. Communication channels; the ways in which the message about the innovation is disseminated. There are a number of options depending available for different situations e.g. word of mouth, mass media, industry forums, demonstration plants. The more effective the communication channels the more likely the innovation will diffuse through an industry.

4. Nature of the social system e.g. its norms, degree of network interconnectedness. Generally, the better an innovation fits into the cultural setting the more likely it is to succeed.

5. Extent of change agents' promotional efforts.
   A change agent is 'an individual who influences clients' innovation decision in a direction deemed desirable by a change agency' [20, p.27]. As well as the selection of appropriate communication channels to publicise an innovation the change agents' promotional efforts are important because attitudes and behaviours of change agents (e.g. industry associations, government agencies) towards change usually depends on a real commitment to promoting an innovation.

III. METHODS

The target population for the research was SMEs from the metal sector in Pasuruan and Sidoarjo areas in the Province of East Java, Indonesia. The metal sector was chosen as it is composed almost entirely of SMEs and contributes significantly to the Indonesian economy. The sector is also well organised making access to data collection attractive for this kind of research being undertaken. The questionnaire was designed to be completed by the SME owner or a senior manager.

A total of 148 usable questionnaires were eventually obtained representing approximately 21% of SMEs in the target industry sectors and geographical areas. The questionnaire data was analysed using the SPSS statistical package.

Semi structured interviews were carried out with representatives from Government and non Government organisations involved with SMEs in the metal sector to gain their views on the research project.

The following section discusses the key result from questionnaire survey and interviews.

IV. KEY RESULTS

The following are key results from the data collection that were used in the development of the implementation framework.

1. Low level of IT usage among the SMEs surveyed.

   The low level of IT usage in Indonesian SMEs indicates the suitability of non-online training for Lean Six Sigma. This is further supported by the preference for face-to-face instruction expressed by SME owners/managers.

2. Low level of understanding and implementation of the improvement tools and techniques.

   Training should be focused initially on addressing these deficiencies.

3. SMEs are particularly influenced in their decision regarding innovation by other SMEs already using the technology.

   SMEs in Indonesia, particularly those located in industrial centres, were influenced by other SMEs in their innovation adoption. Based on this fact, there is a need to diffuse Lean Six Sigma through several SMEs that are leading in industrial centres. Some readiness factors have already used as factors for grouping the involved SMEs in the questionnaire survey of this research. These groups can be used as pilots to introduce Lean Six Sigma into SMEs in industrial centres.

4. The need for Government support in innovation adoption.

   Based on the results discussion, SMEs in Indonesia depend on the support provided by Government in their innovation adoption. The support most needed by SMEs is provision of a resource centre when Lean Six Sigma is diffused. The resource centre should be located in industrial centres and act as a consultant for SMEs.

   In addition to these key points, Rogers [20] believed that the *trialability* of innovation could increase the rate of innovation adoption. Based on Rogers' perspective, the framework should incorporate opportunities to trial Lean Six Sigma to solve the SMEs' problems.

V. FRAMEWORK AND DISCUSSION

ISBN : 978-602-97809-0-1

There are two important issues to present in this section, which are key elements of the framework, including the operational guidelines. The key elements of the framework are owner/manager commitment and involvement, training, employee involvement, culture change and external support.

Key elements of the framework

After discussing results from the surveys and interviews as well as studying the literature on Lean Six Sigma and diffusion of innovations theory, it is concluded that there are five key elements for implementing Lean Six Sigma in SMEs. The elements are owner/manager commitment and involvement, training, employee involvement, culture change and external support, as presented in Fig. 1.

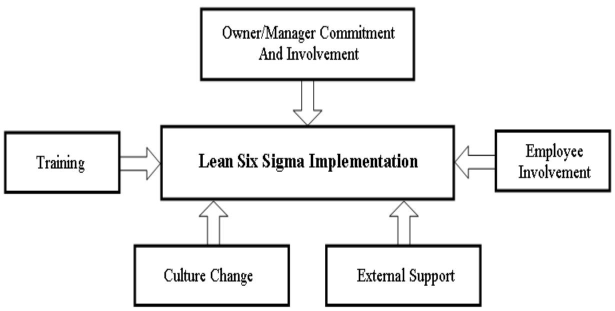

Fig. 1 Framework for Lean Six Sigma Implementation in SMEs

Some of the elements assembled in the framework above have also been used by others. Antony, Kumar and Madu [1], Coronado and Antony [7], Park [18], Schon [21] and Yusof [28] have used these elements in their TQM and Six Sigma studies. Management commitment towards innovation also features as a key factor in diffusion of innovation studies conducted by Bradford and Florin [4] and Rogers [20]. This research has shown that it is essential that external support should be a component of an effective implementation model.

As stated in many TQM or other quality improvement programs and innovation studies, management commitment to, and involvement in, the implemented program is crucial. The literature on SMEs emphasises the importance of the role of owners in organisation development. The justification of choosing this element is that the role model in SMEs is on the owner or management level, particularly in Indonesia. For instance, if the organisation adopts innovation, the entire organisation will commit as their leader does. In other words, owner/manager commitment towards innovation will influence their employees' commitment to the adopted innovation.

Table I is based on the research findings and presents a list of items that should be considered by the owner or manager of SMEs. These items show activities that should be employed by an owner/manager as their commitment to and involvement in Lean Six Sigma. The activities are divided into pre-implementation and implementation stages.

However, the items listed above are not activities that absolutely have to be done by the owner or management of SMEs. The activities can be modified according to the level of readiness of adopters. For instance, implementing 5S as a foundation to implement Lean Six Sigma can be omitted if the organisation is sufficiently advanced e.g., already practising 5S.

Training

The research shows that training is a very important component to help employees in the organisation understand the requirements for adopting innovation. In Lean Six Sigma organisation, training normally involves sending a number of people at the management level, and employees, to attend Lean Six Sigma training. The Lean Six Sigma training is quite similar to Six Sigma training which uses a belts system i.e., green belt, black belt.

TABLE I
MANAGEMENT COMMITMENT AND INVOLVEMENT AT PRE-IMPLEMENTATION AND IMPLEMENTATION STAGES OF LEAN SIX SIGMA

Items	Stage
Allow Government or other parties to evaluate the organisation	Pre-implementation
Attend Lean Six Sigma training	Implementation
Communicate Lean Six Sigma to entire organisation as new strategy to compete i.e., direct communication through meeting, poster, etc.	Implementation
Giving support for training i.e., time	Implementation
Financial support if Government only covers half training fees	Implementation
Implementing 5S as a foundation to implement Lean Six Sigma	Implementation
Give rewards to critical problem solving	Implementation
Actively involve in all problem solving activities	Implementation
Actively involve in seminars, workshops, etc. to build knowledge particularly in relation to Lean Six Sigma and innovation	Implementation

Owner/manager Commitment and Involvement

In Indonesia, training is an important component when a Government or non-Government agency introduces new technology to SMEs. Thus, training is also needed to introduce Lean Six Sigma in SMEs. This is because the majority of SMEs perceive Lean Six Sigma as a new approach, even though past training conducted by the Indonesian Government and JICA have introduced some improvement tools and techniques used in Lean Six Sigma. Basically, training should contain the *what* of Lean Six Sigma (the fundamental concept of Lean Six Sigma) and *how to* implement Lean Six Sigma (DMAIC methodology and tools/techniques).

Table II suggests the focus of training, type of trainer and the stage of the implementation process at which training should be given to SMEs. Most of the suggestions are based on Green Belt and Black Belt training in Lean Six Sigma. However, they are modified according to the real conditions of Indonesian SMEs, such as a special training focus on 5S. From the survey results and also a field trip to SMEs, it was found that the majority of SMEs are not implementing 5S techniques. It is believed that establishing 5S as a foundation of Lean Six Sigma will help organisations to detect any problems more easily and faster. The need for implementing 5S has also been acknowledged by Wheat, Mills and Carnell [29] as an important aspect for implementing Six Sigma and Lean Enterprise.

Employee Involvement

The main involvement of employees in Lean Six Sigma implementation is in the infrastructure of Lean Six Sigma itself. Integration between the owner or management and employees is formed in a team that normally works together to solve problems in their organisation. The infrastructure itself is not permanent. It means that the number of people in a group is dependent on the complexity of the problem.

context, the terms used in Lean Six Sigma should be changed. For instance terminology, such as 'project team' may be more suitable than 'Lean Six Sigma infrastructure'. It is believed that the replacement of this term does not conflict with the Lean Six Sigma concept, and it would serve to make Indonesian SMEs feel more comfortable with the terms they use. The use of a particular term can significantly influence the willingness of an Indonesian SME to implement or reject innovation.

TABLE III
EMPLOYEE INVOLVEMENT ACTIVITIES

Activities	Stage
Attend and participate actively in Lean Six Sigma training	Implementation
Be involved in 5S implementation as a foundation to Lean Six Sigma implementation	Implementation
Be actively involved in problem solving activities in his/her project team	Implementation
Be responsible to his/her process e.g., data record	Implementation

Culture Change

Organisations that implement Lean Six Sigma need to use the improvement tools and techniques that are part of DMAIC methodology. Every step in DMAIC involves tools or techniques, from basic to advanced, to solve a problem. Based on the problem solving concept in Lean Six Sigma and the current condition of SMEs in Indonesia, there are activities which should be used in the implementation stage of Lean Six Sigma as presented in Table IV.

TABLE II
TRAINING DESIGN ON LEAN SIX SIGMA FOR SMES

Trainee	Focus	Trainer	Stage
Owner or manager level	Lean Six Sigma which explains basic understanding of Lean Six Sigma includes benefits of this approach, key elements to implement Lean Six Sigma	Academic or independent consultant	Pre-implementation
	5S as foundation of Lean Six Sigma implementation	Academic or independent consultant	Implementation
	- Improvement tools and techniques includes DMAIC methodology - Real simple case study in the sample organisation that solve using DMAIC	Independent consultant or people from industry who implement Lean Six Sigma	Implementation
Employees	Lean Six Sigma which explains basic understanding of Lean Six Sigma includes benefits of this approach, key elements to implement Lean Six Sigma	Academic, independent consultant	Pre-implementation
	- Improvement tools and techniques includes DMAIC methodology	Independent consultant or people from industry who	Implementation

A crucial aspect arising from this research which should be kept in mind is that it is important to keep the approach simple. Apart from training modification to suit the Indonesian

One of the elements that assures the success of innovation, particularly Lean Six Sigma, is having an appropriate culture. In the context of Lean Six Sigma, culture focuses on the use of data and problem solving ability based on data analysis.

ISBN : 978-602-97809-0-1

The need for this culture change is based on the low use of data by Indonesian SMEs to solve their operational problems. The research largely found that SMEs tend to solve problems based on their experience or gut feelings.

TABLE IV
CULTURE CHANGE IN SMES AT THE IMPLEMENTATION STAGE OF LEAN SIX SIGMA

Activities	Stage
Implementing 5S	Implementation
Data record of every processes in organisation	Implementation
Follow DMAIC cycle to solve problems	Implementation

External Support

External support is a very important element in helping SMEs in their innovation. This research has shown that external support is also important for Indonesian SMEs. The support can vary from training to assistance provided by Government and non-Government agencies to support in implementation of Lean Six Sigma. This research also shows that other SMEs, particularly the more advanced ones and key customers can provide appropriate support to SMEs that are interested in adopting an innovation.

In order to make the support valuable for SMEs, there are several activities that should be used during the pre-implementation and implementation stages of Lean Six Sigma, as listed in Table V.

TABLE V
EXTERNAL SUPPORT TO IMPLEMENT LEAN SIX SIGMA

Activities	Stage
SME's owner/manager should be open to the evaluation of organisational weaknesses conducted by assessors from Government or non-Government agencies	Pre-implementation
SME's owner/manager should be open to becoming a leader in innovation by actively participating in all supports conducted by external parties such as Government and university.	Pre-implementation and implementation

The evaluation of SME weaknesses is aimed at helping the design of future support for SMEs. SMEs should be open to this evaluation and not avoid sharing information with the assessor. Also, the openness of SMEs to the support provided such as training and assistance of Lean Six Sigma by external parties will help them successfully implement Lean Six Sigma.

VI. CONCLUSIONS

The paper has presented the elements of a Lean Six Sigma framework for Indonesian SMEs. The elements are owner/manager commitment and involvement, training, employee involvement, culture change and external support. In particular this research identified the importance of the framework element 'external support' which had not been emphasised in implementation frameworks revealed in our literature review. This support can take various forms from training to assistance provided by Government and non-Government agencies to support in implementation of Lean Six Sigma. In particular, the finding show that SMEs owners and managers particularly value the opportunity to learn from other SMEs, often the more progressive ones, which take a lead in implementing new ideas in their organisations. Support from key customers for the implementation of new technology was also shown to be important to SME owners and managers.

We believe that the framework presented here will provide useful guidance to SMEs and others stakeholders involved in the implementation of Lean Six Sigma into Indonesian SMEs. Furthermore, the general nature nature of the frameworks should enable it to be used for the implementation into SMEs of a wide range of other technologies besides Lean Six Sigma.

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

Effects of Brand Equity on Customer Satisfaction and Brand Choice on Mobile Phone

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***Abstract* – The purpose of this study was to measure brand equity attached to customer satisfaction and brand choice by using a LISREL model to test the structural effects of an intervening variable (customer satisfaction) on a number of latent variables (brand loyalty, brand awareness, perceived quality, and brand association) to endogenous variables (brand choice). Structural equation modelling was used on survey data from 155 consumers to test the model and corresponding hypotheses. The results support the conceptualization of brand equity as composite of customer's satisfaction and brand choice as well as the hypotheses proposed in our research model.**

Keywords – **Brand equity, Customer satisfaction, Brand Choice, SEM.**

I. Introduction

Consumers vary in life experiences, traditions, education, work, hobbies that form preferences of the consumer's perspective to the product. Despite of these differences, they also have similarity in preference. The similarity of a group of customers forms consumer segmentation. Marketers need to know the characteristics of the targeted segments to meet the needs of consumers in these segments. Marketers investigating these factors may therefore gain valuable insights into the creation and retaining of brand loyalty among customers. Firms with large groups of loyal consumers have been shown to have large market share, which in turn, has been shown to be associated with higher rates of return on investment [1].

On the consumer side, the selection of products to be purchased is a separate issue. This is due to the many products offered in the same type, with or without a brand. When confronted with non branded products, consumers will have difficulty to choose, learn about and repurchase the same product even though he was satisfied with the product. This makes branding an important issue for the manufacturer as it makes it easier for consumers to recognize or identify if they need the same product in later occasions. In addition, the brand also gives assurance to consumers to get satisfaction each time they use that brand.

The rapid flow of information has lead to cellular phones (hand phones, or HP) becoming primary communication tools. From the manufacturers' perspective, HP is a product that has a number of product variations, high demands and high level of responsiveness. The high demand and responsiveness forced the manufacturers to continue products improvement so that consumers decide to buy the product.

Every brand must have attributes. These attributes are created and managed so that consumers can know exactly what is contained within a brand. In addition to the attributes, the brand also has a series of benefits. The manufacturers must be able to translate the attributes into benefits that can be directly felt by consumers because they do not only buy attributes, but also the benefits. According to Lancaster, consumers will select a particular brand if they perceive the great benefits of a brand [2]. For marketers, consumer satisfaction is one of the primary goals to strive for. Without satisfaction, brand equity - important for continuity reasons - is unlikely. Consumer satisfaction provides cues as the quality of marketing decisions [3].

Satisfaction is the result of the experience of the product, something a consumer feels after comparing the expectation to with the actual performance of the product (actual product performance) [4]. Consumers who are dissatisfied will be able to perform such an act of complaining, halt to the purchase, warning friends and taking legal actions. As Kapoor [5] put it, a consumer is buying and trying a brand; if the brand gives satisfaction then he will return to buy or even to be loyal.

II. LITERATURE REVIEW

Praktikno [6] conducted a study about brand choice involving five variables: associations with the brand, customer satisfaction, attribute preferences, preferences and selection attitude toward the brand. The main purpose of this study was to compare two objects of research between KFC (Kentucky Fried Chicken) and McD (Mc Donald).

Purnawati [7] involved five different variables in her research, ie. a tribute benefit, brand image, brand preference, and selection of brand promotion activities. The object of her research was decisions to prescribe drugs by doctors.

Another study, conducted by Ching-Fu Chen and Yu-Ying Chang [8], examined the relationships between brand equity, brand preference, and purchase intentions on international air passengers' decisions in Taiwan. The findings indicate positive relationships between brand equity, brand preference, and purchase intentions with a moderation effect of switching cost affecting the relationship between brand equity and purchase intentions. More specifically, the effect of brand equity on purchase intentions is not significant for passengers with low switching costs.

III. THEORITICAL FRAMEWORK

Brand is a name, term, sign, symbol, design, or a combination of everything that is expected to identify goods or services of one seller or group of sellers and is expected to distinguish the goods or services from a competitor's products [9]. It takes a long time to build a successful brand. On the hand, if the company does not "care", one moment in a time is enough to destroy the brand [5]. Ries [10] states that marketing is branding; marketing is how we build the brand in consumers' minds. If we are able to build a strong brand, then we will have a strong marketing program as well. If not then any effort we do not will be able to achieve our marketing objectives.

A. Brand Equity

Brand Equity is a set of brand assets and liabilities associated with a brand, name, symbol that can increase or decrease the value given by a product or service at both companies and the customers [11]. Some of the elements that build brand equity are [11]:

- Brand loyalty is composed of several variables: Committed Buyer, Liking the Brand, satisfied Buyer, Habitual Buyer, and Switcher.
- Brand awareness is composed of several variables: Top of Mind, brand recall, brand recognition and Unaware of brand.
- Perceived quality is composed of several variables: Performance, Service, Security, Reliability, Product Characteristics, Compliance with specifications, and results.
- Brand association. Associations related to a brand is generally associated with the following things: product attributes, intangible attributes, benefits for customers, Prices, Usage, Users/customers, Celebrity/famous people, Life Style, and the Product class.

B. Customer Satisfaction

Satisfaction is the result of the experience of the product, consumer feelings after comparing the expectation to the actual performance of the product (actual product performance) [4]. In general, satisfaction is happy or unhappy feelings resulting from comparing product performance (outcome) to the consumer's own expectations [12]. Five driving forces in customer satisfaction [13]:

1) Product Quality: According to Garvin, there are eight dimensions of quality of products, namely: Performance, Features, reliability, conformance, durability, Service ability, Aesthetics, and Perceived Quality.

2) *Service Quality:* Parasuraman, and Berry Zeithml [14] develop dimensions of service quality (SERVQUAL) as follows: Tangibles, Reliability, Responsiveness, Assurance, and Empathy

3) Emotional Factors

4) Price

5) Price of Accruing

In addition, there are several other factors that influence consumer satisfaction. These factors include: demographics, product performance, brand image, price and value, employee performance, the advantages and weaknesses of competing factors, the information received by consumers, perception of manufacturer responsibility, consumer value, and consumer lifestyles [15].

C. Brand Choice

Brand choice is a process to determine which brands are selected from an existing category of purchase (Bucklin and Gupta, 1992 in [3]). Chandrashekaran in Purnamawati [3] states that the brand choice of a brand is going through a pattern where someone would form an idea or a belief in some alternative, construct a preference, then based on the preferences of consumers will be able to determine the selection of a brand.

Kotler [12] asserts that the character will determine the buyer's purchase decision process and ultimately make the decision to buy. The process of customer purchase involves five stages, i.e. the introduction of the problem, information search, alternative evaluation, purchase decision and service after purchase. Consumers form their purchase habit or interest to repurchase (preferences) in the evaluation stage.

According to Hawkins, Best and Coney in Simamora [4], based on factors to consider, decisions can be basically divided into: decision making based on the attributes (attribute-based choice) and decisions taken based on the attitude (attitude-based choice). The decision to choose is important for the action to buy or not to do it among the many available alternative brands. Engel, Blackwell and Miniard [16] explains that the consumer decision-making is influenced and shaped by various factors. The factors can be divided into three categories: (1) individual differences, (2) environmental influences, and (3) psychological factors.

IV. METHODS

The proposed model (see Figure1) was constructed from three main groups:

- The independent variables are brand loyalty, brand awareness, brand association and perceived quality.
- The intervening variable is customer satisfaction.
- The dependent variable is the selection of the brand.

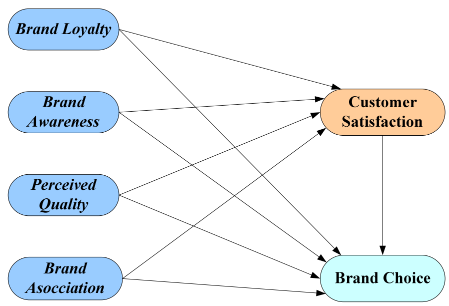

Fig. 1 Research Model

Research Hypothesis

Hypothesis 1: Brand Equity significantly affects customer satisfaction.

- $H_0 : \rho_1 = 0$ Brand Equity does not significantly affect the customer satisfaction.
- $H_1 : \rho_1 \neq 0$ Brand Equity significantly affects customer satisfaction

Hypothesis 2: Brand Equity significantly affects brand choice.

- $H_0 : \rho_1 = 0$ Brand Equity does not significantly affect the brand choice.
- $H_1 : \rho_1 \neq 0$ Brand Equity significantly affects brand choice

Hypothesis 3: Customer satisfaction significantly affects brand choice.

- $H_0 : \rho_1 = 0$ Customer satisfaction does not significantly affect the brand choice.
- $H_1 : \rho_1 \neq 0$ Customer satisfaction significantly affect the brand choice

The data used in this study were perceptive data from mobile users as respondents. Data were collected by distributing questionnaires to a number of respondents to obtain primary data which was subsequently processed statistically to obtain the results of the analysis. Data collected from questionnaires subsequently processed by using the technique of Structural Equation Modelling (SEM) which is one of multivariate analysis techniques. According to Hair [17], SEM is a multivariate technique that combines aspects of multiple regression and factor analysis, to estimate a series of relations simultaneously. According Solimun [18], SEM is the technique of integrated analysis of the confirmatory factor analysis, path analysis and structural model.

A tool used in this analysis is software called LISREL. The LISREL program was to analyse the relationship between dependent and independent variables, including the existence of the effect of the variable. The relationship between the dependent variable and independent variables seen from correlation coefficients or weighting factors on the results of LISREL processing.

Fit indices included in the current investigation are the comparative fit index (CFI), the LISREL goodness-of-fit index (GFI), Adjusted Goodness of Fit Index (AGFI), the root mean square error of Approximation (RMSEA), Incremental Fit Index (IFI), Comparative Fit Index (CFI)[19].

V. RESULT AND ANALYSES

Results of the model fit are shown in table 1 and 2. The output was examined for common anomalies such as negative error variances, extremely large parameter estimates, etc. No such anomalies were identified.

Table 1. Detail of LISREL goodness of fit measures

Var	Chi Square	df	P-Value	RMR	RMSEA	GFI	AGFI	CFI	IFI
BL	30.06	18	0.06	0.05	0.06	0.96	0.91	0.95	0.95
BAS	6.18	7	0.52	0.03	0.09	0.99	0.96	1.00	1.00
BAW	0	0	1.0	-	-	-	-	-	-
PQ	38.06	14	0.00	0.04	0.09	0.94	0.88	0.94	0.94
CS	13.62	14	0.5	0.02	0,07	0.98	0.95	1.00	1.00
BC	0	0	1.0	-	-	-	-	-	-

Based on the overall goodness of fit statistics, the four models for brand equity yielded satisfactory fit statistics (Brand Loyalty (X^2=30.06, df=18, P-value=0.06, RMR= 0.05, RMSEA=0.06, GFI=0.96, AGFI=0.91, CFI=0.95,IFI=0.95) Brand Awareness (X^2=0, df=0, P-value=1.0), Brand Association (X^2=6.18, df=7, P-value=0.52, RMR= 0.03, RMSEA=0.09, GFI=0.96, AGFI=0.96, CFI=1.0,IFI=1.0), Perceived Quality (X^2=38.06, df=14, P-value=0.00, RMR= 0.04, RMSEA=0.09, GFI=0.94, AGFI=0.88, CFI=0.94, IFI=0.94) indicating that the reproduced correlation nearly equals the observed correlations in the models.

Similarly, the model for customer satisfaction and brand choice yielded satisfactory fit statistics (Customer Satisfaction (X^2=13.62, df=14, P-value=0.5, RMR= 0.02, RMSEA=0.07, GFI=0.98, AGFI=0.95, CFI=1.0,IFI=1.0) Brand Choice (X^2=0, df=0, P-value=1.0), indicating that the reproduced correlation nearly equals the observed correlations in the models

Table 2. LISREL goodness of fit measure

Indicators	Value
Chi Square	1381.62
Df	602
P- Value (>=0.05)	0.0
RMR (< 0. 05)	0.19
RMSEA (<= 0.80)	0.092
GFI (>=0.90)	0.67
AGFI (>=0.90)	0.62
CFI (>=0.95)	0.72
IFI (>=0.95)	0.72

Based on the overall goodness of fit statistics, the structural models for customer satisfaction and brand choice yielded satisfactory fit statistics (i.e X^2=1381, df=602, RMSEA=0.092, RMR=0.19), indicating that the reproduced correlation nearly equals the observed correlations in the model.

The relationships between variables are indicated by the regression coefficients between these variables. This is related to the research objectives to be achieved through the formation of structural models (SEM). The effect values between latent variables, endogenous variables and exogenous variables can be seen in the following table:

Table 3. Detail of influence value

Latent Variable	Customer Satisfaction	Brand Choice
Brand Loyalty	0.34	0.14
Brand Awareness	0.28	0.12
Perceived Quality	1.38	0.30
Brand Association	-0.16	0.30

The influence values between customer satisfaction and brand choice is 0.66.

Significance test is needed to determine which independent variables have a significant impact on the level of the dependent variable. Significance test was conducted using t-test using LISREL. Confidence level (α) used for tests of significance in this study was 5% or the value of t-values ≤ 1.96. The results of t-value for complete structural model are as follows:

Table 4. The result of t-value for structural model

Endogenous variables	Exogenous variables	t-values	Information
BL	CS	3.73	Significant
BL	BC	2.10	Significant
BAS	CS	4.93	Significant
BAS	BC	2.97	Significant
PQ	CS	4.93	Significant
PQ	BC	3.22	Significant
BAW	CS	1.58	Not Significant
BAW	BC	1.14	Not Significant
BC	CS	3.73	Significant

Based on the overall result of t-value for structural model yielded that brand loyalty, brand association, perceived quality statistically significant at the 5 percent level.

The significance level between the independent variables (Brand Equity (Brand Loyalty, Brand Awareness, Perceived Quality, Brand Association) with dependent variables using F test (F table=2.21) is shown in table 4.

Table 5 The result of F test

Independent Variables	Dependent Variables	F values	Information
Brand Equity (Brand Loyalty, Brand Awareness, Perceived Quality, Brand Association)	Customer Satisfaction	99.8	Significant
Brand Equity (Brand Loyalty, Brand Awareness, Perceived Quality, Brand Association)	Brand Choice	6.545	Significant

Based on the analysis derived from the applications of LISREL to the hypothesized model, the following managerial implications can be drawn:

A. The effect of brand equity on customer satisfaction

- There are links between the two elements of brand equity, i.e. Brand Loyalty and Perceived Quality, and consumers' satisfaction. The two other elements that do not affect consumers’ satisfaction are Brand Awareness and Brand Association

- Based on the effect values, the performance of perceived quality, service, performance, reliability, product characteristics, and suitability of the product specifications, has the largest value in determining consumer satisfaction. On the other hand, committed buyer, linking the brand, spokesman buyer, habitual buyer, and the switcher has a low influence in determining consumer satisfaction.

- To improve customer satisfaction, mobile phone manufacturers can pay more attention to the implementation of elements of Perceived Quality. Although two of the four other elements of brand equity (Brand Awareness and Brand Association) do not significantly influence customer satisfaction, but the improvement and development especially on the two elements simultaneously with the other components are expected to have a significant influence on customer satisfaction.

B. The effect of brand equity on brand choice

- There are links between the two elements of brand equity to brand choice. The two elements are Brand Association and the Perceived Quality. The two other elements that do not affect brand choice are Brand Awareness and Brand Loyalty.
- Perceived Quality of performance, service, durability, reliability, product characteristics, and compliance with product specifications and brand association, intangibles product factor, the benefits for customers, relative prices, user, celebrity, life style, and product class have the same effects in determining customer satisfaction.
- To increase the value of brand choice, mobile phone manufacturers can pay more attention to the implementation of the two elements of brand equity

(Perceived Quality and Brand Association). Although two of the four elements of Brand equity (Brand Awareness and Brand Loyalty) do not significantly affect brand choice, the improvement and development especially on the two elements simultaneously with the other components are expected to have a significant influence on customer satisfaction hand phone.

C. The effect of customer satisfaction on brand choice

Consumer satisfaction on mobile products significantly contributed to the choice of the brand by consumers. The higher the satisfactions level of consumers, the higher the probability of choosing the brand.

VI. CONCLUSION

In this paper the influenced of brand equity on customer satisfaction and brand choice on mobile phone were studied. The results have implications manufactures, especially with respect to marketing frequently purchased consumer goods. The results show that brand equity products significantly influenced customer satisfaction and brand choice. Thus, it is possible for manufacturer to increase consumer's satisfaction and brand choice level by building positive brand equity towards their products.

The following research directions may be worthy of investigation in the future. The work can be extended by replicate this study and repeat this model testing approach using a completely new sample. More latent variables could be incorporated into the model; further work could expand the analysis on environmental and psychological factor.

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ISBN : 978-602-97809-0-1

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Analysis And Design Of Accounting Information Systems Revenue Cycle And Inventory At PT. XYZ

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Abstract **- PT. XYZ is trading company engaged in equipment distributor - electrical appliance brand of Philips, who is in need of Accounting Information Systems to develop a system that is currently running the manual to computerize. The research methodology used is the method of analysis and Object Orientation-Based System Design (OOAD). Methods of data collection conducted a survey on the running system as well as interviews also based on the theory that supports, obtained from a book associated with the analysis and system design. The design method is carried out by designing the proposed system.**
The conclusion the Accounting Information Systems Sales, Cash Receipts and Inventory to help PT. XYZ in its operation. Conclusions from the research that has been done is the application of this information system can help minimize the occurrence of the transaction data recording errors by employees, because if there is an error - error in data recording the transaction, the employee concerned must give reasons for the error that occurred. In the event that minimizes the errors that occurred due to improper recording of data transactions by employees, it is intended that each employee can be more focused in its activities and more responsible for all actions taken.

Keywords *- Accounting Information Systems, Sales, Cash Receipts, Purchases, Cash Expenditure*

I. INTRODUCTION

In the economic development of post-financial crisis which occurred in late 2008 until mid-year 2009, the competition in the electronics business more difficult. To face competition in the electronics business support is required in the form of procedures, human resources, technological support, and information to assist company management in making decisions.

PT. XYZ is a company engaged in the sale and installation of electrical appliances. Currently, PT. XYZ has a few problems in the revenue cycle and supply, as for some of the problems facing the company is unable to meet a few times or send the order received late due to the unavailability of goods in the warehouse, the company owner did not obtain information on the amount of gross sales updates per month, and sometimes Double billing occurs on the customer. Seeing the problems faced by PT. XYZ, the management of PT. XYZ requires an information system to support sales and cash receipts process.

Therefore, the author seeks to analyse and design information system that can help the management to solve problems encountered in the process of sales and cash receipts.

The scope of the discussion of this research is the process of sales, cash receipts and inventories of finished goods at PT. XYZ. Specifically, this research will be limited to the following process:

Specifically, this research will be limited to the formulation of the problem as follows:

1. Sales and cash receipts
   a. Recording orders made by customers.
   b. Delivery of goods to customer orders.
   c. Billing for orders that have been sent to the customer.
   d. Cash receipts from the charges made to customers.
2. Sales Returns.
   a. Make a note of returns of goods.
   b. Create a travel permit goods sales returns.
   c. Create a debit memo.
   d. Not discuss the delisting of receivables, the recognition of liabilities for claims from suppliers of stock defects.
3. Calculation of Cost of Goods Sold.
4. Not discuss the VAT (Value Added Tax).

The objectives that can be obtained are as follows:

1. Analyse accounting information systems sales, cash receipts, and inventory at PT. XYZ.
2. Designing accounting information systems sales, cash receipts, and inventory at PT. XYZ in accordance with the information needs to support corporate activities.
3. Providing solutions to the problems that arise in the PT. XYZ.

The benefits that can be obtained are as follows:

1. Defining the problems that arise in business processes of PT. XYZ.
2. Help resolve problems that arise in business processes of PT. XYZ.
3. Help improve the performance of PT. XYZ in the process of sales and cash receipts.

ISBN : 978-602-97809-0-1

II. LITERATURE REVIEW

According to Jones and Rama (2006, p5), Accounting Information Systems is part of the Management Information System (MIS) which provides information on accounting and finance, such other information obtained from the process of routine accounting transactions.

According to Wilkinson (2000, p), the main objective of the revenue cycle is to facilitate the exchange of goods and services with a certain amount of money with the customer. Here is the target of general revenue cycle:

1. To record customer orders quickly and accurately.
2. To verify that the customer deserves the credit.
3. To deliver the product on the agreed date.
4. To perform billing for products or services in a timely manner and with correct procedures.
5. To record and classify cash receipts promptly and appropriately.
6. To post sales and cash receipts into the appropriate customer accounts in a special journal sales and cash receipts.
7. To secure the product to be sent.
8. To secure the cash until paid.

According to Mathiassen et al. (2000, p4) "Object is an entity with identity, state (level of living) and behavior." The object is fundamental in the OOAD, each object is described in a clustered because there are some objects that have similar properties or functions known as classes. "Class is a description of each collection of objects that use the structures, patterns of behavior and attributes together."

According to Mathiassen et al. (2000, P15), the method of object-oriented analysis and design has four main activities are described as follows:

1. System definition.
   According to Mathiassen et al. (2000, p24), the system definition is a description of a computerized system described in everyday language.
2. Rich picture.
   According to Mathiassen et al. (2000, p26), Rich Picture is a picture that represents the informal understanding of the situation from the maker.
3. Factor.
   According to Mathiassen et al. (2000, p39), FACTOR is
   - Functionality: The function that supports the tasks of the application domain.
   - Application Domain: The part of the organizations that administer, oversee or control of a domain problem.
   - Condition: A condition in which the system will be developed and used.
   - Technology: The technology used to develop systems and technology systems that will be executed.
   - Object: The main object of the problem domain.
   - Responsibility: System overall responsibility in relation to the context
4. Problem domain analysis.
5. According to Mathiassen et al (2000, Q6), Problem Domain is part of the context of managed, monitored, or controlled by the system. The purpose of the analysis domain is to identify problems and create a model of the problem domain, the activity in the problem domain. Modelling consists of classes, structure and behavior.

According to Mathiassen et al. (2000, Q6), domain name application is an organization to manage, supervise or control a problem domain. Activities in the analysis domain consist of an application usage (utility), function (function), and interfaces (views). Architectural Design is designing the architecture of a machine. The purpose of the architectural design is to develop n a computerized system. Results from the architectural design is the arrangement for a component system and process, within the architectural design, there are several activities consist of the criteria, components, and process.

III. DISCUSSION

Business process system that runs at PT. XYZ is as follows:

Customers come first, and until the customer ordering the goods sales will check the status of first customer in the customer data. If the customer is not active, customers must register first. If the active customer, sales will check customer accounts receivable in advance based on customer data. If the customer limit exhausted, the customer must pay the first payment, if there is a limit sales to direct sales order processing. In sales order processing, sales will check the stock of goods to the warehouse based on the data items. If the existing stock, the sales will directly process the sales order. If there is no stock sales to customers will confirm that the stock is less, and sales will make the sales order into three copies, one will be archived by the Head of duplicate sales, by customer and will be archived by the Head of the Warehouse.

After sales create sales order, sales order sales will give to the Head of Sales for the check list of subscribers, the list receivable due and be authorized in advance. After getting sales order Head of Warehouse, Warehouse Division will make two copies of the warrant of work, which will be archived copies of it and one of them will be given to the warehouse. After the warehouse receives a warrant of work, Part Warehouse will check the inventory of goods according to the data. If goods are not sufficient, Part Warehouse will be confirmed to the Head of Warehouse, and if the goods are part of the warehouse will provide the goods according to the warrant of work, and preparing the delivery of goods and labour will be filing a second warrant. After the warehouse to prepare articles, the Head of Sales will create an invoice and will authorize it; the invoice was made into three copies. The first copies will be archived and will submit copies of invoices both go to the Warehouse. After creating an invoice and authorize it, the Head of Sales will make the travel permit to be given to the shipment and will be filing, the Head of Sales will also provide an invoice in triplicate, and the shipments will make a statement of delivery of goods and the delivery will send the goods to the customer.

Once a customer receives his order, the customer will receive a sales order and the third will receive the goods and invoice the third. After that Customer will check the goods according to the third invoice.

Head of Sales will check maturity bills according to customer data, customer If there is a maturity, the Head of Sales will be confirmed to be collected. Warehouse Division will make the letter a double bill, which one will be archived and second will be given to sales to confirm to the customer. Customers will receive a letter of double bills, and customers will pay according to the letter notes. Customers can also pay by cash and checks, after which customers will authorize the letter notes. Sales will be confirmed to the customer and ask for signatures from customers for proof of payment, the sales will create a duplicate receipt, one will be archived for himself and the second will be given to the Head of Accounting and Finance. After receiving the Proof of Payment of Sales, Head of Accounting and Finance will authorize and shall file the duplicate receipt.

As already described above, the revenue cycle process in PT. XYZ can be described as follows:

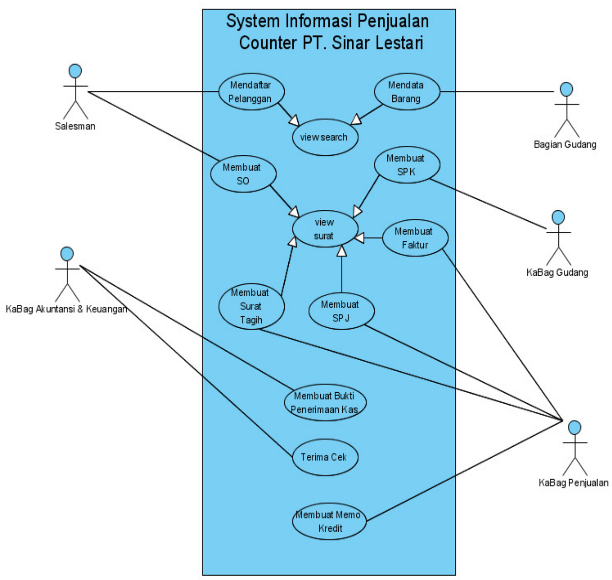

Figure 1. Sales and Cash Receipt Use Case Diagram.

For an explanation of the sales and cash receipt use case diagram above, can be seen in use case sales and cash receipt use case definition below:

1. Customer registration.
   Occurs when there are customers who want to make a reservation, the customer must first become a member, and filling in data, the sales will sign up customers. Involving object : customer, sales
2. Create sales order.
   Occurs when customers ordered items, sales would make sales order that contains the data items in a message by the customer will then be submitted to the head of sales.Create work order. Involving object : customer, sales, head of sales.
3. Create work order.
   Occurs at the time of receiving a sales order from the next head of warehouse sales made to the DSS warehouse for packing goods in accordance with SO. Involving object : sales, head of warehouse
4. Create invoice.
   Head of sales will create an invoice as a bill that will be included along with the warrant path to the customer. Involving object : customer, head of sales.
5. Create delivery order.
   Head of sales will make the delivery order as a letter that the delivered goods ordered in accordance with the sales order. Involving object : customer, head of sales.
6. Create invoice.
   Head of Sales makes sales invoices for orders due to customers. Involving object : head of sales.
7. Create cash receipt.
   Head of Accounting & Finance makes cash receipt to be inserted into the database. Involving object : Head of accounting and finance.
8. Receipt cheuque.
   Head of Accounting & Finance received the cheuque and enter data into the database. Involving object : Head of accounting and finance.
9. Create credit memo.
   Accounting & finance division received a report from the head of warehouse returns and credit memos will be made to cut off customer receivables based on invoices and delivery orders obtained from the customer returns. Involving object : head of accounting and finance, customer, head of warehouse.

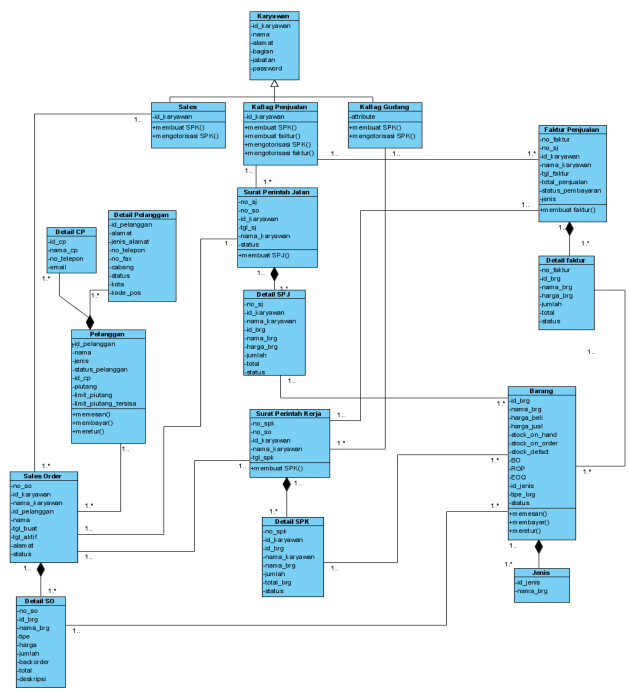

Figure 2. Sales Class Diagram.

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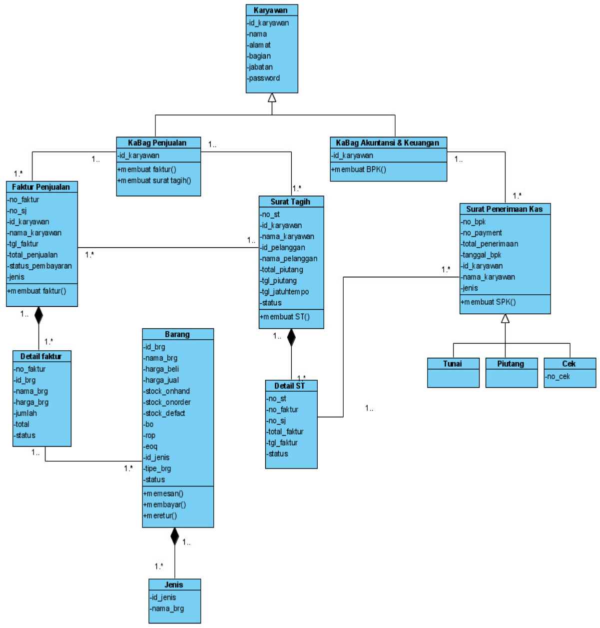

Figure 2. Cash Receipt Class Diagram

For an explanation of the sales and cash receipt class diagram above, can be seen in class definition below:

1. Employee Class.
   Employee class is made to collect information about the attributes of employees, employee identification numbers, name, address, department, title, and a password.
2. Customer.
   Customer class is made to collect information about the attributes of the customer, customer identification numbers, name, address, city, zip code, telephone number, fax number, branch, credit limit and customer status.
3. Product.
   Products class are made to collect information about attributes of goods, product identification numbers, names, types of product, purchase price, sale price, the stock in hand, ordered stock, damaged stock, and the status of product.
4. Sales order.
   Sales orders class are made to collect information about the attributes of sales orders, namely the sales order number, employee identification number, name of employee, customer identity number, customer name, date of sales orders and sales order status.
5. Sales order detail.
   Sales order detail class are made to collect detail information about the attributes of sales order, sales order number, product identification number, quantity, sale price, back order quantity, total, description.
6. Work order.
   Work order class are made to collect information about the attributes of work order number, sales order number, employee identification number, name of employee, work order date.
7. Work order detail.
   Work order detail class are made to collect information about attributes of work order detail number, employee identification number, product identification number, quantity, and sum of quantity.
8. Delivery order.
   Delivery order class are made to collect information about attributes of delivery order number, sales order number, employee identification number, delivery order date, employee name, and delivery order status.
9. Delivery order detail.
   Delivery order detail class are made to collect information about attributes of delivery order number, product identification number, delivery quantity, sum of delivery quantity.
10. Invoice.
    Invoice class is made to store information about the attributes of sale, invoice number, delivery order number, employee identification number, employee name, invoice date, total sales invoices, and payment status.
11. Invoice detail.
    Invoice detail class is made to store information about the attributes of sales detail, invoice number, product identification number, quantity, sale price, total invoice.
12. Billing statement.
    Billing statement class is made to collect information about the attributes of billing statement, billing statement number, employee identification number, employee name, customer identification number, customer number, total billing, billing date, due date, billing statement status.
13. Billing statement detail.
    Billing statement detail class is made to collect information about the attributes of detail billing statement. Billing statement number, invoice number, invoice date, total sales invoice.
14. Cash Receipt.
    Cash receipt class is made to collect information about the attributes of cash receipt, cash receipt number, payment number, cash receipt amount, cash receipt date, employee identification number, employee name, payment clasification.

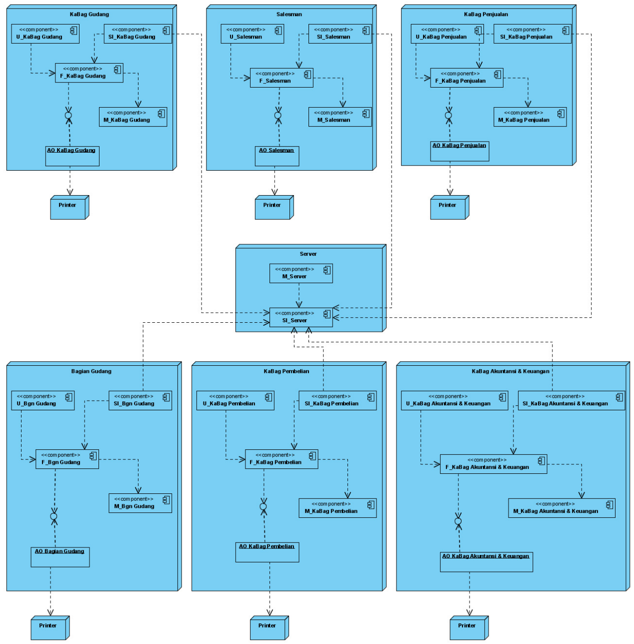

Figure 3. Component Architecture Diagram.

Usefulness of the system is designed to improve the performance, handling transactions and activities from shops and minimize potential problems. This system is also used for efficient service to its customers and assist employees in carrying out their operations or tasks - each.

The new system design will be presented to the shop before the store can be implemented and are expected to understand the usefulness of the new system and can apply them in the store activities. The new system will be implemented in stages in implementation. This is so that stores can learn the system and know him better, so it can adjust to the new system.

The author uses several tools such as Microsoft Office Visio 2003 to design UML diagrams, Microsoft Visual Studio (VB.Net) in 2005 to design and program the UI, Microsoft SQL Server 2005 to design the database and Crystal Report for reporting.

IV. CONCLUSIONS

After analysing the process of sales and cash receipts, at XYZ, then the researchers have several conclusions, among others:

1. Application of this information system can help minimize the occurrence of the transaction data recording errors by employees, because if there is an error - error in data recording the transaction, the employee concerned must give reasons for the error that occurred.
2. In the event that minimizes the errors that occurred due to improper recording of data transactions by employees, it is intended that each employee can be more focused in its activities and more responsible for all actions taken.
3. For each - each part that existed at the PT. XYZ has the authority and responsibility of each - each, because in this case each - each section there are different access rights - the difference in obtaining information, so that each - each section has a data confidentiality cannot be known by other parts.
4. For the salesman, the sales department needs a report sales data which reports sales data can be used as benchmarks for the sale to be able to assess where sales are more productive, thus increasing the company's sales charts.
5. Given this accounting information system is expected to assist the company in overcoming the problems of short-term and long term arising mainly deals with sales and cash receipts, purchases and cash disbursements.

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

Reinforcement-Concrete Ratio of Building Frames

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Abstract - **The ratio of reinforcement-concrete is the measurement of reinforcement content in reinforced concrete. Higher the ratio means higher content of reinforcement in the reinforced concrete and it will increase the cost of the reinforced concrete frame. The objectives of this research are to determine the reinforcement-concrete ratio for the element of frame based on the categories of buildings which are 1 to 5 storey height and buildings which are more than five-storey height and whether there is significant difference in the reinforcement-concrete ratio for the element of frame between buildings of not more than five-storey and more than five-storey height. Secondary data on the quantity of reinforcement and concrete for the element of frame are collected from the elemental cost analyses available at The Malaysian Surveyor (the professional journal of the Institution of Surveyors, Malaysia). The results of this research show that the mean reinforcement-concrete ratios for the building categories of 1 to 5 storey height and more than 5 storey height are 188.70kg.m^3 and 242.23kg/m^3 respectively. Findings of this research conclude that the buildings which are in the category of more than 5 storey height are having higher reinforcement-concrete ratio compared to buildings which are in the category of 1 to 5 storey height and the difference is statistically significant.**

Keywords - **Frame, building, reinforcement-concrete ratio, height.**

I. INTRODUCTION

Frame is an important element to every building. The main function of frame of a building is to transfer the building load to the substructure [1]. The construction cost of frame is an important cost item to overall construction cost of a building. In the context of Malaysian construction industry, the construction cost for superstructure frame can be up to more than 10% [2] of the total construction cost of a building. Most of the buildings in Malaysia are using reinforced concrete structures. The items that govern the total costs of concrete structures include:

1. Forms
2. Reinforcing steel
3. Concrete
4. Finishing
5. Curing [3]

From the items listed above, it is observed that reinforcing steel and concrete are two items those affect the total cost of structure of a building. The ratio of reinforcement-concrete is the measurement of reinforcement content in reinforced concrete. Higher the ratio means higher content of reinforcement in the reinforced concrete and it will increase the cost of the reinforced concrete frame.

The information of reinforcement-concrete ratio is useful in preparing the approximate estimates for the element of frame of a construction project. The information will help the estimator to estimate the quantity of reinforcement required after knowing the quantity of concrete. It is generally believed that higher reinforcement-concrete ratio for the element of frame is required to support the heavier load caused by the increased height of the building.

II. OBJECTIVES

The objectives of this research are to determine:

1. The reinforcement-concrete ratio for the element of frame based on the categories of buildings which are 1 to 5 storey height and buildings which are more than five-storey height.
2. Whether there is significant difference in the reinforcement-concrete ratio for the element of frame between buildings which are 1 to 5 storey height and buildings which are more than five-storey height.

III. LITERATURE REVIEW

Seeley explained that constructional cost of buildings rise with increases in their height [4]. Ahmad stated the frame is a main element of building and its cost is influenced by the size of the construction, height of the building, load it will bear and the column span [5]. Ashworth argued that the construction costs of tall structures are greater than those of low rise buildings offering a similar amount of accommodation partially due to the factor of higher structural costs [6]. The literatures imply the relationship between the height of a building and the reinforcement-concrete ratio of the building. The author could not find studies on reinforcement-concrete ratio published even after intensive search through online database.

IV. METHODLOGY

Secondary data on the quantity of reinforcement and concrete for the element of frame are collected from the elemental cost analyses available at The Malaysian Surveyor (the professional journal of the Institution of Surveyors, Malaysia). Data is then analysed to determine the mean of reinforcement-concrete ratio to achieve the first research objective. As for the second research objective, hypothesis testing is conducted [7].

Hypothesis of the research:

H_0: There is not difference in the reinforcement-concrete ratio for the element of frame between buildings of not more than five-storey and more than five-storey high.

H_1: There is difference in the reinforcement-concrete ratio for the element of frame between buildings of not more than five-storey and more than five-storey high.

V. DATA COLLECTION

At the end of the process of data collection, data from forty-two (42) buildings (samples) are successfully collected. From the forty-two buildings, five (5) are in the category of transport, industrial buildings, twelve (12) are in the category of administrative buildings, three (3) are in the category of health, welfare buildings, one (1) is in the category of refreshment, entertainment, recreation buildings, one (1) is in the category of religious buildings, six (6) are in the category of educational, cultural, scientific buildings, ten (10) are in the category of residential buildings, whereas the other four (4) are in the category of other buildings. Details are as Table 1.

Table 1: Samples According to Type of Buildings

Type of Buildings	Quantity (%)
Transport, Industrial Buildings	5 (11.9%)
Administrative Buildings	12 (28.6%)
Health, Welfare Buildings	3 (7.1%)
Refreshment, Entertainment, Recreation Buildings	1 (2.4%)
Religious Buildings	1 (2.4%)
Educational, Cultural, Scientific Buildings	6 (14.3%)
Residential Buildings	10 (23.8%)
Others	4 (9.5%)
Total	42 (100%)

From the aspect of the height of buildings, there are twenty-eight (28) buildings (66.7%) are in the category of 1 to 5 storey height whereas fourteen (14) buildings (33.3%) are in the category of more than 5 storey height. Details are as Table 2.

Table 2: Samples According to Height of Buildings

Height of Buildings	Quantity (%)
1 To 5 storey height	28 (66.7%)
More than 5 storey height	14 (33.3%)
Total	42 (100%)

VI. ANALYSIS

Analysis for the ratio of reinforcement-concrete (RC Ratio) for each building is conducted with the formula:

RC Ratio = Weight of reinforcement (kg) ÷ Volume of concrete (m^3). Table 3 presents the results of reinforcement-concrete ratio analysed. From the analysis, the mean of reinforcement-concrete ratio for all the buildings is 206.54kg/m^3.

Table 3: Reinforcement-Concrete Ratio

Project	Reinforcement-Concrete Ratio (kg/m^3)
1	266.38
2	303.69
3	127.44
4	169.60
5	238.53
6	61.17
7	270.02
8	289.52
9	125.38
10	186.04
11	173.31
12	248.09
13	268.70
14	144.00
15	225.34
16	407.21
17	280.95
18	270.15
19	205.18
20	204.36
21	266.01
22	201.50
23	171.53
24	174.08
25	142.71
26	334.90
27	113.66
28	177.48
29	109.48
30	153.26
31	175.87
32	147.02
33	153.46
34	234.70
35	139.24
36	155.49
37	221.83
38	199.38
39	176.06
40	244.90
41	225.55
42	291.56
Mean = 206.54	

The data is further analysed to determine the mean of reinforcement-concrete ratio based on the categories of buildings which are 1 to 5 storey height and buildings which are more than 5 storey height. The results show that the mean reinforcement-concrete ratio of buildings which are 1 to 5 storey height is 188.70kg/m^3 (based on 28 samples) whereas the mean reinforcement-concrete ratio of buildings which are more than 5 storey height is 242.23kg/m^3 (based on 14 samples). The results indicate that buildings which are in the category of more than 5 storey height are having higher reinforcement-concrete ratio compared to the buildings which are in the category of 1 to 5 storey height. Details are as Table 4.

Table 4: Reinforcement-Concrete Ratio
(Based on categories of buildings)

Height of Projects	Mean Reinforcement-Concrete Ratio (kg/m^3)
1 To 5 storey height (N=28)	188.70 (Standard Deviation = 66.29)
More than 5 storey height (N=14)	242.23 (Standard Deviation = 61.86)

Hypothesis testing is conducted to determine whether the difference in reinforcement-concrete ratio between both building categories significant. The results of the hypothesis test are that the value of t is -2.581 and it is significant at 0.05 level (95% confidence). Details are as Table 5. Hence, the null hypothesis is rejected.

Table 5: Hypothesis Testing

t Test for Equality of Means	
t	-2.581
Sig. (2-tailed)	.015

VII. CONCLUSION

As the reinforcement-concrete ratio is a factor which will affect the construction cost of building frame of a building, the understanding on it becomes crucial. In addition to that, such understanding will also help in the preparation of approximate estimate for the cost of a building. The results of this research show that the mean reinforcement-concrete ratios for the building categories of 1 to 5 storey height and more than 5 storey height are 188.70kg.m^3 and 242.23kg/m^3 respectively. Findings of this research conclude that the buildings which are in the category of more than 5 storey height are having higher reinforcement-concrete ratio compared to buildings which are in the category of 1 to 5 storey height and the difference is statistically significant.

VIII. LIMITATION

Due to the constraint of data availability, there are only 42 samples collected for this research. The validity of the research findings would be greatly improved with a higher number of research samples available.

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ISBN : 978-602-97809-0-1

Consumer Decision Making: Indonesian Female Shopping Style

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Abstract - **The purpose of this study is to find out the characteristics of Indonesian female with the consumer style to identify shopping styles. All previous studies of tended to test the generality of the consumer style inventory (CSI). We developed six dimensions, the consisted of quality consciousness, brand consciousness, price consciousness, reliance on mass media, shopping influences, and, convenience and time consciousness. We obtained 120 respondents. Exploratory, factor analysis and a confirmatory factor analysis are adopted to validate the CSI inventory and marketing and consumer behavior implications also discussed.**

Keyword – **Consumer decision, Female, Shopping styles (CSI)**

I. Introduction

Consumers are motivated and take action through their goals. In order to reach their goals, they undergo some intellectual, emotional and behavioral processes. These lifelong activities become a part of life and create style of shopping when the consumer determines the way that provides the best satisfaction. Decision-making style is defined as the emotional and cognitive tendencies which have permanent and constant effects on consumer shopping style.

Indonesian female rapid income rate influences more products and services for women available, many of which are from foreign countries. As described, based on the commercial global integration unfolds in the world's market places, decision making process is becoming an increasingly complex phenomenon.

In recent years, lots of researchers become more and more interested in purchase behavior of the female experiences. To explore the changing market consumes structure of the female become more and more important to marketers because they can determine consumer behavior of the female in the future. Given the unique market environment, how do Indonesian consumers make purchasing decisions? A consumer decision-making style is defined as a mental orientation characterizing a consumers' way to making consumer choices, and then they developed a consumer style inventory (CSI). CSI scale divided into eight central decision making dimensions which influence a consumers' decision making styles (Sproles and Kendall 1986). These eight instruments: (1) Perfectionism/high quality (2) Brand consciousness (3) Novelty-Fashion Consciousness (4) Recreational (5) Price Value Consciousness (6) Impulsiveness (7) Confused by over choice (8) Brand-Loyal. For this study we only have six CSI factors are validated.

CSI scale represents the most tested instrument currently; however, it cannot generalize to all consumers, particularly to adults, because student samples do not represent the general population (Gordon et al. 1986). As the limitation of above, this study purpose is to find out the characteristics of Indonesian female with the CSI to identify their shopping styles.

II. Literature Review

Investigation consumer decision making styles in terms of shopping goods and in convenience goods they could not obtain identifiable styles (Bauer, Sauer and Beeker, 2002). There were any differences in decision-making of the consumers who prefer both domestic and imported goods (Wang, Siu, Hui, 2004). Investigation on Indonesian consumer attitude shows consumer perception and confidence in the quality of imported products were higher than local products (Soenhadji, 2010).

Decision making styles is a mental orientation that describes how a consumer makes their choice. Decision making styles are very important to marketers who want to expand their products or services into new overseas markets. The marketers can easily target their products, services, locations and promotional efforts according to the types of consumer.

Decision making styles of German consumers with non-students samples and confirmatory factor analysis showed that CSI seems unable to measure consumer decision making characteristics effectively in all countries (Walsh et al., 2001). For example, time and environmental conscious are important to German consumers, is not affiliated with the original scale of CSI. This mentioned that the current CSI cannot measure consumer decision making styles of all different cultures and countries.

All previous studies tend to test the generality of the CSI by

ISBN : 978-602-97809-0-1

directly using the developed scales, but these eight dimensions may not be fit the style of decision making of different cultures (Spoles and Kendall, 1986). In order to measure the consumer decision making styles precisely, the new CSI scales developed for Shanghai and Hong Kong working females (Susan, 2005). The study provided by lifestyles investigation institutes via extensive search from local newspapers, magazines and other lifestyles studies. They synthesized the results with the literature and developed four new dimensions which are not found in the CSI including personal style consciousness, environment and health consciousness, reliance on mass media and convenience and time consciousness. After the data analysis, the study suggests these new four dimensions are fit to profile the decision styles of Chinese females.

A common sampling problem for cross-cultural research is unclear which populations represent the nation's culture central tendencies (Nasif et al. 1991, 84). The reliability and validity of the original CSI were developed using student's samples, and many researchers acknowledged that the student population couldn't represent the real population as students didn't have independent economic. In order to respond to the comments of the CSI scale which may not be valid in other countries and culture, our study tend to examine the suitable of CSI and compares the findings to previous research. Our study follows the new dimensions which developed by Susan (2005) and the recommendation methodology for testing the cross national applicability of scales. The sample used in this study was the Indonesian females, which located at Depok, West Java.

The objectives of this study are (1) to test the CSI scales reliability and validity in Indonesian, (2) to explore decision-making styles of Indonesian females (3) to establish a profile of consumer styles for Indonesian females.

III. Methods

Evidence suggests that the CSI is more applicable to developed countries (Lysonski, Durvasula and Zotos 1996). Yet despite the Asia being the third large market in the world and marketing in Asia become more and more complex and also challenging, Therefore, a questionnaire was designed to measure Indonesian female consumer decision making styles. We obtained 120 respondents from 200 questionnaires where delivered. The items mostly based on the exploratory studies of Sproles and Kendall (1986), in this study we affiliated with new dimensions to measure the decision making styles, the complete measuring scale were (1) Quality consciousness (2) Brand consciousness (3) Price consciousness (4) Reliance on the mass media (5) Shopping influences (6) Convenience and time consciousness. The measured dimensions contained Likert-type items and had the following five point scale: "strongly disagrees (1), somewhat disagree (2), neither agrees nor disagree (3), somewhat agree (4), strongly agree (5)."

IV. Data Collection

A total of 200 questionnaires were sent. We decided to utilize the mall intercept surveys at Depok, due to the same culture and some race. Furthermore, mail and telephone survey methods cost too much and unattractive. Accordingly, the sample locations used in this study are the working place. Samples of females are sent to their companies. From 200 sent questionnaires, only 120 were returned.

V. Analysis

To examine the applicability of the dimensions, the analytical methods used in this study were similar to previous research on decision making styles. First, factor analysis, the principal components methods with varimax rotation of factors used to identify characteristics of decision making styles. The amount of variance explained by the eigenvalues was recorded, and also the item-factor correlations (factor loadings) were examined too. The correlations among the samples will be deleted when the factor correlations across the samples was less than 0.1.

VI. Findings

The results of factor analysis and reliability coefficients for each factor are summarized in Table 1.

TABLE I

SHOPPING STYLES DIMENSIONS OF INDONESIAN WORKING FEMALES

1="strongly disagree", 5="strongly agree", significant at the 0.05 level.

<table>
<tr><th>No</th><th>Dimensions</th><th>Mean</th><th>Alpha</th><th>Cronbach</th><th>Factor Loadings</th><th>KMO</th></tr>
<tr><td>1</td><td colspan="6">Quality consciousness</td></tr>
<tr><td>1.1</td><td>Product quality is the most important factor</td><td>4.2583*</td><td>0.7463</td><td rowspan="3">0.7497</td><td>0.762</td><td rowspan="3">0.673</td></tr>
<tr><td>1.2</td><td>I am willing to pay higher price to buy better quality products.</td><td>4.3750*</td><td>0.6317</td><td>0.841</td></tr>
<tr><td>1.3</td><td>I tend to choose better quality.</td><td>4.3250*</td><td>0.6158</td><td>0.848</td></tr>
<tr><td>2</td><td colspan="6">Brand consciousness</td></tr>
<tr><td>2.1</td><td>I am willing to pay higher price for famous brands.</td><td>3.8667*</td><td>0.6733</td><td rowspan="2"></td><td>0.710</td><td rowspan="2"></td></tr>
<tr><td>2.2</td><td>In purchasing, I tend to choose those well-known brands rather than best quality ones.</td><td>4.1500*</td><td>0.6754</td><td>0.696</td></tr>
</table>

ISBN : 978-602-97809-0-1

2.3	I prefer to buy foreign brands than local brands even though sometimes they are more expensive.	3.9250*	0.6938	0.7258	0.662	0.734
2.4	Most of the clothes that I buy are of the same brand name.	3.8667*	0.6739		0.698	
2.5	Even though other brands may be better choices, I sill tend to stick to my favorite brands.	3.9417*	0.6805		0.704	
3	*Price consciousness*					
3.1	I often wait until a store has a sale to shop.	4.1500*	0.6135	0.6560	0.731	0.648
3.2	I am willing to spend time to compare prices among shops in order to buy some lower priced products.	4.2667*	0.505		0.802	
3.3	I am conscious of my economic condition in buying decision.	4.1833*	0.5506		0.775	
4	*Reliance on the mass media*					
4.1	I tend to read information on the packing of a product carefully before making buying decision.	3.8417*	0.6234	0.7127	0.779	0.733
4.2	I consider that advertisements on TV and radio influence my buying decision more than on newspapers and magazines.	3.8333*	0.6901		0.8667	
4.3	I am willing to buy good's quality even though they are not well advertised brands.	3.9333*	0.6708		0.701	
4.4	I consider that is better to buy through advertisements are distasteful.	3.7083*	0.6155		0.785	
5	*Shopping influences*					
5.1	I believe and make reference to the comments in newspapers and magazines when making buying decisions.	4.1833*	0.6115	0.6860	0.741	0.733
5.2	Family members influence my choice of goods and brands.	4.0583*	0.5639		0.790	
5.3	I am often willing to purchase those goods which are recommended by my friends.	3.7500*	0.6771		0.628	
5.4	Advice from salesclerks influences my choice of goods.	4.1500*	0.6251		0.716	
6	*Convenience and time consciousness*					
6.1	I am willing to pay a higher price in order to save time.	4.2250*	0.5694	0.5695	0.836	0.500
6.2	I usually buy goods in places nearby and convenient to me.	4.2667*	0.5694		0.836	

A. Result of Factor Analysis

The six factors are summarized. The factors are; quality consciousness, brand consciousness, price consciousness, shopping influence and reliance on the mass media, convenience and time consciousness.

1) *Quality consciousness*, the factor reflects demand for quality goods. Female are willing to pay higher for their favorite brands, Most of the respondents claimed that the quality of the goods will be the first elements when they making decision in order to get their preferences.

2) *Brand consciousness*, as the second factor, dimensions indicated most of respondents like international brands. They prefer to buy international brands than local brands even though they are sometimes more expensive. This also indicates that female respondents are more interested in value for their money.

3) *Price consciousness*, as third factor, this factor reflects the price characteristic; working females found very price sensitive. They are willing to spend more time to compare prices among shops in order to buy some lower priced products and waiting until the sale season. Indonesian working female will bargain the price of the product, and good at using coupons to have a discount.

4) *Convenience and time consciousness,* they were significantly more conscious of time and convenience. Prefer to buy goods in nearby and convenient locations in order to save time.

5) *Shopping influence,* Indonesian working females are very likely to be influenced by peers and sales people when making decisions making. They are willing to buy goods which are recommended by friends and peers. Besides, good attitude and advices of sales people also influenced the

purchase intensions of the females.

6) *Reliance on mass media,* they always read information on the product packaging carefully before making buying decisions. Most of them are scared of the expired date food that will influence their health condition.

VI. Conclusions and Implications

This study modified the measured items of the CSI, which is originally developed by Sproles and Kendall (1986) and Susan (2005). A six factor model is proposed in this study in order to explore the shopping styles of Indonesia female. Due to more complexity of global marketplace and consumer specialist, it is imperative to develop useful scales to profile consumer decision making styles across cultures and countries. Profiling female consumers by exploring their decision making styles and demographic variables provide more critical ways to identify and understand the variety of consumer segments and to target each segment with the marketing strategies.

The CSI was used in this study for investigation because it can be most powerful techniques to explore consumers to their mental orientation toward shopping. The most important finding in this study is, there is an indication of the generality of several Indonesian female decision-making styles. Also, decision making styles have attracted much attention from marketers from department store and shopping mall. They are interesting about decision styles that the consumers make, and the strategy that marketers can scaffold in order to stimulate the buying behavior of different populations. Public policy makers can also identify the differences in consumer decision making styles that could be applied in educational programs and develop the consumer education programs in order to educate young people to function effectively as consumers.

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ISBN : 978-602-97809-0-1

Pricing and Replenishment Policy for a Deteriorating Item with Partial Backlogging Where Time-and-Price Dependent Demand is Allowed

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Abstract- **The problem of pricing and replenishment policy for deteriorating items in recent years has been mentioned by many researchers. In this paper, we will consider the problem where the demand rate is known, continuous and a function of price and also time. Shortages are allowed and partially backlogged, whereas the backlogging rate is variable and dependent on the waiting time for the next replenishment. The objective is to determine the optimal selling price, secondly the length of the time in which there is no inventory shortage, together with the replenishment cycle time, and order quantity such that the total profit per unit time has a maximum value. For any given selling price, we first show that a unique optimal replenishment schedule exists. Next, we demonstrate that the total profit function is concave according to the price whereas the replenishment schedule is given. Then, an algorithm is developed to find the optimal solution. Finally, a numerical example is developed to illustrate efficiency of the model and also the algorithm.**

***Keywords*: pricing, replenishment policy, deteriorating item, partial backlogging, Economic Order Quantity (EOQ)**

I. INTRODUCTION

Many researchers defined deterioration as decay, damage, spoilage, evaporation, obsolescence, pilferage, loss of utility or loss of marginal value of commodity that results in decreasing usefulness. Most of physical goods undergo decay or deterioration over time, the examples being medicine, volatile liquids, blood banks, and others [1]. Consequently, the pricing and replenishment policy problem of deteriorating items has been extensively studied in recent years. The first attempt to describe the optimal ordering policies for deteriorating items was made by Ghare and Schrader [2]. They presented an EOQ model for an exponentially decaying inventory. Abad [3,4] considered a pricing and lot-sizing problem for a product with variable rate of deterioration, allowing shortages and partial backlogging. Dye [5] developed a joint pricing and ordering policy for a deteriorating inventory with partial backlogging. The demand is known and linear function of price. Later, Dye et al. [6] presented an inventory and pricing strategy for deteriorating items with shortages. Demand and deterioration rate are continuous and differentiable function of price and time, respectively. Chang et al. [7] established an EOQ model for deteriorating items for a retailer for determine its optimal selling price and lot-sizing policy with partial backlogging and log-concave demand.

Wee [8] considered pricing and replenishment policy for deteriorating items when the demand is depend on price. He assumed declining market in his work. Wee and Law [9] developed a model for pricing and inventory control for deteriorating items by considering the time value. Yang et al. [10] considered the optimal pricing and inventory control model for non-instantaneous deteriorating items. the demand in this work is linearly and dependent on price. Tsao and Sheen [11] presented a pricing and replenishment policy model for deteriorating item. In their work shortage is not allowed, but they considered the effects of promotion and permissible delay in payments on the model. Mishra and Mishra [12] determined the optimal price and the optimal replenishment policy for deteriorating items under perfect competition. Mo et al. [13] developed a EOQ model when the demand is dependent on the price and stock level. He et al. [14] presented an optimal production-inventory model for deteriorating items with multiple-market demand. Hsieh et al. [15] considered an optimal lot size model an item with partial backlogging rate when demand is stimulated by inventory above a certain stock level.

An appropriate pricing and replenishment policy for a deteriorating item is presented in this paper. In this model shortages are allowed and partially backlogged. The

ISBN : 978-602-97809-0-1

backlogging rate is variable and dependent on the waiting time for the next replenishment. The demand rate is log-concave and dependent on the price and time. The major objective is to determine the optimal selling price, the optimal replenishment cycle time and the order quantity simultaneously. There are some useful theorems developed in this paper to characterize the optimal solutions.

The rest of the paper is follows. In Section 2, assumptions and notations used throughout this paper are present. In Section 3, we establish the mathematical model and the necessary condition for finding an optimal solution. For any given selling price, the optimal solution is exists and unique. Moreover, we prove that the total profit is a concave function of selling price. Next, in Section 4, we present a simple algorithm to find the optimal selling price and inventory control variables. In Section 5, we use a numerical example and finally, we make a summary and provide some suggestions for future in Section 6.

II. NOTATIONS and ASSUMPTIONS

The following notations and assumption are used throughout the paper:

Notations:

c : The constant purchasing cost per unit.

h : The holding cost per unit per unit time.

s : The backorder cost per unit per unit time.

o : The cost of lost sale per unit.

p : The selling price per unit, where p>c.

Θ: the parameter of deterioration rate of the stock.

t_1 : The length of time in which there is no inventory shortage.

T : The length of replenishment cycle time.

Q : The order quantity.

p^* : The optimal selling price per unit.

t_1^* : The optimal length of time in which there is no inventory shortage.

T^* : The optimal length of the replenishment cycle time.

Q^* : The optimal order quantity.

$I_1(t)$: The inventory level at time $t \in [0,t_1]$.

$I_2(t)$: The inventory level at time $t \in [t_1,T]$.

I_0 : The maximum inventory level.

S : The maximum amount of demand backlogged.

$TP(p,t_1,T)$: The total profit per unit time of the inventory system.

TP^* : The optimal total profit per unit time of the inventory system, that is, $TP^* = TP(p^*,t_1^*,T^*)$.

Assumptions:

- ✓ A single deteriorating item is modeled.
- ✓ The replenishment rate is infinite and the lead time is zero.
- ✓ The basic demand rate, $D(p,t) = (a-bp)e^{\lambda t}$ (where $a > 0, b > 0$) is a linearly decreasing function of the price and decreases (increases) exponentially with time when $\lambda < 0$ ($\lambda > 0$). Thus , the demand rate is a function of price and time, which should reflect a real situation: i.e. the demand may increase when the price decreases, or it may vary through time. Here we adopt the form of the multiplicative exponential time effect for the basic demand rate, which is suitable for describing the time-varying demand. Given a different λ, which can be either positive or negative, this form can represent most cases where demand rate varies with time. The consideration of the time and price dependent demand is useful for the deteriorate items such as: fashion goods, high-tech product, fruits and vegetables [11].
- ✓ Shortages are allowed. We adopt the notation used in Abad [3], where the unsatisfied demand is backlogged, and the fraction of shortage backordered is $\beta(x) = k_0 e^{-\delta x}$, ($0 < k_0 \le 1, \delta > 0$), where x is the waiting time up to the next replenishment and δ is a positive constant and $0 \le \beta(x) \le 1, \beta(0) = 1$. To guarantee the existence of an optimal solution, we assume that $\beta(x) + H(\beta'(x)) > 0$, where $\beta'(x)$ is the first derivative of $\beta(x)$. Note that if $\beta(x) = 1$ (or 0)for all x, then shortage is completely backlogged (or lost).

III. MODEL FORMULATION

For simplicity, we use the same inventory shortage model as in yang et al. [10]. Base on this model; the inventory system is as follows. I_0 Units of item arrive at the inventory system at the beginning of each cycle and drop to zero due to demand and deterioration. Then shortage occurs until the end of the

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current order cycle. The whole process is repeated. Fig. 1 shows the inventory system.

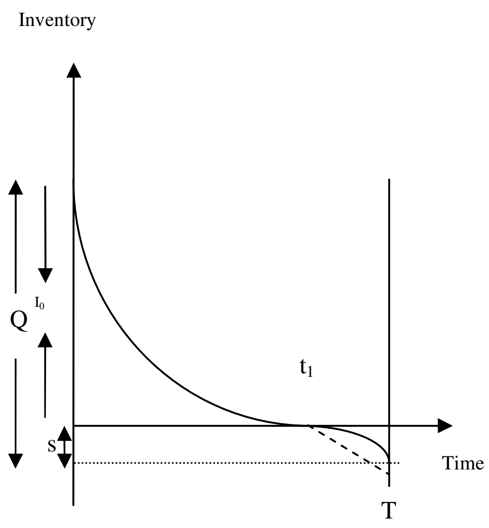

Fig.1. Graphical representation of inventory system

During the time interval $[0,t_1]$, the differential equation representing the inventory status is given by

$$\frac{dI_1(t)}{dt}+\theta dI_1(t)=-D(p,t) \quad , \quad 0\le t\le t_1 \tag{1}$$

With the condition $I_1(t_1)=0$. By solving (1), it yields.

$$I_1(t)=\frac{(a-bp)e^{-\theta t}}{\lambda+\theta}\left[e^{(\lambda+\theta)t_1}-e^{(\lambda+\theta)t}\right] \quad , \quad 0\le t\le t_1 \tag{2}$$

It is clear from figure1 that $I_1(0)=I_0$ so, the maximum inventory level I_0 can be obtained:

$$I_0=\frac{(a-bp)}{\lambda+\theta}\left[e^{(\lambda+\theta)t_1}-1\right] \tag{3}$$

During the second interval $[t_1,T]$ shortage occurred and the demand is partially backlogging according to the fraction $\beta(T-t)$. So, the inventory level at time t is governed by the following differential equation:

$$\frac{dI_2(t)}{dt}=-D(p,t)\beta(T-t)=\frac{-D(p,t)}{e^{\delta(T-t)}} \quad , \quad t_1\le t\le T \tag{4}$$

With the condition $I_2(t_1)=0$ the solution (4) is:

$$I_2(t)=\frac{(a-bp)e^{-\delta T}\left(e^{(\delta+\lambda)t_1}-e^{(\lambda+\delta)t}\right)}{\lambda+\delta} \quad , \quad t_1\le t\le T \tag{5}$$

If we put $t=T$ into (5), the maximum amount of demand backlogged will be obtained as follows:

$$S=-I_2(T)=-\frac{(a-bp)e^{-\delta T}\left(e^{(\delta+\lambda)t_1}-e^{(\lambda+\delta)T}\right)}{\lambda+\delta} \tag{6}$$

Order quantity per cycle (Q) is the total of S and I_0, so:

$$Q=S+I_0=-\frac{(a-bp)e^{-\delta T}\left(e^{(\delta+\lambda)t_1}-e^{(\lambda+\delta)T}\right)}{\lambda+\delta}+ \frac{(a-bp)}{\lambda+\theta}\left[e^{(\lambda+\theta)t_1}-1\right] \tag{7}$$

Now, we can obtain inventory costs and sales revenue per cycle that consist following six elements:

1. the ordering cost is: A
2. the inventory holding cost (denoted by *HC*) is:

$$HC=h\int_0^{t_1}I_1(t)dt=h\left[\int_0^{t_1}\frac{(a-bp)e^{-\theta t}}{\lambda+\theta}\left[e^{(\lambda+\theta)t_1}-e^{(\lambda+\theta)t}\right]dt\right] =\frac{h\left(\theta-e^{\lambda t_1}(\theta+\lambda-e^{\theta t_1})\right)(a-bp)}{\theta\lambda(\theta+\lambda)} \tag{8}$$

3. the shortage cost due to backlog (denoted by *SC*) is:

$$SC=s\int_{t_1}^{T}\left[-I_2(t)\right]dt =\frac{e^{-\delta T}(a-bp)s\left(e^{(\delta+\lambda)T}+e^{(\delta+\lambda)t_1}(-1-(\delta+\lambda)(T-t_1))\right)}{(\delta+\lambda)^2} \tag{9}$$

4. the opportunity cost due to lost sales (denoted by *OC*) is:

$$OC=o\int_{t_1}^{T}D(p,t)(1-\beta(T-t))dt =\frac{\left(\delta(e^{\lambda T}-e^{\lambda t_1})+e^{\lambda t_1}(-1+e^{\delta(-T+t_1)})\lambda\right)o(a-bp)}{\lambda(\delta+\lambda)} \tag{10}$$

5. the purchase cost (denoted by *PC*) is:

$$PC=cQ=c\left(\frac{e^{\lambda T}-e^{-\delta T+\delta t_1+\lambda t_1}}{\delta+\lambda}+\frac{-1+e^{(\theta+\lambda)t_1}}{\theta+\lambda}\right)(a-bp) \tag{11}$$

6. the sales revenue (denoted by *SR*) is:

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$$SR = p\left[\int_0^{t_1} D(p,t)dt + S\right]$$
$$= p\left(\frac{\left(-1+e^{\lambda t_1}\right)(a-bp)}{\lambda} - \frac{e^{-\delta T}\left(-e^{(\delta+\lambda)T}+e^{(\delta+\lambda)t_1}\right)(a-bp)}{\delta+\lambda}\right) \quad (12)$$

Therefore, the total profit per unit time (denoted by $TP(p,t_1,T)$) is given by:

$$TP_{(p,t_1,T)} = \frac{SR-A-HC-SC-OC-PC}{T}$$
$$= -\frac{1}{T}(A + c(\frac{e^{\lambda T}-e^{-\delta T+\delta t_1+\lambda t_1}}{\delta+\lambda} + \frac{-1+e^{(\theta+\lambda)t_1}}{\theta+\lambda})(a-bp)$$
$$+\frac{h(\theta-e^{\lambda t_1}(\theta+\lambda-e^{\theta t_1}))(a-bp)}{\theta\lambda(\theta+\lambda)}$$
$$+\frac{(\delta(e^{\lambda T}-e^{\lambda t_1})+e^{\lambda t_1}(-1+e^{\delta(-T+t_1)})\lambda)o(a-bp)}{\lambda(\delta+\lambda)}$$
$$-(\frac{-1+e^{\lambda T}-e^{-\delta T+\delta t_1+\lambda t_1}}{\delta+\lambda})p(a-bp)$$
$$+\frac{e^{-\delta T}(a-bp)s(e^{(\delta+\lambda)T}+e^{(\delta+\lambda)t_1}(-1-(\delta+\lambda)(T-t_1)))}{(\delta+\lambda)^2}) \quad (13)$$

The main purpose of this paper is to determine the optimal an ordering policies that correspond to maximizing the total profit per unit time. To achieve our purpose, we first prove that for any given *p*, the optimal solution of (t_1,T) not only exists but also is unique. Then, for any given value of t_1,T, there exists a unique *p* that maximizes the total profit per unit time.

$TP(p,t_1,T)$ is function of t_1,T,p. So, for any given p, the necessary condition for the total profit per unit time (16) to be maximized are $\frac{\delta TP(p,t_1,T)}{\delta t_1}=0$ and $\frac{\delta TP(p,t_1,T)}{\delta T}=0$ simultaneously. That is,

$$\frac{\partial TP_{(p,t_1,T)}}{\partial t_1} = \frac{e^{-\delta T+\lambda t_1}(a-bp)}{\theta T}(c(e^{\delta t_1}-e^{\delta T+\theta t_1})\theta -$$
$$e^{\delta T+\delta t_1}h + e^{\delta T}(h+\theta(o+p)) - e^{\delta t_1}\theta(o+p-Ts+st_1)) = 0 \quad (14)$$

and

$$\frac{\partial TP_{(p,t_1,T)}}{\partial T} = \frac{1}{T^2}(A + c(\frac{e^{\lambda T}-e^{-\delta T+\delta t_1+\lambda t_1}}{\delta+\lambda} + \frac{-1+e^{(\theta+\lambda)t_1}}{\theta+\lambda})(a$$
$$-bp) + \frac{h(\theta-e^{\lambda t_1}(\theta+\lambda-e^{\theta t_1}))(a-bp)}{\theta\lambda(\theta+\lambda)} +$$
$$\frac{(\delta(e^{\lambda T}-e^{\lambda t_1})+e^{\lambda t_1}(-1+e^{\delta(-T+t_1)})\lambda)o(a-bp)}{\lambda(\delta+\lambda)} -$$
$$(\frac{-1+e^{\lambda t_1}}{\lambda} + \frac{e^{\lambda T}-e^{-\delta T+\delta t_1+\lambda t_1}}{\delta+\lambda})p(a-bp)$$
$$+\frac{e^{-\delta T}(a-bp)s(e^{(\delta+\lambda)T}+e^{(\delta+\lambda)t_1}(-1-(\delta+\lambda)(T-t_1)))}{(\delta+\lambda)^2} +$$
$$\frac{1}{(\delta+\lambda)^2}e^{-\delta T}T(a-bp)(-c(\delta$$
$$+\lambda)(\delta e^{(\delta+\lambda)t_1}+e^{(\delta+\lambda)T}\lambda)+\lambda(e^{(\delta+\lambda)T}(\lambda p-s)+$$
$$e^{(\delta+\lambda)t_1}s)+\delta^2(-e^{(\delta+\lambda)T}o+e^{(\delta+\lambda)t_1}(o+p-Ts$$
$$+st_1))+\delta\lambda(e^{(\delta+\lambda)T}(-o+p)+e^{(\delta+\lambda)t_1}(o+p-Ts+st_1)))) = 0 \quad (15)$$

theorem1. For any given p, we have

(a) The system of (14) and (15) has a unique solution.

(b) The solution in (a) satisfies the second order conditions for maximum.

Please see [4],[5],[6] and[10] for details.

From the analysis carried out so far, we know that, for any given positive, the point T^*,t_1^* which maximize the total profit per unit time not only exists but is unique.

Next, we study the condition under which the optimal selling price also exists and is unique. For any T^*,t_1^* the first-order necessary condition for $TP(p,t_1^*,T^*)$ to be maximize is $\frac{\partial TP_{(p,t_1^*,T^*)}}{\partial p}=0$, so:

$$\frac{\partial TP_{(p,t_1^*,T^*)}}{\partial p} = -\frac{1}{T^*}(-bc(\frac{e^{\lambda T^*}-e^{-\delta T^*+\delta t_1^*+\lambda t_1^*}}{\delta+\lambda} +$$
$$\frac{-1+e^{(\theta+\lambda)t_1^*}}{\theta+\lambda}) - \frac{bh(\theta-e^{\lambda t_1^*}(\theta+\lambda-e^{\theta t_1^*}\lambda))}{\theta\lambda(\theta+\lambda)} -$$
$$\frac{b(\delta(e^{\lambda T^*}-e^{\lambda t_1^*})+e^{\lambda t_1^*}(-1+e^{\delta(-T^*+t_1^*)})\lambda)o}{\lambda(\delta+\lambda)} + b($$
$$\frac{-1+e^{\lambda t_1^*}}{\lambda} + \frac{e^{\lambda T^*}-e^{-\delta T^*+\delta t_1^*+\lambda t_1^*}}{\delta+\lambda})p - (\frac{-1+e^{\lambda t_1^*}}{\lambda} +$$
$$\frac{e^{\lambda T^*}-e^{-\delta T^*+\delta t_1^*+\lambda t_1^*}}{\delta+\lambda})(a-bp) -$$
$$\frac{be^{-\delta T^*}s(e^{(\delta+\lambda)T^*}+e^{(\delta+\lambda)t_1^*}(-1-(\delta+\lambda)(T^*-t_1^*)))}{(\delta+\lambda)^2}) = 0 \quad (16)$$

ISBN : 978-602-97809-0-1

By assuming that $\lambda < 0, |\lambda| > \theta, |\lambda| > \delta, bp < a < 2bp$, it is clear from (16) that $\frac{\partial TP_{(p,t_1^*,T^*)}}{\partial p} = 0$ has a solution if $bc - bp + (a - bp)) < 0$. Further, the second-order derivations of $TP(p,t_1^*,T^*)$ with respect to p, is:

$$\frac{\partial^2 TP_{(p,t_1^*,T^*)}}{\partial p^2} = -\frac{2b\left(\frac{-1+e^{\lambda t_1^*}}{\lambda}+\frac{e^{\lambda T^*}-e^{-\delta T^*+\delta t_1^*+\lambda t_1^*}}{\delta+\lambda}\right)}{T^*} < 0$$

Consequently, $TP(p,t_1^*,T^*)$ is a concave function of p for a given T^*, t_1^* , hence a value of p that obtain from (16) is unique. As a result, we prove that exist a unique value of p (p^*) which maximizes $TP(p,t_1^*,T^*)$. p^* can be obtained by solving (16). The solution of $bc - bp + (a - bp)) < 0$ is the lower bound for the optimal selling price p^* such that $\frac{\partial TP_{(p,t_1^*,T^*)}}{\partial p} = 0$.

Combining the above finding and theorem 1, we propose the following algorithm for solving the problem.

IV. ALGORITHM

We propose a simple algorithm to obtain the optimal solution (p^*,t_1^*,T^*) of the problem.

step1: start with $j = 0$ and the initial trial value of $p_j = p_1$. Which is a solution to $bc - bp + (a - bp)) = 0$

step2: by using (14) and (15), find the optimal of (t_1^*,T^*) , for a given price p_j .

step3: use the result in step 2, and then determine the optimal p_{j+1} by (16).

Step 4: if the difference between p_j, p_{j+1} is sufficiently small (i.e., $|p_j - p_{j+1}| \le 0.0001$), set $p^* = p_{j+1}$, then (p^*,t_1^*,T^*) is the optimal solution and stop. Otherwise, set $j = j + 1$ and go back to step 2.

By using above algorithm, we obtain the optimal solution (p^*,t_1^*,T^*) .then; we can obtain Q^* by using (7) and TP^* by using (13).

V. NUMERICAL EXAMPLE

To illustrate the solution procedure and the results, let us apply the proposal algorithm to solve the following numerical example. The results can be found by applying the Mathematica 6.0. We redo the same example of [8] (with little change) to see the optimal inventory control policy and optimal selling price. This example is based on the following parameters and functions: *A=$250/*per order, *c=$200/*per unit, *h=$40* per unit time, *s=$80/*per unit/per unit time, *o=$120/*per unit, θ*=0.08,* $f(t,p) = (500 - .5p)e^{-0.98t}$, $\beta(x) = e^{0.2x}$

First we solve $p_l = p_1 = bc - bp + a = 600$. After three iteration, we have $p^* = 600.748$, $t_1^* = 0.0596757$, $T^* = 0.0779141$, $TP^* = 73493.5$, $Q^* = 14.9959$.

Note that we run the numerical results with distinct starting values of 500,520,540,…,700. The numerical results reveal that TP^* is strictly concave in p , as shown in Fig.2. As a result, we are sure that the local maximum obtained here from proposed algorithm is indeed the global maximum solution.

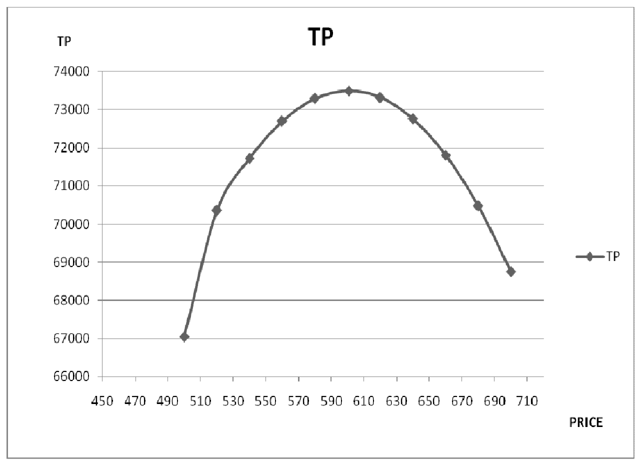

Fig. 2. Graphical representation of $TP(p|t_1^*,T^*)$

VI. CONCLUSIONS

In this paper, the model for determining the optimal pricing and optimal replenishment policy for deterioration item is developed. The demand is deterministic and depended on time and price simultaneously. Also, shortages is allowed and partially backlogged where, the backlogging rate is variable and dependent on the waiting time for the next replenishment. In the paper, some useful theorems which characterize the optimal solution are framed and an algorithm is presented to determine the optimal price and optimal replenishment policy. Finally, a numerical example is provided to illustrate the algorithm and the solution procedure.

This paper can be extended in several ways, for instance, we could extend model by considering the non- zero lead time. Also, we may consider the permissible delay in payment or promotions in the model. Finally, we could extend the deterministic demand function to stochastic demand function.

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ISBN : 978-602-97809-0-1

Strategic Decision Making for Production Optimization: A Case Study of Diesel Locomotive Works (DLW), Varanasi - India

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Abstract **- Diesel Locomotive Works (DLW) manufactures diesel electric locomotives primarily for Indian Railways. Indian Railways requirement is given to DLW by Railway Board, the top management body under Ministry of Railways, Government of India. DLW has an installed capacity of 125 locos. During 2004-2005, the unit produced 121 locos. Targets for 07-08 and 08-09 were increased to 220 and 250 locos respectively. Almost doubling the target in just four years was an uphill task. Such targets are still more difficult in government sectors like Indian Railways. However, DLW not only achieved it but also exceeded the same by producing 222 locos in 07-08 and 257 in 08-09. The paper aims to summarize the strategic decisions taken to double the production level of DLW in four years of time. The paper enumerates the possibilities upto which strategic and radical decisions can be taken in a government-owned industrial setup in India. The paper is basically a case study. To increase the out put, strategic decisions were taken to purchase/outsource large number of items which used to be manufactured in-house. Achievement of loco production targets was the result of concerted efforts by all departments. The strategic decisions have transformed DLW, from an integrated locomotive manufacturer, to more of an assembler of locomotives.**

Keywords - Outsourcing, Strategic Decisions, Productivity, Multi-Skilling.

I. Introduction

Diesel Locomotive Works is a production unit under Ministry of Railways, India. It manufactures diesel electric locomotives primarily for the requirements of Indian Railways. Every year a few locomotives are manufactured for non-railway customers and export commitments. Presently, locos manufactured are working in wide horse power range from 1350 hp to 4500 hp. The unit was established in 1963, as an integrated locomotive manufacturing unit, to manufacture diesel electric locomotives

of ALCO design in the horse power range of 1350 to 2600 hp. It had capability to manufacture diesel generating sets of similar capacities. The installed capacity of the plant progressively increased to 140 locos (102 WDM2, 20 YDM4 and 18 WDS6 types of locos) in 1989-90 as in [7].

In 1995 DLW went for transfer of technology agreement with General Motors, USA for upgrading the technology of diesel electric locos in India. From 97-98, manufacturing activities of 4000 hp WDG4 and WDP4 locos were started. The new design of locos resulted in doubling of the inventory level as practically all components of new locos were uncommon from the earlier ALCO type of locos.

The production level of the DLW slowly increased from 4 locos in 1963-64 to 164 in 1997-98. Then it gradually reduced to 121 in 2004-05 due to reduction in demand and then again peaked to 222 in 2007-08 and to 224 in 2008-09, additional 33 locos were manufactured from Parel workshop in 08-09, the manufacturing partner of DLW. As an integrated loco manufacturer, DLW required basically steel plates, sheets, bars, billets, structural steel sections, casting and forgings. The rest of the job of conversion from raw material to finished product was done internally.

With the targets pegged at 250 locos/year, capacity constraints in manufacturing were envisaged. To over-come the shortage of capacity, strategic decisions were taken to outsource many activities. Vendor development exercises were undertaken to develop supply sources of large number of items in bulk quantities. Design of many items was changed to improve productivity of in-house manufactured items. Shops contributed in production by improving productivity and using flexibility in deployment of staff and infrastructural resources. Finance, stores and other departments improved their working by removing the bottle-necks in their systems.

DLW has various departments like design, finance, stores, personnel, production etc. The production department is responsible for loco production. The loco consists of three major assemblies, block, engine and loco chasis with under-truck and superstructures. The various assemblies are manufactured in different shops and then assembled in loco assembly area. The production shops are divided into block, engine and loco division.

II. Research Methodology

ISBN : 978-602-97809-0-1

The case study methodology is a common feature in Supply Chain Management (SCM) research (e.g. [2], [17], [18]) and it can be used to review both intra- and inter-organisational interactions and relations. Typically, the case study employs a combination of research methods – and these may be qualitative, quantitative or both. Further, Reference [31] identifies three types of case study: exploratory, explanatory, and descriptive. The case study method has resulted in a holistic, in-depth investigation of the interacting issues of enhancement of production through strategic decision making. Reference [29] notes that case study research is not sampling research but that the selection of cases should maximize what can be learned within a specific time-frame.

The research paper is a case study. It depicts how strategic and growth oriented operational decisions are taken by practicing managers in government sector. In nut shell, there is little room to violate or circumvent the rules.

The methods of data collection employed included interviews, direct observation and company's documentary sources. Reference [30] notes the importance of using multiple sources of evidence within case study research. Observational evidence was gathered during formal events such as meetings and supplier development programmes and, less formally, during visits or interviews. These opportunities provided details of the research subjects' surroundings as well as the relevant interaction and behavioural and environmental conditions [28]. Interviewing the multiple participants involved in the thinking-doing under study not only are particularly useful steps, they become mandatory if we really want to achieve deep understanding in research on thinking-doing processes[1]. Individual depth interviews were conducted with the relevant executives/officers who are in-charge for outsourcing/purchasing activities and decision making to understand the dynamics of decision making. The outcome of the actions were discussed with respect to data available from files/reports and then views noted down. The interviews lasted for 60 to 90 minutes. Many a time interviews were supplemented with a round of the division and interview of the dealing staff.

Relevant files of the purchase, planning, accounts and other departments' were studied. DLW publishes various reports on accounting, safety etc.

III. TRACING THE HISTORY - DLW'S PRODUCTION PLANNING

Variation of production level, from DLW's premises, from 1997-98 to 2008-09 is traced in figure 1. The things became favourable in industries as GDP growth rate picked up from 4.3% in 2003 to 8.4% in 2006.

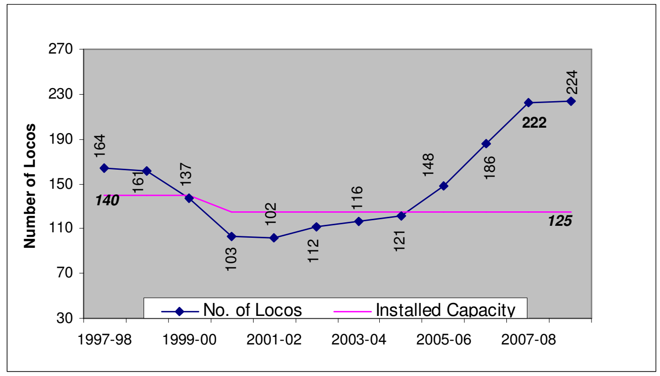

Fig. 1 Variation in Production Level of DLW

The demand for locos also started picking up. In Sep '06 Railway board revised its targets of 80 locos for 06-07, to 150 locos. In June'06, targets given for 07-08 were at 200 and for 08-09 at 250 locos. In Feb '08, targets for 07-08 were revised upward to 220 locos. In view of good economy, Railway board has projected the requirement of locos at the level of 250 in the coming years. To increase the production by 82% from 121 to 220, in just three years duration was looking beyond reach. Nearly 30% of manpower involved in direct or indirect production was lost due to retirement and meager intake of fresh faces. The strength of production staff was 3034 in 1997-98, which reduced to 2151 in 2004-05 [8].

OVERTIME – AS A MANAGEMENT PHILOSOPHY

Production level higher than installed capacity was managed by limited outsourcing and widespread use of overtime. Giving overtime to staff was a regular measure for about 20 years. Considerable savings are also achieved if hourly rates of overtime are near to the normal rates [15].

The peak of 164 locos in 1997-98 was managed by increasing the capacity of the shop by giving overtime to production related direct and indirect staff as no long term demand was seen in the horizon. Railway Board used to issue loco production targets on yearly basis, rather than rolling plan for 3 to 5 years [9]. Hence a short term solution of giving overtime to staff was resorted to.

Overtime increased by 31% in 97-98, in comparison to 92-93, whereas during the same period production staff reduced by only 2.7%, from 3120 to 3034 (e.g. [9]. [10]). It indicates that control and reasoning in giving overtime was lost. Researchers (e.g. [22]) have also confirmed that unions tend to establish and maintain overtime. Overtime is considered as undesired practice in the industries particularly in government sector as staff gets habituated to it. Hence in Oct'99 it was decided to get rid of overtime.

IV. STRATEGIC INITIATIVES

Target was 'doubling the outturn in 4 years'. Such type of targets are herculean tasks in industrial setups where volumes are low, items are specialized, made to order & not 'off the shelf' types, big in size and technologically intensive.

DLW as an organization responded very positively to the challenge thrown to it by Railway Board, by not only achieving

ISBN : 978-602-97809-0-1

the target but also exceeding it, through various strategic initiatives. Production of 121 locos of 2004-05 was done with fixed assets of Rs.144 crores [12]. To achieve outturn of 220 in 07-08 required almost doubling of fixed assets to Rs.288 crores. Availability of funds was a big problem. Moreover, even if the funds were available construction of facilities, procurement and installation of machines and their commissioning was not possible to be completed within a few months. At the same time, the government decided to go for overall reduction of staff strength and it became impossible to go for increase in staff to the level required for 250 locos.

Owing to the perils associated with overtime, increasing capacity and production with overtime was not envisaged. By outsourcing companies can not only lower their short-term direct costs but also their long term capital investments thus leveraging core competencies [26]. Outsourcing provides for possibilities to expand output with limited capital investments and increased flexibility with reduced risk of exposure (e.g [5], [21]).

A. OUTSOURCING/BALANCING INPUT: PRACTICING THE THEORIES

Core competency of DLW was in manufacturing of engine block, underframe, superstructures, under trucks, cylinder heads, connecting rod and camshaft. DLW has got special purpose machines, technical know how and highly skilled manpower required for manufacturing these items as core activities. In 05-06, as a capacity-enhancement measure, management decided to keep core competency items as shop manufactured and, to purchase the non-core assemblies and subassemblies. Outsourcing of non-core activities has been widely accepted and has been recognized and recorded by the researchers alike (e.g. [20], [24]). The production programme varies in both volume and product mix. Hence, product and volume flexibility concepts were utilized to outsource activities. Hence, DLW opted for balancing input activities. Balancing input is another name of outsourcing. 'Balancing input' is the input given to the production activities in the form of purchased items from trade, in full or part quantities of yearly requirement.

The extent of outsourcing done during the period 2004-05 to 2008-09 is as shown in the graph, which clearly depicts that DLW was able to generate workforce of 285 men in 07-08 and 463 men in 08-09.

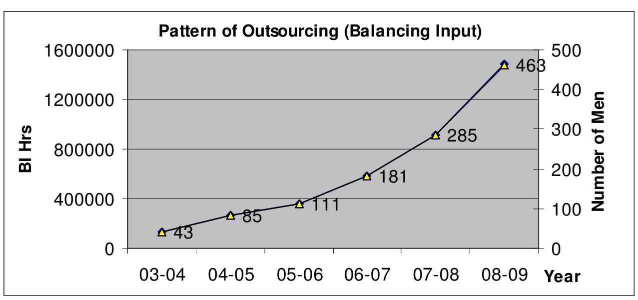

Figure 2: Pattern of Outsourcing in DLW

B. STRATEGIC DECISIONS IN OUTSOURCING

Traditionally, DLW used to resort to outsourcing simple, non core activities in fabrication as well as fabrication\machining. This trend was followed till 06-07. But as the target burgeoned, shops were not able to find small items to outsource. Whether to perform specific activities within the boundaries or outside of the boundaries is an issue of ongoing concern to firms [27]. Top management reviewed the policy of outsourcing and decided to outsource new items. For 07-08 onwards, items covered hitherto under core activity category, like underframe, engine block, main base; camshafts etc. were included in outsourcing list. Each of the core activity items was labour intensive, e.g. an underframe consumes 4500 hrs. Hence by outsourcing these items, large capacity could be created in one go. But at the same time extensive vendor development efforts were required and planned.

Parel workshop started helping DLW in 05-06, by supplying a few machining and fabrication items. At this point, another strategic decision was taken. DMW, Patiala, was entrusted to supply assembled engines to Parel at the rate of two per month. By 08-09, contribution of Parel increased to 33 locos, about 15% what DLW produced.

C. 'MANUFACTURING' TO 'PURCHASE'

In order to generate more capacity, 30 odd items were removed from 'manufacturing' list and made 'purchase' items. These items were small value items to fabricate or machine, but required lot of efforts to fabricate. By purchasing similar low manpower-high effort type of items, DLW was able to generate about 63000 hrs in 2007-08, equivalent to 20 men's work.

Division	03-04	04-05	05-06	06-07	07-08	08-09
Engine	0	1584	39449	148087	164483	213878
Block	24633	48696	66328	70223	116047	94543
Loco	113496	221404	249144	363083	633675	1173763
Total BI Hrs	**138129**	**271684**	**354921**	**581393**	**914205**	**1482184**
Equated Men	**43**	**85**	**111**	**181**	**285**	**463**

Table 1: Man hours equivalent Input planned as Outsourcing (Balancing Input)

D. IMPROVING STAFF UTILIZATION

Staff can be generated by improving the utilization of available staff. Various ingenious productivity improvement and wastage reduction methods were planned by production shops. By better management, it was ensured that the staffs were fully loaded. To take care of staff, welfare measures, such as redressal of grievances, availability of safety equipment, fast payment of dues etc. were efficiently managed. Deserving staff were awarded suitably from time to time.

V. PLAN IMPLEMENTATION

The rules framed by government are such that financial decision making requires many departments. Leadership in strategic sourcing planning is crucial not only in setting and communication clear objectives and targets but also in

ISBN : 978-602-97809-0-1

motivating and rewarding employees to improve performance [3]. DLW was fortunate to have a leader with a vision to make the organization capable of meeting stiff targets.

Production division is the core activity area where the actual loco production activities are undertaken. There was always resource constraint of material and manpower. By assimilating all the constraints, production division manufactured the locos as per the enhanced targets.

A. The Top Leadership

'Where there is a will there is a way', acceptance of target was the first move, which started with the belief of General Manager, the CEO of DLW, of achieving the targets. In turn he convinced top management, consisting of Chief Mechanical Engineer, Financial Advisor, and Controller of Stores that the targets were achievable. Each department was to be revitalized to rise to the occasion. Organizational value congruence reduce conflict by increasing the degree to which members identify with each other [6]. GM, DLW was able to imbibe the organizational values and objectives in his team so that all the departmental heads were able to dovetail their efforts to the common cause of targets.

GM used to spend daily 2 hrs on the production shop floor and another 2 hrs in other departments. During Shop floor visits, he used to meet officers and supervisors and most importantly the staff who, were actually working on the locomotive or its subassemblies. The GM ensured that, subsequent to shop visits, in next 2 hrs the problem and solution discussed on shop floor got implemented in design office or procurement cell. Then next day GM himself informed the staff that actions initiated on one's suggestions. The speed of the leader is the speed of the team [25]. The result oriented approach of GM set the ball of improvement rolling.

B. Unions and Staff

Before year 2000 the unions were of the view that everything should be made in-house, so that staffs' incentive is safe. Stoppage of overtime further cleansed the mind of unions and staffs. Now, the management had upper hand. The option was clear to the unions either to work for upliftment of DLW, be part of development of the nation or lag behind, lose orders and jobs to private parties in coming years. With increase in targets and general pro-privatisation scenario in the government sector, perception of unions changed. The change in perception was very positive. Unions became target-production oriented. They never objected to policies of outsourcing while ensuring that the present staff does not lose incentives.

C. Stores

In DLW, the purchase function is performed by Stores department. The demands are generated based on the locomotive production plan, tenders floated and evaluated and purchased orders are placed.

Previously, tenders used to be floated about a year before the requirement. Floating of tenders was advanced, by six months. Tenders were floated one and a half years before the requirement. Priority of opening of the tenders was fixed based on the time required for receipt of material against the tenders from the date of tendering. Global tenders were given top priority, followed by long-lead & bulky items and then came the turn of low value items. Minimum ordering quantity was increased to three to five years, for low valued items. It facilitated the better quality of the supplied items by bigger suppliers having better manufacturing facilities. Condition of phased delivery of products was included in the tender documents itself, which ensured that there was no excessive supply of material to DLW to choke the stocking wards. As a time saving device, in exceptional cases, repeat orders were placed on the suppliers to meet urgent requirements which arose due to failure of supplies from other suppliers.

As a vendor delight measure, the material was received and accounted for fast, reducing the time of bill payment within one month.

D. Design

Design division played crucial role in identification and development of sources for the items which were planned for outsourcing, at the same time simplifying the design and standardization of components used on different locos to reduce inventory [13].

Introduction of microprocessor control on locomotives was a strategic decision. WDG3 locos used to be manufactured with E-type excitation system. In the E-type excitation locos, shop had to make control panel and had to do lot of electrical wiring in the loco. From 06-07, the design of these locos was changed to microprocessor control from E-type control system. Microprocessor controlled locos' control panel was designated as trade item. Hence, lot of electrical and sheet metal shops' capacity was released for doing other work. Another advantage of these locos was that the wiring had less work content.

Outsourcing requires extensive search and development of vendors. Design teams undertook visits of likely suppliers, short listed the good ones and worked with the suppliers to develop items at the suppliers' premises. Development of vendors for superstructures, underframe, engine block, main base etc. was the major contribution.

E. Finance and Accounts Department

An indenter views the role of finance and accounts department as negative, just a department to create road blocks in the path of progress. At the same time finance and accounts have to see that public money is well spent. Hence finance has to make the balancing act. Previously, finance department did not appreciate their role and responsibility in meeting the production targets. Attitudinal change was required, which could be brought about by the senior managers, by way of counseling the staff and officers. A simple act of compiling all the check points in a check list reduced the cycle time of dealing with proposals from months to a few weeks. Proposals for procurement or works contract were sent to finance for

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financial concurrence. Previously as a routine files used to be returned to the proposing department many times, always with new set of queries. Hence crucial time was lost in to and fro movement of files resulting in delays in implementing decisions leading to delayed implementation of projects. The check lists ensured that proposals were made correctly at first place and checked in one go by finance. It also instilled sense of responsibility on the staff of finance department.

F. *Role of Quality Assurance*

To infuse the ideals of assuring the quality of the processes at shop and at vendors' premises level, inspection department was reorganized and renamed as quality assurance department. Officers and supervisors were re-designated as quality assurance managers.

To ensure quality of all the vendor supplied items, a system of check list was evolved. Based on the customer and shop feedback, quality points were included in the check list. These check lists were continually updated to cover the quality issues based on the new problems encountered during inspection or shop usage. The check lists were made available to the suppliers so that they themselves could check the items produced and only then offer the material for inspection or supply on their own certificate. In short, suppliers were told about our quality requirements objectively.

VI. Management by Production Division

Production division ensured that the resources are fully utilized, productivity improved, process simplification resorted to and most suitable items identified for outsourcing. Production team is equipped with the required knowledge. Moreover realignment of resources of shops is required once the outsourcing materializes. Hence bottom-up approach is preferable. Staff management incorporated productivity improvement measures, waste reduction and superior man management methods like multi-skilling, rotation, floating staff etc.

A. *Reduction in 'Overhead Staff'*

The shop staff is categorized as direct worker (dw), essentially indirect workers (eiw) and non –incentive (ni) staff. For doubling the production large numbers of staffs were required. To generate staff, efficient staff management was resorted to, by reducing the number of eiw and ni. It was done by zero base assessment of the staff required for other than production work. The productivity of eiw and ni was increased by better tooling, protective equipment, material handling equipment, environment, measuring and test equipments and off course loading the staff to full of their capacity. Hence it is apparent that manpower was so managed that dw were reduced least where as overhead causing eiw and ni were reduced to greater extent.

B. *Productivity Improvement Measures*

To increase capacity of a plant, productivity improvement is also one of the important methods. From 04-05 onwards, major contributor of productivity improvement measures was the time study of new processes. A new axle turning lathe was commissioned in Nov'07. The commissioning activity was completed very fast and the machine was put into production in Dec'07 itself. The rate of production with the new machine was benchmarked at 2.2 axles per shift compared to 1.5 axles with older machine, resulting shooting up of 50% on productivity. Similarly the productivity of new wheel turning machine was kept at 25% higher than the old machines.

C. *Waste Reduction Measures*

Wastage of capacity in production is broadly categorized as - replacement hours and idle time. A 'replacement hour' is the time required to correct or repair a defective component. 'Idle time' is the time for which staff wait for work due to non availability of raw material, machine, power etc. So a replacement hour is the indicator of poor quality and idle time is the indicator of labour wastage. According to Reference [23] - many businesses are able to reduce the waste disposal requirements and associated waste costs through a combination of various schemes such as: (a) cleaner production initiatives (b) source management of waste streams and (c) supply chain partnerships.

Staff and supervisors were motivated to control the process, modify the methods to enhance the quality of the product. "Do it right, the first time" motto was explained and engrained in the minds of staff. Reduction in replacement hours by 27% over 04-05 in 08-09 was achieved (from 43633 hrs to 31686 hrs). Idle time could be reduced by optimal utilization of manpower. Whenever there was a failure on account of machine, staff was shifted to another machine or to similar machines. Idle time was reduced by 38% from 98908 hrs in 2004-05 to 60637 hrs in 2008-09 [14]. Reduction in replacement hours and idle time was equivalent to generation of 24 staffs.

D. *Innovative Measures*

The productivity improvement is a never-ending journey. By carefully planning and execution, the painstaking investment in the initial cost, effort, and people may be rewarded by overwhelming results. The dimensions of vertical trust (trust between employees and leaders) are positively related to the dimensions of organizational innovativeness [16]. Change must involve people and must not be imposed, plan the actions, establish communication channels are some of the process commandments for improving the productivity [25]. Production division, followed these commandments, designed and executed innovative measures, resulting in increased production.

Although shops had constraints of limited manpower resources and irregular supply of items from trade yet they utilized the staff completely by devising innovative measures, improved the processes and production, hitherto unknown in railway's governmental parlance. Some of the measures are as follows

1). Availability of material was not always uniform. There were always shortages of material in first few months of a year in the assembly area, due to consumption of material at a higher rate, towards the end of the previous year. It resulted in excess capacity or idling of staff on one occasion and manpower capacity constraints at the other.

2). In 05-06, a new method of staff utilization was implemented in sheet metal shop. For first six months full strength of staff was deployed in Sheet Metal Shop, to advance manufacturing of superstructures. When material position in assembly area improved, 30 sheet metal shop staffs were transferred to underframe and assembly area to increase production. Temporary shifting of staff became the norm to tide over the manpower constraints in the localized area of shops.
3). Similarly, few artisans of Truck machine shop were made flexible and floating in the sense that they were transferred to assembly or underframe area where ever capacity constraint was noticed.
4). As more and more outsourced material started trickling in, production level of sheet metal shop, which used to produce superstructures of the order of 15 locos/month, was truncated to produced only 2 locos/month of outturn. The man power so saved was transferred and utilized in underframe shop and loco assembly area. Now the shop makes items just sufficient to keep the CNC machines operational and to avoid complete wipeout of skill of fabrication of superstructures.
5). Floating gangs of fitter and welders were developed by withdrawing few staffs from different sections for specific periods.
6). Similarly machinist of general purpose CNC machines and that of conventional machines were trained in operation of at least three machines. It ensured flexibility in operation of machines, clearing load centers, reduction in idle time.
7). DLW's Technical Training Center trains act-apprentices for 2 years. These apprentices are not railway employees. Usually these trainees are given training in laboratory conditions. As an unconventional method 80 trainees were booked to work on locos, as on the job training for one year. By utilising trainees, shops were able to maintain the production all time of the year by drastically reducing the impact of leave or low attendance of regular staffs.
8). Practically in all manufacturing systems problem of unbalanced production line exists. To balance the production line, more staff was employed at the point of constraints. Such points were identified and staffs were booked in 3rd shift, e.g. in block, underframe, truck machine shop, CNC machines and light machine shop.
9). Increase in capacity was also achieved by improving processes, there by reducing rejections. Shops truly fulfilled its responsibility by improving the quality of manufacturing process. For example, detailed study of camshaft manufacturing processes resulted in reduction of rejections from 11% in 2005-06 to 6.5% in 2008-09.
10). Cylinder head for engines are complex castings. Quality of casting has got great bearing on the quality of machined product. Each head passes through 15 different stages. Rejection at any of the stage causes complete rejection of the head losing up to two months of work. A strategic decision advised by shops was to outsource cylinder heads to casting suppliers, so that defects are controlled at suppliers end.
11). Similarly shop identified items which were low in manpower content and criticality and could be outsourced without jeopardizing the product quality. For example, control shaft consists of 35 small items; each item goes to many load centers.

E. Production Control and Communication Meetings

Communication plays critical role in an organization whether it is vertical or horizontal. Downward vertical communication can stimulate employee commitment. Further, it is much more effective to build on freedom and motivation of employees [4]. DLW as an organization has matured to communicate in all directions at operational level. The seamless flow of information was made possible by the General Manager. Direct contact of General Manager with officers, staff and supervisors, as detailed in leadership paragraph resulted in excellent flow of information. The freedom to staff and supervisors to communicate and propose changes in manufacturing processes energized the production team.

At shop floor level, daily meetings were conducted in the morning on production issues. These meeting were modified to deal the extended issues concerning quality, safety, environment and process development. Efforts were put in to foster team working. Fighting supervisors were persuaded to settle issues bilaterally before start of the meeting. It resulted in competition among supervisors that they should not get a bad point in the meeting. Stress was on the completion of the job on requests of one another without the intervention of higher officers. The culture of cooperative working gave rise to sense of ownership of the shop to the supervisors. Cooperation and ownership resulted in automatic removal of production problems in-situ and helped production enormously. 'Ownership as a motivator' has been studied by many authors. Researchers have concluded that ownership improves productivity [19]. Though in government industry's context, ownership stands for giving certain degree of freedom to decide and work.

Communication gap between supervisors is dangerous as it results in lack of focus on priority. Supervisors and their team of staffs tend to fall apart. There is always a suspicion about manager's decision, lack of clear direction, results in lack of ownership in decision and interest at shop floor.

VII. Conclusion

DLW was established about four decades ago to manufacture diesel electric locomotives. Till 04-05, its manufacturing philosophy was that of a truly integrated diesel locomotive manufacturing plant. The complete engine, underframe, superstructure fabricated bogies and over 2000 components were manufactured under one roof starting from such basic construction material as plates, sheets, bars and pipes. With increase in production targets DLW has transformed itself from an integrated locomotive manufacturer to a locomotive assembler. The management and staff has shown dexterity in both as an integrated manufacturer and as well as an assembler. The success has been built on the outsourcing of manufacturing activities, bringing attitudinal changes in working by various departments, flexibility and multi-skilling of production staff. Ability to get the material out of vendors was the strong point of the organization. The cooperative, flexible, motivated and ownership driven staff is the inner strength of DLW.

ACKNOWLEDGMENT

The authors wish to acknowledge the contribution of DLW-Varanasi and FMS-BHU, Varanasi (INDIA) for conducting this study. Further, first author is thankful to All India Council of Technical Education (AICTE) CAYT Scheme for funding.

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

Movie Advertising Feature on SoloMovie's Website Using Association Rule

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Abstract **– This paper discusses the design of movie advertising feature on SoloMovie's website. The movie advertising feature is a component that installed on the SoloMovie's website. It displays movie advertising based on customer characteristics which are obtained from customer transactions database. An apriori algorithm, one of an association rule algorithm in data mining technique is used to process the database. The feature displays the movie advertising for every customer personally and helps SoloMovie to see the pattern of movie categories which are pleased with the customer.**

Keywords **— Data mining, association rule, apriori algorithm, movie advertising feature, and website.**

I. INTRODUCTION

SoloMovie is a private company in rental services of like mini-cinema and karaoke rooms. Customers can rent their room to watch the movies or do karaoke. SoloMovie has a website and facebook account as a service publication media. Unfortunately, the website only publishes company profile. It didn't publish movie information that were available on the SoloMovie. Then, the facebook only be used by SoloMovie to publish the new release movies. Ideally, the website becomes the main media for publishing information, such us company profil, updated content, and various promotions. Thus, the website becomes one of efforts to improve the quality service for customers.

In addition, SoloMovie also did not take the benefit from the customer transaction database for the broader interests. In other words, the data became data tombs. By data mining techniques, it can be analyzed to find relationships between the data and obtained new information that is easily understood and useful for the owner ([3], [7]). Data mining was known as knowledge discovery in data, using automatic or semiautomatic tools [2]. Reference ([4]-[6]) state that, generally, the tasks of data mining are prediction, classification, clustering, and association. Prediction is the process of determining the pattern or behavior of specific attributes in the data for the future. Classification is the grouping of data into categories based on existing samples. Clustering is the grouping of objects without any sample. The association is making the rules relating to the set or item sets with other items, so the presence of an items in a transaction affect the possibility of an item or a combination of other items presence.

Association rule was known as market basket analysis. It is used to analyze customer buying habits. It is widely used for data analyzing of large sales transactions to make a promotion, customer segmentation, targeting, and catalog design ([3], [4], [7]). For example, the result of market basket analysis revealed that 80% of the people who buy bread, noodles and sauces will also buy milk. In practice, the information can be used for organizing products in the display or giving special discount/promotion. Reference [1] utilized the market basket analysis for retail. Amazone, an online book store also utilized association rule to displays book advertising that have an association or a relationship with the books purchased or seen by customers [4].

This paper discusses an implementation of association rules, particularly an apriori algorithm to display the movie advertising on the SoloMovie's website. The database used is the member customer transaction. The advertising presented is more personal for each member and general for non-member.

II. METODOLOGY

The designing of movie advertising feature is divided into two stages. First, we generate an association rule and knowledge presentation form from customer transaction database. It has seven steps which were known as knowledge data discovery (KDD) steps. It is data selection, data cleaning, data transformation, data integration, data mining, pattern evaluation, and knowledge presentation [2]. Second, we made a website component to implement the KDD as a movie advertising feature into SoloMovie's website. It is include designing of website interface and programming of website component.

The first step in the KDD is selecting tables and fields in costumer transaction database. Only kategori_film, data_film, transaksi, and detail_transaksi table were selected. Then, we clean or discard unuseful data from the tables. The next step is transforming data into tabular format to simplify the data processing. Then, we use the apriori algorithm to generate the pattern of movie categories which usually viewed by the members. The next steps is identifying and evaluating the patterns that have been formed. The last step is the design of knowledge presentation. It is designing the rules of advertising that will be used to display the movie advertising for the members, based on patterns that have been obtained.

The following are association rule formulas and an apriori algorithm.

A. Association Rule

Association rules task are searching and finding relationships between existing items in the collection of data, so the presence of items in a transaction affects the possibility of the existence of another item or a combination of other items ([4]-[6]). Reference [4] stated that there are three parameters that must be determined before processing data, ie a minimum of frequent item sets, a minimum support and a minimum confidence. In the generating an association rule, if there were frequent item sets, support and confidence which are smaller than the minimum values of them, the rule is not feasible to use. Frequent item sets are an item or a combination of high occurrence frequency of items. The minimum value of frequent item sets needs to be set at the beginning as the initials. Support is the number of transactions containing items both in antecedent and consequent. Support measures the magnitude level of the validity of rules that was generated. Confidence is the ratio between the number of all items in antecedent and consequent to the number of all items in antecedent of all transactions. Confidence measures the degree of uncertainty rules "if-then" formed from the association rules. The term antecedent used to represent the "if", and the consequent represents the "then" in the association rules. For example, "if action then horror", it mean that action as antecedent, horror as consequent. Since there was no specific formula to determine the minimum support and confidence, it can be determined by the following formula.

$$MinimumSupport = \frac{\Phi}{N} \tag{1}$$

$$MinimumConfidence = \frac{\Phi}{K} \tag{2}$$

Φ	Minimum frequent item sets
N	Total number of members who have rental transactions of mini- cinema room.
K	Number of movie categories which satisfy Φ

In this study, we used N as the number of members who have rental transactions of mini-cinema room, not as total number of transaction (as usually in market basket analysis). It was taken because the aim of this study is to find out what movie category viewed simultaneously by a member. The calculation of the support and confidence as follows [3]:

$$Support(A,C) = P(A \cap C) = \frac{N_{A \cap C}}{N} \tag{3}$$

$$Confidence(A,C) = P(C \mid A) = \frac{P(A \cap C)}{P(A)} = \frac{N_{A \cap C}}{N_A} \tag{4}$$

A	A set of movie categories acted as antecedent
C	A movie category acted as consequent
$N_{A \cap C}$	Total number of members who viewed both A and C.
N_A	Total number of member who viewed A.

The formula (3) shows that the support is the ratio between the number of members who viewed both A and C and the total number of members who have transactions of mini-cinema room rentals. Confidence is the conditional probability that all of transaction contained consequent, it exists in antecedent. An association rule is formed when the support and confidence are greater than minimum support and confidence.

B. Apriori Algorithm

Association rules using algorithma apriori has two stages [3].

1. Find all frequent item sets; that is, find all item sets with frequency $\geq \Phi$. It is known as join step.
2. From the frequent item sets, generate association rules satisfying the minimum support and confidence conditions. It is known as prune step.

C. Lift Ratio

Lift ratio used to evaluate the pattern whether it has a strong association or not [4]. Lift ratio is the ratio between the confidence of a rule and benchmark confidence. Benchmark confidence is the ratio between the number of all items acted as consequent and the total number of members who have rental transactions of mini-cinema room.

$$BencmarkConfidence(A,C) = \frac{N_C}{N} \tag{5}$$

$$LiftRasio(A,C) = \frac{Confidence(A,C)}{BencmarkConfidence(A,C)} \tag{6}$$

III. RESULTS AND DISCUSSION

The following are the results of the KDD and the design of movie advertising feature.

A. Data Selection

There are four tables that are selected from all tables in SoloMovie data base. The tables and the fields are shown in

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Figure 1. Using a query technique, we can make a single table that display data from all of the fields.

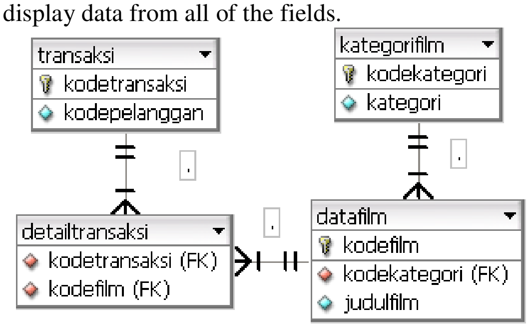

Fig. 1 The tables and fields for data mining.

B. Data Cleaning

From query, we found that total number of rental transactions is 418 transactions. Then, 94 of them done by a nonmember, and 18 transactions carried out by the owner of the SoloMovie. Thus, there are 305 rental transactions made by 184 members. So the total number of members who have rental transactions of mini-cinema room (N) are 184.

C. Data Transformation

At this stage, we made tabular format and transactional format of the data. Transactional format has two fields namely ID field and the category field which characterized by a single transaction. The tabular format is a matrix form, which the left side is members and the top are movie categories. We place signs 1 on a cell of the matrix if a member views the movie category, and 0 if conversely. The tabular format is useful for data mining processing.

D. Data Mining

For the initial, below are the minimum frequent item sets, support and confidence.

$$MinimumFrequent\ (\Phi) = 4$$

$$MinimumConfidence = \frac{4}{10} = 0.4 = 40\%$$

$$MinimumSupport = \frac{4}{184} = 0.0217 = 2.17\ \%$$

By doing apriori algorithm (join and prune steps), the final association rule generated was shown in Table I.

TABLE I

FINAL ASSOCIATION RULE

Pattern "If A, Then C"	*Support* and *Conficende*		Lift Ratio
	S (%)	C (%)	
if drama romantis, then drama	2.17	57.14	1.55
if action and comedy, then horor	2.72	71.40	2.23
if action and comedy, then drama	2.17	57.14	1.55
if action and horor, then comedy	2.72	41.67	2.07
if action and drama, then horor	2.17	40.00	1.25
if action and drama, then comedy	2.17	40.00	1.99
if comedy and drama, then action	2.17	44.44	1.95
if comedy and horor, than action	2.72	62.50	2.74

The final association rule was generated in four iterations. In the second iteration, we found a pattern "if a drama romantis, then drama" (the first pattern). It has support 2.17% and confidence 57.14%. Support 2.17% indicate that as many as 2.72% (4 members) of the total members (184 members) who seen the drama romantis movie, usually see the drama movie. Confidence 57.14 % indicate that 57.14% members who saw the drama romantis movie, also saw the drama movie, or as much as 42.86% of them have not seen the drama movie. The other patterns or final association rules were generated in third iteration. In the fourth iteration, we didn't find a pattern because there was no pattern satisfying the minimum support and confidence. The iteration was stopped in the fourth iteration because there were no item sets which have frequency ≥ Φ for the fifth iteration.

E. Pattern Evaluation

Lift ratio is a tool to evaluate the rules. Table I show the lift ratio of each rules. It can be seen that the last rule "if comedy and horror, than action" has the highest lift ratio, 2.74. It means that the rule has the highest strength of association compared to the others.

F. Knowledge Presentation

Movie advertising on the website will be displayed based on the final association rules. The association rule actually showed the member habits in movie renting. So, each member will get different movie advertising based on their habits or their rental transactions. At this stage, we design a concept, how to show the movie advertising based on the probability of member transaction and final association rules. It shows in Table II.

TABLE II

CONCEPT OF KNOWLEDGE PRESENTATION (ADVERTISING)

No	Possibility of Each Member Transactions	*Knwoledge Presentation*
1	All of the movie categories which have seen by the member are in the final association rules.	The application displays the movie categories that exist in the final association rules. It displays five movies from each category.
2	A member seen the movie categories which a part of it are in the final association rules and another are not.	The application displays the movie categories that exist in the final association rules. It adds other movie categories. It displays five movies from each category.
3	All of the movie categories which have seen by the member are not in the final association rules.	The application displays the movie categories which have seen by the member. Each category displays the five films.
4	Never done a mini cinema rental transaction.	The application displays the new release movie.

Table III show the sample of knowledge presentation or advertising feature in the SoloMovie's website. Each category will be displayed 5 movies.

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TABLE III
SAMPLE OF KNOWLEDGE PRESENTATION (ADVERTISING FEATURE)

No	**Member Name**	**Member Transactions**	***Movie Categories Displayed***
1	Erose Perwita Sagi Putri	*comedy, action, action*	*Comedy, action, horror*
2	Probo Pranomo Dewo	*Action, adventure, horror*	*Action, adventure, horror, comedy*
3	Septiana Arya	*drama comedy, thriller*	*drama comedy, thriller*
4	Ririn	-	*New release movie*

G. Component of Advertising Feature on SoloMovie's Website

An interface designed was implemented using a content management system (CMS) web, Joomla®. The interface designed has two parts, namely the interface for non member and the interface for members (using login). Figure 2 show the design of interface for members. The movie advertising feature was implemented on "Special films for you" position.

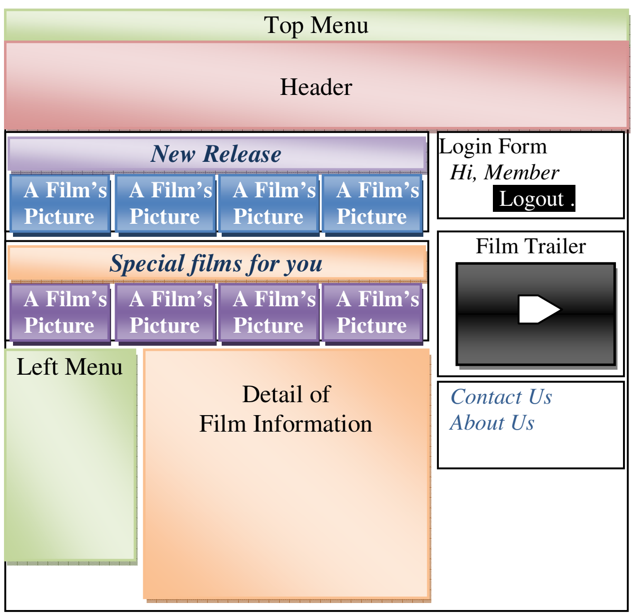

Fig. 2 Design of SoloMovie 's website.

Figure 3 show the prototype of SoloMovie's website. A component developed is installed in the web. It uses appriori algorithm to generate final association rules from the transaction database. Then the rule is used to display movie advertisement according to the concept of knowledge presentation (advertising) that was generated as shown in Table II. A member who has login will see the movie advertisement personally.

Fig. 3 Prototype SoloMovie 's website.

IV. CONCLUSIONS

It has utilized the SoloMovie's database of member transaction for making the movie advertising feature. It is installed on SoloMovie's website. The feature displays the movie advertisement to every customer personally and helps SoloMovie to see the pattern of movie categories are pleased with the customer.

ACKNOWLEDGMENT

Thanks to Mr. Harry as the owner of Solo Movie for giving us an oppurtunity to make a research in their company and utilizing their database.

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ISBN : 978-602-97809-0-1

An Efficiency Analysis of the Philippine Public Basic Education Sector

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Abstract – **This paper presents a comparative examination of the relative efficiency levels of the basic education sector of the Philippines, using parametric and non-parametric tools of analysis. The study sought to identify the basic school inputs relevant to improvements in test scores, considered to be the output in the empirical model developed. Data from the DepEd, NETRC and NSCB were used. Using school divisions as the basic decision making unit (DMU), a parametric method of presenting units as firms facing technical inefficiencies in production with a stochastic component called Stochastic Frontier Analysis (SFA) was used to identify education and environmental inputs key to output improvement. Maximum-likelihood estimates confirm that teachers, rooms and seating ratios significantly improve outputs at the elementary level, while fewer significant variables registered at the secondary level. Technical efficiency scores (89.4%-elementary, 90.4%-secondary) show that both levels are facing technical inefficiencies in translating outputs into outcomes, with variations across divisions. A non parametric efficiency tool, Data Envelopment Analysis (DEA), was used to compute for the relative output and input efficiency scores for both public elementary and secondary school divisions. Results show that school divisions have output and input efficiency scores of 0.79 and 0.71 at the elementary level, and 0.69 and 0.68 at the secondary level. This implies that test scores can still be further improved by 21% at the elementary level and 31% at the secondary level, keeping inputs constant. The input efficiency scores imply that inputs can still be reduced by 29% at the elementary level and 32% at the secondary level and still maintain the same level of output of test scores. The study adds further empirical support to the need of greater reform in input-relevant policies of the public basic education sector in the country.**

Keywords — **Education Production Functions, Education in the Philippines, efficiency frontiers, linear optimization, efficiency**

I. INTRODUCTION

Among the publicly provided social services in developing countries, education plays one of the most central functions of sustaining long run economic growth and reducing poverty. It also greatly advances a country's stock of human capital, simultaneously with public health, nutrition and sanitation, among others. In the seminal work of Lucas (1988) on endogenous growth models, he emphasized the differences in human capital accumulation among countries as a key factor in explaining differences in their economic growth. As a consequence, economies need to invest substantial resources in order to promote economic growth.

In the Philippines, 15.6% of the national government expenditures go to education, culture and manpower development [1]. The percentage is comparable with that of countries of similar per capita income [2]. On the other hand, local governments spend 5.9% of their total expenditures to education as well. The national government, though the Department of Education, still remains to be largest source of funding for the basic education which at 2008 figures stand at PhP155 billion [3]. LGUs contributed approximately PhP27.8 billion in 2008 [4].

Despite the country spending a considerable proportion of its national and local government resources on education, its education outcomes specifically on the school attendance rates are average compared to that of countries with similar per capita income levels [2]. However, when one takes into consideration test scores, one finds that the Mean test scores from the National Achievement Tests (NAT) have not improved significantly in many years. It has also varied considerably within and among schools [5]. Disparities in attendance rates are also very much pronounced among regions/provinces in the Philippines, especially between poor and richer regions. Boys' access to schools has also been found to be less favorable than girls across all income groups and in most localities [6].

This paper aims to contribute the policy analysis of explaining wide discrepancies in education outcomes in the Philippines, using parametric and non-parametric tools of analysis whose characteristics add value to the possible policy recommendations. These two tools, the Stochastic Frontier Analysis (SFA) would help identify inputs that help attain higher output efficiency levels, while the Data Envelopment Analysis (DEA) would help in comparing relative efficiency levels. Both tools are increasingly becoming popular tools of efficiency analysis.

II. OVERVIEW OF THE BASIC EDUCATION SECTOR IN THE PHILIPPINES

The conduct of the basic education system in the Philippines is primarily anchored to the Department of Education (DepEd). The DepEd operates elementary and secondary schools through more than 180 school divisions, which roughly represent cities and provinces (includes municipalities).

A. *Trends in Public Spending*

ISBN : 978-602-97809-0-1

Overall real public basic education sector spending in the country declined from 1998 to 2008. Real LGU education spending remains fairly constant [7] and most of the spending still comes from the DepEd, indicative of the highly centralized spending structure of the sector.

As a share of the Gross Domestic Product and National Expenditures (less Debt Servicing), education's share continues to decline. From 19.7% share of the National Government Expenditures, it went down to 15.8% last year. The same pattern can be observed from education spending as a percentage of GDP, where the latest figure stands at 2.1% from 3.24% in1998. In per pupil real terms (using 2002 prices), real per pupil spending has remained fairly constant within the time period, while nominal real per pupil spending has increased by more than 20%. In the year 2005, real per pupil spending dropped at its lowest point within the time period at PHP 6,619 [1], [7].

B. *Trends in Outcomes*

In the recent years, improvements in test scores were made both at the secondary and primary level. The growth in test scores is "too slow" amidst reforms. The Mean Percentage Scores (MPS), the measure used by the National Education Testing and Research Center in measuring aptitude scores, was below 50 for many years at the secondary level [3]. Though the primary level has higher averages, it has not improved significantly as well. Divergence between scores in subjects areas persist. Moreover, boys tend to have worse scores than girls and poorer performing less than urban regions.

III. Theoretical Framework and Empirical Model

A. *Education Production Functions*

There is no specific economic theory that deterministically relates education outcomes and specific education inputs. There is however, an education production function (EPF) that treats school districts/divisions as producers, concerned with maximizing student achievement test scores as "outputs". The EFP is closely an adaptation of the production functions in the producer theory in microeconomics. It examines how student achievement outcomes are influenced by school inputs, household characteristics and community variables. As a tool to analyze education outcomes, it has been debated tremendously as which explanatory variables to include is often a subject of controversy. Theoretically, there is no definite set of variables to include [8]. There are also debates in schooling quality literature over whether the most used commonly school inputs such as class size, teacher experience, teacher education and term length make a difference in the cognitive development of school children [9]. Variable omission bias may also pose a difficulty since many the variables that would account for student ability are hardly measurable, leading to an omitted variable bias [10].

Because of the limited availability of data, a lot of EPFs have focused on input based information/variables. Some models had failed to account for community variables that are capable of explaining external shocks not within the controls of the school and affecting student performance, i.e. nutrition status, poverty etc. As such, this paper formulated a stochastic specification of the EPF that can be used to analyze the efficiency of education management units, which shall be treated as the decision making units (DMUs) of the education sector.

B. *A Stochastic Presentation of the EFP*

A stochastic production specification stems from the "anecdotal evidence" and other empirical evidences as well that not all producers are always successful in their optimization problems. Kumbhakar and Lovell (2000) explains that not all producers succeed in utilizing the minimum inputs required to produce the outputs they choose to produce, hence, not all producers are technically efficient. Moreover, even if producers are technically efficient, not all producers succeed in allocating their inputs in a cost effective manner, hence, not all producers are cost efficient [10].

Due to the evident failure of some producers to optimize, it may be desirable to "redefine" production and cost analysis, away from the traditional functions towards frontiers. Kumbhakar and Lovell (2000) define these production frontiers as the minimum input bundles required to produce various input bundles, or the maximum output that can be produced with various input levels given a technology. Producers are labeled as technically efficient if producers are operating on their frontiers and producers are technically inefficient if producers are producing beneath it. A production frontier can be written as

$$y = f(x_i;\beta)*TE_i \qquad (1)$$

Where y is the scalar output of producer i, i=1,…I ; x is a vector of N inputs used by producer I, $(x_i;\beta)$ is the production frontier and β is a vector of technology parameters to be estimated. TE is the output oriented technical efficiency parameter, then it follows that

$$TE_i = \frac{y}{f(x_i;\beta)} \qquad (2)$$

This equation defines that technical efficiency as the ratio of observed output to maximum feasible output. y_i achieves its maximum feasible value of $f(x_i;\beta)$ only under the condition that TE_i=1. In other words, if TE_1<1 presents a measure of shortfall of the observed output from the maximum feasible output. In equation 1, the production frontier $f(x_i;\beta)$ is deterministic or involves no randomness. In equation 2, the observed shortfall of observed output from the maximum feasible output is attributed to technical inefficiency; as a consequence, such specification does not take into account that outputs can be affected by random shocks that are not under the control of the unit. In order to incorporate producer-specific shocks, requires the specification of a stochastic production frontier, hence the equation (1) can be stated as

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$$y = f(x_i;\beta) * \exp\{v_i\} * TE_i \qquad (3)$$

where $[f(x_i;\beta) * \exp\{v_i\}]$ is the stochastic production frontier[1]. As a consequence, the function now captures a deterministic part $f(x_i;\beta)$ common to all producers and a stochastic part $\exp\{v_i\}$, which captures the effect of random shocks on each producer. Consequently, the equation (2) would now be composed both of a deterministic and a stochastic component

$$TE_i = \frac{y_i}{f(x_i;\beta) * \exp\{v_i\}} \qquad (3)$$

which defines technical efficiency as the ratio of observed output to maximum feasible output in an environment characterized by $\exp\{v_i\}$. Kumbhakar and Lovell (2000) assumed that $f(x_i;\beta)$ takes a log-linear or a translog Cobb Douglas form. The stochastic production function can be specified as

$$\ln y_i = \beta_0 + \sum_n \beta_n \ln x_{ni} + v_i - u_i \qquad (4)$$

Where v_i is the two-sided "noise component" and u_i is the nonnegative technical inefficiency component of the error term; v_i is assumed to be independent and identically distributed random variable. It is also symmetric, distributed and independent of u_i.

Since the stochastic production makes it possible to estimate the degree of efficiency in the utilization of inputs by producers, the analysis can be extended one step further and relating producer performance with "exogeneous" variables, which are not directly under the control of the DMU but nevertheless influence the outcome of the production process. Pereira and Moreira (2007) further explain that these variables characterize the environment were production takes place. This may take as an alternative specification, along the lines of incorporating inefficiency determinants into the SFA [12].

Furthermore, these exogenous variables relating to the environment may be determinant of producer technology. Should a relevant variable is omitted from the production function; producers that use "it" more intensively would appear more efficient [12]. As such, omission of the variable may lead to dubious efficiency estimates. As a consequence in some cases, environmental/exogenous variables may have explanatory power for efficiency and a possible value added when tested may be checked.

C. Data Envelopment Analysis

Data Envelopment Analysis is linear programming-based tool for the analysis of the efficiency of producers, termed as decision making units (DMUs). It has been widely used to compare relative efficiencies of organizations like hospitals, schools, banks and non-profit organizations among other things. A score indicates whether a certain DMU is performing efficiently compared to other units. The score is normally expressed as 0-10 or 1-100%. DEA works by comparing the output and input ratio of the DMU on the efficient frontier. Mathematically, DEA can be presented as

$$\max\left[\frac{\sum_{s=1}^{S} u_s \times y_{s1}}{\sum_{m}^{M} v_m \times x_{m1}}\right] \quad \text{s.t.} \quad \frac{\sum_{s=1}^{S} u_s \times y_{s1}}{\sum_{m}^{M} v_m \times x_{m1}} \le 1 \qquad (5)$$

where i=1,..n ; u_s , v_m >0, ; and s=,…S ; m=1,…M

Where y_{s1} is the quantity of output s for DMU 1, u_s is the weight of output s, x_{m1} is the quantity of inputs M of DMU 1 and v_m is the weight for input m. This imposition attempts to find a set of output and input weights that will lead to maximum efficiency score of the DMU with the constraint that no DMU will have a score greater than one [14].

Coelli, Battese and Rao (1998) illustrates the concept of DEA frontiers in terms of constant returns to scale and variable returns to scale. The Constant Returns to Scale (CRS) frontier of the production function is the line 0-CRS. The Variable Returns to Scale (VRS) is represented by the concave curve VRS_o to VRS_1 . The technically efficient DMU is on both frontiers. The VRS curve allows for the optimal level of outputs and inputs to vary with the size of the DMU in the sample [13].

Efficiency score could be further decomposed into its two components, Technical Efficiency (TE) and Scale Efficiency (SE). To illustrate, a certain DMU on point J would have inefficiency measured by $\frac{YZ}{YI}$ on the CRS-DEA, which is basically the distance of J from the CRS frontier. One of ratio's component is scale inefficiency defined by $\frac{YZ}{YJ}$, the distance between CRS and VRS frontiers. After accounting for SE, pure TE is the point $\frac{YJ}{YI}$.

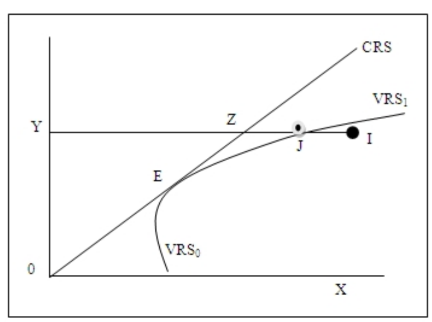

Fig. 1. Data Envelopment Analysis Illustration.

[1] The idea behind the SFA was introduced by Aigner, Lovell and Schmidt in 1977, as well as Meeusen and van den Broeck in 1977. A production frontier with an error term is presented in the model. The error term contains two components, one allowing for the technical inefficiency and another that permits

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Furthermore, efficiency scores from DEA can be computed as either input oriented or output-oriented. The former answers the question, "*by how much can inputs can be reduced without changing output levels?*", while the latter answers, "*how much outputs can be increased further without changing input bundles?*". Efficiency estimates were to be computed using DEAP 4.1 developed by Tim Coelli (1996). Variable Returns to scale were used to analyze efficiency levels to take into account the size of school divisions. School divisions manage as few as two (in case of Vigan and Munoz cities) to as much 206 (in Cebu City).

D. SFA Empirical Framework

The basic model is given by

$$\ln MPS_i = \beta_0 + \beta_1 \frac{Te_i}{St_i} + \beta_2 \frac{Te_i^2}{St_i^2} + \beta_3 \ln \frac{St_i}{Rm_i}$$
$$+ \beta_4 \ln \frac{Se_i}{St_i} + \ln elec + \ln water + v_i - u_i$$

Where: lnMPS is the log of the Mean Percentage Score (MPS) of the school division, a measurement of the achievement test score of students. $\frac{Te_i}{St_i}$ is the average teacher per 100 students in the school division. $\frac{Te_i^2}{St_i^2}$, or the square of $\frac{Te_i}{St_i}$ is also added since $\ln \frac{Te_i}{St_i} = \ln Te_i - \ln St_i$ which are correlated with each other. It is not expressed in logs because it would be difficult to disentangle the effects of school size (based on students) and school inputs (teachers). $\ln \frac{St_i}{Rm_i}$ is the log of the average number of students assigned per room. $\ln \frac{Se_i}{St_i}$ is the log of the average number of seats assigned per student. i is a school division, v_i is the two-sided "noise component" and u_i is the nonnegative technical inefficiency component of the error term.

Environmental variables include the following: **lnwater** is the log of the households with access to safe drinking water, a proxy for sanitation and health; **lnelec** is the log of the household electrification ratio in the unit.

The data on education outcomes and inputs were bridged from the NETRC and the Basic Education Information System (BEIS) of DepEd. Electricity and Sanitation data were taken from the Countryside in Figures of the National Statistical Coordinating Board. The year covered for both indicators is 2005, since this is the latest year available for both.

Both levels are covered. The goal at this point is to attempt to test the significance of basic inputs and possibly some environmental variables which may be important determinants of school achievement. Technical efficiency estimates for the school divisions are also computed.

IV. RESULTS

A. Stochastic Frontier Estimation Results

The summary statistics of the variables used in the Stochastic Production Function are in Annex 1. There are varying degrees of differences in outputs and outcomes across the sample.

Two specifications were done for the SF estimation: the first specification covering all school divisions where the data is completely available (183 out of the 185) and the second specification covering the provinces where the environmental variables are complete (only available for 77 provinces, as no further disaggregation for the cities). Frontier estimates are shown in Table 1 for both levels of education. Robust standard errors are used to remove spatial autocorrelation and heteroskedasticity.

VARIABLES	Log of Primary MPS		Log of Secondary MPS	
teacher per 100 students	0.298**	0.605***	0.0516	0.254*
	-0.119	-0.198	-0.11	-0.154
teacher per 100 students squared	-0.0350**	-0.0797***	-0.00696	-0.0430*
	-0.0166	-0.0253	-0.0187	-0.0248
log of pupil per room	-0.158***	-0.272	-0.163	-0.354
	-0.0557	-0.166	-0.204	-0.495
log of seat per pupil	-0.214***	-0.237***	-0.128***	-0.0882
	-0.0589	-0.0795	-0.0469	-0.0743
log of electricity coverage		0.104		0.246
		-0.175		-0.212
log of sanitary toilet coverage		0.143**		0.156**
		-0.06		-0.0648
Constant	3.077***	0.984	3.908***	1.486
	-0.353	-1.076	-0.382	-0.976
lnsig2v	-4.358***	-4.234***	-4.161***	-4.088***
	-0.352	-0.15	-0.326	-0.16
lnsig2u	-3.875***	-11.66***	-4.077***	-11.75***
	-0.648	-0.176	-0.872	-0.118
Observations	183	77	183	77
Robust standard errors in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				

Table 1.SFA Estimates, in two specifications for the two levels of education.

All variables have the expected signs, especially the input ratios, though electrification rate is statistically insignificant. The test is significant overall since the p-value (probability value or the lowest significance level at which the null hypothesis can be rejected) is equal to 0.0000. Moreover, lnsig (which is the two-sided "noise component") and lnsig (which is s the nonnegative technical inefficiency component of the error term) are significant in all specifications. This means that technical inefficiency is present across all units. It also means that a stochastic production function is an appropriate specification.

At the primary level, the log of teacher per pupil ratio as an input has the expected positive sign. Its square is negative implying diminishing returns. Teachers contribute a lot to test score improvements, however, as the quadratic term would indicate is only up to a certain level. The log of the number of pupils per room is also significant, implying that congestion detrimentally affects tests scores. The log of the number of seats available per pupil is also significant at the 1% level, implying test score improvement gains when seat-deprived schools are decongested through additional supplies. All of these imply the significant role of basic educational inputs to improvements in test scores at the elementary level. Only one environmental variable is shown to be significant. Access to sanitary drinking water significantly improves tests scores in a province. Electricity coverage on the other hand is not statistically significant. It is recommended further that other environment proxies should be used to capture other exogenous factors that may be affecting school divisions.

At the secondary level, the signs of the regression estimates also conform to the a priori expectation, however, a number of the explanatory variables are not statistically significant, like in the case of pupil per room. The estimates show as well that congestion in seating ratio at the elementary level greatly depresses test scores compared to the secondary level. Water sanitation is still statistically significant and has almost the same effect as that of the elementary level.

B. Technical Efficiency Estimates

Overall, Philippine public school divisions are technically inefficient (89.4%-elementary, 90.4%-secondary). The highest technical efficiency scores at both levels were registered by Digos City. Regionally speaking, divisions in Eastern Visayas were the most numerous in the most technically efficient. Sulu is the least technically efficient at both levels. This implies that Sulu is most challenged school division is terms of translating inputs to outcomes, which is most likely due to socioeconomic conditions prevailing in the province.

Mean-Primary : 0.894				Mean-Secondary : 0.904			
Highest Five		Lowest Five		Highest Five		Lowest Five	
Digos City	*0.960*	Sagay City	*0.779*	Digos City	*0.958*	Lanao del Sur	*0.815*
Batangas	*0.957*	Candon City	*0.777*	Romblon	*0.958*	Cadiz City	*0.807*
Calapan City	*0.956*	Cadiz City	*0.758*	Southern Leyt	*0.957*	Candon City	*0.805*
Ormoc City	*0.955*	Silay City	*0.751*	Batangas	*0.956*	Maguindanao	*0.779*
Laoag City	*0.955*	Sulu I	*0.748*	Eastern Samar	*0.953*	Sulu I	*0.770*

Table 2. Technical Efficiency Scores from SF Maximum Likelihood Estimation.

C. Data Envelopment Analysis Efficiency Scores

Using education inputs and outputs data of school divisions from the BEIS and NETRC, input and out efficiency scores were computed. Efficiency estimates were computed using DEAP 4.1 developed by Tim Coelli (1996). In the procedure, divisions can now be classified as input efficient or output efficient. Efficiency scores were computed on variables returns to scale to take into account the size of school divisions. Both elementary and secondary levels of basic education were considered for this analysis in order to later compare the relative performance of school divisions, which manages both levels. In that way, a test can be conducted whether a division that is efficient at the elementary level is also efficient at the secondary level.

Overall, most school divisions are technically inefficient, input-wise or output-wise, whether at the elementary and secondary level. School divisions performed best on the output efficiency, with a score of 0.79 at the elementary and 0.69 at the secondary.

Several divisions have also emerged as 'champion' divisions, whose outcomes are on the "frontier", as indicated by an efficiency score of 1. The overall input efficiency score for elementary is 0.71 and 0.68 for secondary. It means that school divisions can reduce input usage by 29% for elementary and 32% for secondary and still attain the same level of test scores. For output efficiency, elementary school divisions can still increase their test scores by 21% with the amount of inputs they have and 32% for secondary schools. The figures are summarized below.

	Elementary DEA Input Efficiency	Elementary DEA Output Efficiency	Secondary DEA Input Efficiency	Secondary DEA Output Efficiency
Mean	0.71	0.79	0.677	0.686
Standard D	0.147075	0.118848	0.136406	0.136291
Minimum	0.38	0.546	0.441	0.481
Maximum	1	1	1	1

Table 3. Summary of DEA Efficiency Scores as computed from DEAP 4.1

D. Potential Improvements in Efficiency

Aside from identifying efficient and inefficient school divisions, DEA also provides a technique of estimation of potential input and output targets for the inefficient school divisions to produce at the efficient level (or the frontier). Due to "political improprieties" that adjusting teacher per students ratios among and within school divisions and to the difficulty of adjusting inputs in the short-run, only the potential improvement in test scores shall be presented in this paper. Moreover, due to the non-parametric nature of DEA, some inputs/factors that affect education outcomes are immeasurable/ unquantifiable and might vary as well with school divisions.

The most inefficient (output-based, elementary) school division based on the variable returns to scale estimate is Silay City with a score of 0.546. The first school divisions of Sulu (Sulu 1) registered the lowest output-based efficiency at the secondary level, though it is also ranked 5th at the elementary level. Comparing with the top ten most efficient school divisions, the bottom ten least efficient have below average test scores. The ten best performing divisions are very congested already in terms of input ratios but was able to have an average MPS of 66.9. The bottom ten, which are drastically less congested have an average MPS of 44.76 only. The output efficiency of the bottom ten provinces at the elementary level is only 0.5715, hence the test scores could be potentially improved by 43% further, without changing input bundles. This amounts to a difference of an average of 19.14 points higher than the present level. It may be noted that with the exception of Candon City, three of the divisions are from Negros and the rest from Mindanao.

At the secondary level, the same procedure was done. The top ten most efficient provinces are among the most congested yet test scores are on the frontier/among the highest in the country, as compared to the least efficient divisions. The average DEA output index is .4939, which means that further 50.6% improvements in test scores is still possible without changing input bundles in the ten least efficient divisions. The average MPS of 37.12 of the bottom ten provinces could still be increased to as much as 55.9 points. Sulu 1, which is the worst performing school division at the secondary level, has the potential to increase its test scores by as 15 MPS points.

However, it can be observed that the DEA efficiency estimates at the elementary and secondary levels, geographical patterns seem to emerge. Most of the worst performing school divisions are in Mindanao, where armed conflict and political instability are relatively more pronounced. The high poverty incidence and

ISBN : 978-602-97809-0-1

poor infrastructure most likely depressed the efficiency scores in the island. In Negros Island and in the inefficient divisions of Ilocos, it may be recommended to investigate the determinants of inefficiency, since these are relatively above average in school inputs. Other school and environmental variables may explain such.

E. Relative Efficiency of School Divisions

School divisions who do well at managing elementary schools usually also do well in secondary, at both input and output efficiency measures. The spearman correlation rank below shows the rank correlation for all pairs of variables. All ranks are statistically significant up to the 1% level, with the strongest correlation between output and input efficiencies of the secondary level. The secondary output and input efficiency scores are positively and very strongly correlated at 0.86, while the elementary output and input efficiency is also positive and strongly correlated at 0.69. Cross elementary-secondary input and output efficiency scores are positive and moderately correlated (ranging from 0.46 to 0.63), all of which are statistically significant at the 1% level.

	Elementary Input Efficiency	Elementary Output Efficiency	Secondary Input Efficiency	Secondary Output Efficiency
Elementary Input Efficiency	1			
Elementary Output Efficiency	**0.6897*** **	1		
Secondary Input Efficiency	0.5639***	0.5065***	1	
Secondary Output Efficiency	0.4605***	0.6345***	**0.8601*** **	1

Table 4. Spearman Correlation Rank of DEA Scores

The finding as shown in the Spearman correlation matrix above adds to the evidence that school divisions' productive efficiency is similar for both levels of education. This further indicates that inefficiencies present in the school division are observable/do manifest in the outcomes of elementary and secondary schools under its management.

V. CONCLUSIONS

The study applies DEA and SFA as tools of analyzing relative efficiency and input relevance. As there is an increasing need to analyze efficiency (whether within and between firms, output and input-wise) and while not absolutely perfect, the methodologies add value in comparing performance.

In a setting where considerable amount of resources are used, the application of DEA and SFA are given as an example in a public setting. Results show that inefficiencies are present among the public basic education units (school divisions) in the Philippines, indicating varying degrees of effectiveness of resource use despite a highly centralized governance system.

Policy-wise, the effective use of education resources should be a crucial component of education policies that executed at the division level. As the education sector as whole is perennially challenged, and while there is a general agreement that the sector is indeed underfunded and that the greater funding is progressive to the system, however, the paper finds that there is a need to scrutinize how individual school divisions should more effectively translate valuable inputs into outcomes.

Further studies can be carried out by comparing the relative efficiency levels within the school divisions themselves, as there is an increasing move to decentralize relevant portions of decision making capacities at the division level, as well as the and the increasing role of local government units in funding various education inputs. Moreover, the integration of other variables (geographic, socio-demographic, etc) in these of tools of analyzing efficiency would help in the design of empirics-based policies.

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ANNEX 1. SUMMARY STATISTICS OF VARIABLES USED

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
Primary Mean Percentage Score, 2006-2007	184	59.8	8.92	38.3	81.6
Primary Pupil Per Teacher Ratio	184	34.79	7.42	11.58	55.61
Primary Pupil Per Room Ratio	184	39.2	16.38	11.75	122
Primary Seating Ratio	184	1.11	0.3	0.66	2.52
Households with access to safe drinking water	78	81.08	16.21	32.5	100
Households electrification Rate	77	94.42	9.69	57.8	100

ISBN : 978-602-97809-0-1

Household Survey for Cities Region Development Project: Conjoint Analysis

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***Abstract*-In this paper an attempt has been made to provide a lucid analysis of the current scenarios of infrastructural facilities (Supply and demand) in urban areas of Bangladesh. Such an analysis has been made in the framework of simple statistical tools and a sophisticated statistical tool namely, Conjoint Analysis. Data used for the analysis are household level responses collected by Face-to Face interview. Several policy implications have emerged from the study outcomes and these are useful for formulating guidelines for improved and expanded facilities and services for urban citizens. Such findings will supposedly help launch the Cities Region Development Project (CRDP) in a more beneficial way for the society. People's perceptions, aspirations and requirements have been well reflected in the study outcomes.**

***Key words*:** Household Survey, CRDP, Conjoint Analysis, Part-worth.

I. BACKGROUND

Bangladesh has experienced increased Urbanization since independence in 1972. Rapid urbanization has created growing demand for urban infrastructure and services. The development of urban infrastructure has not kept pace with rapid urbanization, causing an acute shortage in every type of urban service. Rapid urbanization is largely attributed to migration from rural areas. Migrants compete for limited employment opportunities, and tend to be in low income group setling in urban slums without access to basic services.

Through the urbanization, large cities and surrounding secondary towns have been agglomerating with close economic and social linkages, forming city regions. Industrial clusters are emerging in agglomerated cities and these have been a driving force of the national economic growth. The contribution of urban areas to the national gross domestic product grew from 26% in 1973 to 42% in 1999. However, lack of long-term vision, strategic planning and coordination among various public entities has been preventing the city regions from materializing their full economic growth potential. Capital investments have often been selected to meet supply-demand gaps and not to promote competitive industries based on strategic assessment of development potentials.

In this view, there was a flagship study namely, " Inclusive Growth and Good Governance for Clustered Cities Development: Innovative interventions in South Asia". Under the second package of RETA 6337: Development Partnership Program for South Asia (the RETA), Roundtable discussions were held in 2008 with key stakeholders, who positively reacted to the new approach to the urban development in Bangladesh. The proposed PPTA will be built upon the conceptual framework to be developed under the RETA, and make a concrete program for capital investments and institutional developments to be funded under the ensuing City Region Development Project (CRDP). A city region comprises a large metropolitan city (City corporation such as Dhaka, Cittagong and Khulan), Secondary towns (Pourashavas) clustered nearby and adjacent areas.

Thus, in order to gather clear picture of current scenarios a baseline survey at household level was conducted in 2009. The principal aim of the survey was to collect primary information on service provisions and their expansions; needs and aspirations of citizens..

II. DATA DESCRIPTION AND SAMPLE SIZE

For attaining the above mentioned objectives the survey was conducted in 4320 households in Dhaka City Corporation (DCC) and 5 Municipalities. Out of total sample size 1858 (43%) were from Dhaka and remaining 2462 from 5 municipalities selected proportionately by number of households. In DCC 22 (25%) wards out of 90 were selected using Probability Proportionate to Size (PPS) by number of households. For such purpose the last voter list was used. From 5 municipalities 35 wards (7per municipality) were selected using the same procedure.

However, from each selected ward both in DCC and 5 municipalities, 2 Mohallas were randomly selected resulting in 114 mohallas altogether. Total allotted households were equally distributed among chosen Mohallas and were selected using Simple Random Sample (SRS) following the latest voter list. One respondent (household head) per household was interviewed.

ISBN : 978-602-97809-0-1

However, it is worth noting that sample size in Mohallas was further bifurcated by slum and non-slum in the ratio 1: 2 as well as by gender.

III. METHODOLOGICAL ISSUES

Two types of statistical tools namely, Descriptive statistics and Conjoint Analysis were adopted for the present study. Here we briefly present the basic idea behind Conjoint Analysis (CA) .

Function of CA

For each factor level or for each feature CA provides a value for each feature. Such a value is also termed **as utility**. Features/factor levels having highest such value is declared as the most important for respondents. CA secures utility scores (Called part-worths) of each level of a factor from ratings or rankings of consumers.

How Utilities Correspond to Preferences

We calculate one utility for each feature for each respondent using preference rankings. When utility of one attribute feature (level) is added to the utility of some other attribute's feature (level), the sum will show correspondence with position of this combination in the original preference ranking by the respondent. CA calculates utilities for different combination of features of attributes. Such calculated utilies correspond to preference ranking of combination of features of attributes. For example if a particular combination shows highest utility value, it corresponds for highest preference also.

- → It shows importance of each level of each factor (attribute).
- → It identifies which attribute is more important compared to others.

For each respondent utilities are derived from preference ranking or rating of combinations of features of attributes. Range of utilities of an attribute can show its importance. Comparing the sets of utilities one can identify groups / segments of respondents.

Approaches to CA

There are principally two approaches to CA viz. **two-factor evaluation** and **multi-factor evaluation**.

In two-factor approach large numbers of factors are involved and combination of levels of each pair of factors are taken at a time. Multi-factor approach is like complete factorial design. It defines different product profiles by taking all factors together. Each profile is written on a card and it is given to customer for his overall preference value/rating about the product. If product profiles are too many, one can select a limited number of them using orthogonal design in which effects of main factors are studied ignoring second and higher order interactions.

One can obtain respondent's preferences value either in interval scale or ordinal scale. In the former a respondent puts a value between say, 0 to 10 while in the later the respondent ranks product profile from highest 1 to the lowest rank as per number of combinations.

Utility (Part-Worth) by Level

Using the technique of Multiple Regression with dummy variable of utility of each level of each factor for a respondent can be obtained. Preference value is treated as dependent (criterion) variable and levels of factors are treated as regressors in the regression model. Utilities are selected in such a way that errors between actual preference values and corresponding estimated preference values are minimized. This is the **OLS Procedure of Regression.** For any product profile preference value for any product profile is obtained by adding the utility values of respective levels of factors of that profile. For example, if a profile has 3 levels having estimated utilities .86,-.27,-.10 respectively, then that combination has utility= (.86-.27-.10)=.49

Conjoint Analysis Procedure

Several esoteric softwares are available for conjoint analysis. Computer starts with random starting values of utility estimates or part- worth functions and iteratively it modifies those utility estimates until prediction of consumer preferences are within some tolerable error margin.

Dummy variable regression can be used to estimate the components of a conjoint analysis. Consumer/ customer/ agent preferences are treated as dependent variable and dummy variables for attributes can be treated as predictors. Such regression may look like the following one.

Predicted preference

$$= \beta_1 X_1 + \beta_2 X_2 + ... + \beta_k X_k$$

Here $X'S$ are dummies for attribute levels.

A value of $\beta = 0$ will indicate that the corresponding factor does not matter. A larger $\beta - value$ means more utility and a consumer is more inclined about that attribute.

IV. RESULTS AND ANALYSIS

We provide our study results and analysis in two parts namely, Descriptive Statistical Analysis and Conjoint Analysis.

A. Descriptive Analysis

At first we present the idea about major problems faced and perceived by respondents in their day-to day life. While over 85% respondents consider `irregular power' and `gas' supply a major problem, over 65% put emphasis on `polluted atmosphere'. Inadequacy in water supply has been mentioned by 39% respondents as a major problem and `traffic congestion' is another horizon of problems cited by 43% respondents. Besides, `poor drainage' (34%), `solid waste management' (30%), `poor sanitation & sewerage system' (19%) are added problems as envisaged by respondents. Parallely, respondents expressed their aspirations about what they desire from management of city Corporations and Municipalities. The most commonly felt aspirations of respondents are undisrupted power & gas supply (70%), `reduction in pollution (60%)' `removal' of traffic jam (38%)' `improved water supply (34%)' `improved drainage (29%)' and `solid waste system (24%)' accompanied by `improved law & order situation (15%)'.

Here we provide a brief descriptive scenarios of various service provisions that are available.

Access to Electricity

Among total sampled households, over 90% have electricity connection at home and of them, more than 80% have direct connection. Out of those who have electricity connection at home, 87% are dissatisfied due to irregular supply.

Among reasons behind not having electricity connection, non-availability has been cited by 42% households, closely followed by difficulty in geting connection (by 38%). Long distance (from the supply point involving huge cost) has been mentioned by 37%, while about 26% consider high cost of utilizing electricity.

Access to Gas

About 76% households under the survey have so far gas connections at home.

Households having gas connection mentioned several problems such as Inadequate and irregular supply, and Inadequate pressure.

Sources and Availability of Water

Overall, 47% households use `piped drinking water' while 22% own `hand tube wells', 21% use `pump operated tube wells', and 4% each use `street hydrant/community taps' and `other sources'. About 1% householduse Pourashava/DCC hand tube wells.

Overall 52% households do not have `piped water connections', while 73% stated `non-availability', 24% mentioned `difficulty in getting connection' and 75% have cited problems such as `Poor quality of Water' (61%), `Unreliable supply' (42%), `Inadequate quantity' (37%).

Sanitation and Sewerage Situation

Over 70% households have their own latrine at home. More than 25% share latrine with 1-2 families and 4% do not own any.

Only 60% are connected with sewerage system

Drainage System

On the whole 44% households claimed to have covered pucca drainage in their locality. While 30% use open *pucca drainage,* 3% use open *katcha* and 23% have no drainage. While 51% blame that drains are seldom cleaned, 39% say that drains are occasionally cleaned.

Solid Waste Management

Regarding waste management, 46% households state that they dump the garbage near living house. While 43% household belong to `door-to-door collection system', only 8% use the `street garbage bin' and 3% have other disposal arrangement of garbage. Over 79% are dissatisfied with garbage management system run by city corporation.

An important issue covered in the study concerns about mobility behaviour of respondents. We present such analysis here.

Household Modes of Transport

Majority of the households (over 93%) are connected to small road and, remainings are almost equally connected by trail and dirt road/lane

Mode of Transport for movement to Workplaces and/or Schools

People use at least 10 modes of transport to go to workplace/school such as walking, bicycle, motor cycle, baby taxi, taxi, bus, car, micro bus, train, boat etc. The most widely used mode of connectivity is walking, followed by rickshaw and private bus service while the least used ones include waterways (boat), train and taxi.

Use of Public Transport

Regarding use of public (transport) buses, 16% respondents mentioned that they never used this type of transport. Further more 28% use public rarely and 14% use them occasionally . Non-availability and poor quality of services are considered to be major drawbacks of public transport.

In order to assess the desires of the people, exercises on portfolio choice behavior of respondents were performed in the frame-work of Conjoint Analysis. Such results are presented below.

B. Conjoint Analysis Results

Conjoint analysis has been performed for service provisions like electricity, gas and water.

Electricity supply

Here we show the levels of attributes used for combinations for Conjoint Analysis as posed to the respondents.

Attribute Price : 10% more than existing rate,
: 20% more than existing rate
: 30% more than existing rate

Attribute Hours of Supply: 10 hours per day
15 hours per day
24 hours per day

One typical Example for ranking is shown below

Table 1:
TYPICAL EXAMPLE OF RANKING

	Price		
	10% more	20% more	30% more
Hours: 10	2	6	1
15	4	3	7
24	9	8	5

We have created dummy variables for each attribute as follows.

X_1=1 if supply time = 15 hrs otherwise X_1 =0

X_2=1 if supply time = 24 hrs otherwise X_2 =0

Z_1=1 if price is 20% more otherwise Z_1 =0

Z_2 =1 if price is 30% more otherwise Z_2 =0

Predicted preference= $\beta_1 X_1 + \beta_2 X_2 + \beta_3 Z_1 + \beta_4 Z_2$

$=.53X_1 +.86X_2 -.15Z_1 -.36Z_2$

Here we assume Price 10% higher and 10 hours service as bench mark.

There are 9 combinations of attribute levels and they were shown to each respondent and were asked to put part-worths between 0-10 as per his/ her own perception. Then regression was run. The typical example shows that the most desired choice of a person will be the least pay (10% more) and the most service (24 hours). And naturally, highest pay and least hours

ISBN : 978-602-97809-0-1

service will be the lowest preference. We want to answer question, what are the utilities for price and service hours in determining preferences.

Table 2:
CONJOINT ANALYSIS RESULTS: UTILITY VALUES FOR ELECTRICITY

Hours of Service	Price: 10% more	20% more	30% more
10	00	-.15	-.36
15	.53	.38	.17
24	.86	.71	.50

Examining the levels of attribute from the highest to the lowest rated levels we can identity the relative importance of each of the attributes. If different levels of an attribute produce different utilizes, then that attribute is important. Analysing the trade- offs we can assess the desire of the people. For example, in the above table, the combination 10% higher price and 24 hours service and also the combination 20% more price and 24 hours are the most desire of the people. As it appears, people are more concerned about service than price. So, medium price level but highest hours of service is the most desired combination. Even after increasing the price by a certain amount people want to remain connected as long as regularity in supply is there. So, it is clear that people are quality conscious having intention to make trade-off between quality and price. A common practice of judging goodness of fit of prediction is to find correlation between original assessment of respondents and predicated utilities. We have obtained such correlation coefficient to be r=0.789 which indicates quite good capture of consumer preferences. We naturally expect a linear behavioral movement in price of electricity and hours of its supply.

Conjoint Analysis Results: Utility values for Gas

Gas is one of the most important consumption items. Considering the fact that supply of gas is inadequate, access to gas is quite problematic and it is quite expensive as well, respondents' desire was assessed in the frame work of Conjoint Analysis. Following levels of attributes were posed to the respondents to assess their choices and preferences.

Attribute Price : 10% more
: 20% more
: 30% more

Attribute 'Supply': G1: Continuous 12 hours supply with normal pressure
G2: Continuous 15 hours supply with normal pressure
G3: Continuous 24 hours supply with more pressure

Table 3:
A TYPICAL EXAMPLE OF RANKING

		Price: 10% more	20% more	30% more
	G_1(12hrs)	5	2	1
Supply:	G_2(15hrs)	8	4	6
	G_3(24hrs)	9	3	7

We have created dummy variables for each attribute as follows.
X_1=1 if supply time = 15 hrs otherwise X_1 =0
X_2=1 if supply time = 24 hrs with more pressure otherwise X_2 =0
Z_1=1 if price is 20% more otherwise Z_1 =0
Z_2 =1 if price is 30% more otherwise Z_2 =0

Predicted preference= $\beta_1 X_1 + \beta_2 X_2 + \beta_3 Z_1 + \beta_4 Z_2$
$=.58X_1 + .49X_2 - .27Z_1 - .18Z_2$

We show the estimated utilities below.

Table 4:
ESTIMATED UTILITIES FOR GAS

		Price: 10% more	20% more	30% more
	G_1(12hrs)	00	.58	.49
Supply:	G_2(15hrs)	-.27	.31	.22
	G_3(24hrs)	-.18	.40	.31

Results in above table clearly suggest that people are more concerned about quality of service compared to rise in price. Considering gas is an highly essential item, people appear to make trade-off between high price and regularity in gas supply. Correlation between original assessment of respondents and predicated utilities is 0.513.

V. CONCLUSIONS AND RECOMMENDATIONS.

In this paper statistical analyses were performed on data collected in a baseline survey conducted at household level in DCC & other 5 municipalities. Survey outcomes appear to be very useful for planning and augmenting CRDP .

Baseline survey results based on Descriptive Analysis and Conjoint Analysis suggest several things that are useful for policy makers for effective launching of CRDP. These are delineated below.

1. Uninterrupted or almost so power supply
2. Uninterrupted or almost regular gas supply
3. Measures to reduce pollution are needed
4. Make easy access to power, gas and water connection
5. Modify traffic rules and operations to lessen the burden on people.
6. Making a trade -off between raising price of electricity and ensuring regular power supply can fulfill the desire of the majority citizens
7. Providing regularity and quality of water supply at a higher cost is acceptable to the citizens. Easy access is also a concern of the citizens.
8. Consumers appear to be happy to make a trade-off between regularity in gas supply and its increased price.

9. Poor and insufficient service system of DCC & municipalities regarding drainage and waste management need to be taken care of.
10. Increase in public transport facilities is of serious importance to be taken into account so that people can comfortably render services to the society. Here also people put more emphasis on availability and quality of services compared to price.

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

A LOCATION-ALLOCATION MODEL WITH SEASONAL TIME DEPENDENT DEMAND (CASE : FERTILIZER INDUSTRI IN INDONESIA)

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Abstract - Location allocation problem covers the core component of distribution system. There are roughly three different levels of decisions in a supply chain: the strategic, tactical, operational level. In fertilizer industry the problem of location and allocation facilities accure in how to locate warehouses in each region, and how many facilities needed to serve the consumer. Location and allocation problem involve determining not only how much each customer is to receive from each facility but also the number of facility along with their locations and capacities.In our research, we propose the solution model of location allocation for fertilizers industry in Indonesia, that minimaze total cost that include shipment cost, inventory cost and facility cost. This paper propose an integrated location allocation model for a 4-echelons supply chain system which consists of i manufacturer, j warehouse at level 2, k warehouse at level 3, l distributor and m retailers. A time-dependent demand pattern which is approximated by a polynomial function at retailers that fluctuates by time and may not be identical for each retailer, and all entities of the entire echelon. The model is to determine how many facilities in each echelon and where is the location. The total system cost consists of facility cost, inventory cost and transportation cost. A heuristic solution procedure is developed to find the solution.

Keyword : location allocation, inventory cost, shipment cost, fertilizer industry

I. INTRODUCTION

Location-allocation problem covers the core component of distribution system. There are roughly three different level of decision in a supply chain. the strategic, tactical, operational level [6]. In some of literature the three strategic level decided separated one and another. For the example location model generally not included inventory cost and distribution cost counted directly based on delivery cost. A failure in decided the relationship between inventory cost and distribution in location-allocation facility can effected not optimal solution, because location facility effected by inventory cost and distribution cost.

For the example in fertilizer industry location-allocation facility occur when industry must decided how many warehouses do they have, where is the location, and how many product they have delivery to the point of destination. The Government make a rule about the regionalization for each producer. The influence of regionalization has impact the marketing, selling and producer activity in Indonesia. The policy of subsidiary fertilizer at farmer level cultivated to fulfill six right asas that is : right place, type, time, quality, and price which is equitable so that farmer can use fertilizer appropriate with their necessity. The problem that has been indentified in fertilizer industry in Indonesia, based on research that has been found by Kariyasa & Yusdja (2005) among other thing is not appropriate distributor warehouse location that cause delay on distribution and expensive cost on transportation. Regionalization system that has been created at county level not followed by regionalization at distributor level and retailer. This research propose, model location-allocation problem in Indonesia, that can minimize the total cost of transportation, inventory and facility.

Agustina & Nurbahagia (2007) research about subsidiary urea fertilizer by regionalization-distribution policy and establish subsidiary price to national logistic system in Indonesia. Agustina & Nurbahagia (2007) develop the regionalization which consider facility design. Whereas, a matter of a fact, regionalization system doesn't consider about warehouse location with the result its often happen a shortage at retail level and the price of fertilizer is increasing. Agustina & Nur Bahagia (2007) model do not consider about warehouse capacity, a matter of a fact warehouse capacity is a factor that decided distribution of fertilizer until retailer. This problem of course will effected scarcity of fertilizer and increasing price that often occur as a consequence of scarcity fertilizer will always happen, so we have need to do frequent observation toward fertilizer logistic system.

This journal propose location-allocation facility model with integrated system production and distribution. Another research that make a location-allocation model

ISBN : 978-602-97809-0-1

facility for subsidiary urea fertilizer in Indonesia is submitted by Santoso et al (2007) that develop integrated distribution system model with time dependent demand. Miranda & Gorrido (2006) try to integrated the three level decision in distribution system with simultaneous model of location-allocation with inventory cost and transportation cost. This Research develop 2 echelon that consist of 1 factory and several warehouse with 2 stochastic capacity constraint. Shen & Qi (2007) develop integrated distribution system model to determine amount of warehouse that needed to minimize distribution total cost. In their research, Shen & Qi (2007) added routing to determine location facility decision, shipping from warehouse to retailer use vehicle routing model with linier direct shipping model.

Location-allocation model facility that develop in this research has distribution structure consist of echelon 1 production unit that located at province, echelon 2 is distribution centre, echelon 3 distribution centre at Kabupaten and echelon 4 is distribution centre at subdistric. To make this research easier can be done by supply chain 4-echelon approach that consist of *I* production unit, *j* distribution centre at echelon 2, *k* distribution centre at echelon 3, *l* distribution centre at echelon 4 and *m* retailer with time dependent demand.

II. FRAMEWORK

Supply chain is a system from facility and activity that have a function to provided, production and distribute goods to costumer. Supply chain management basically have an integrated approach from supplier, manufacturer, warehouses and retailer, that goods can be produce and distribute with the right quantity, location, and in the right time that can be minimize the total cost to improve service quality [3].

Physically structure of supply chain can influence the supply chain performances, it make the channel structure become important things to design an efficient supply chain that facilitate the flow of goods. Therefore, in this research we develop the model that has decision variable : How is the capacity each location? How many goods that have to be produces and where is the place?. As many as the facility is open as much as the cost that has occur. Model structure that will be develop in this research can be seen in picture 1. There is 4 entity that involve , *o* as manufacture, *g* as warehouses, *k* as distribution centre and *l* retailer

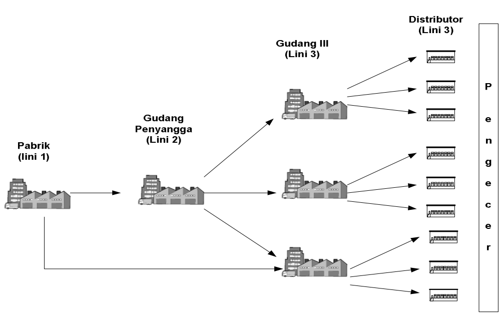

Fig. 1 Distribution structure

III. MODEL FORMULATION

In this paper we assumes that manufacturer produces goods on maximum capacity. Whereas, distribution system in ideal condition where each retailer receipt demand. Warehouse capacity in each distribution area it's enough to fulfill the demand in that area. Demand at retailer is seasonal time dependent, so inventory quantity in each periods is zero, therefore there is no safety stock

Index notation

i plant/producer ($i = 1, 2, \dots, n$).

j second tier warehouse index of plant i ($j = 1, 2, \dots, oi$).

k the third tier warehouse index of plant i which part of second tier area of warehouse j ($k = 1, 2, \dots$, uij).

l distributor index supplied from the third tier of producer I and part of second tier area of warehouse j ($l = 1, 2, \dots, v_{ijk}$).

m retailer's index which has appointed of distributor l to distribute subsidized urea fertilizer produced by procedur i in the third tier warehouse k area and the second tier warehouse k area ($m = 1, 2, \dots, r_{ijkl}$).

c Optional indeks for land or sea way (c = 1 for land dan 2 for sea)

Notasi Parameter

C_i Production cost (HPP) (rp/ton)

h_i percentage of holding cost at producer warehouse (ton/tahun)

h_{ij} percentage of holding cost at second echelon warehouse II (ton/tahun)

h_{ijk} percentage of holding cost at third echelon warehouse III (ton/tahun)

h_{ijkl} percentage of holding cost at distributor (ton/tahun)

s_1 *safety stock* at first echelon (ton)

s_2 *safety stock* at second echelon (ton)

s_3 *safety stock* at third echelon (ton)

s_4 *safety stock* at distributor (ton)

K_i maksimum capacity at producer i (ton)

K_j maksimum capacity at second ecehlon warehouse IIj (ton)

K_k maksimum capacity at third echelon warehouse III k (ton)

K_l maksimum capacity at at distributor l (ton)

OTD_{ij} transportation cost from producer i to ecehelon II j (Rp / ton . km).

OTD_{ijk} transportation cost from warehouse at echelon II j to warehouse at echelon III k (Rp / ton . km)

OTD_{ik} transportation cost from producer i directly to warehouse at echelon III k (Rp/ton. km)

OTD_{ijkl} transportation cost from echelon III k to distributor l (Rp / ton . km).

ISBN : 978-602-97809-0-1

OTD_{ijklm} land transportation cost from from distributor l to retailer m (Rp / ton . km)

d_{ij} distance from producer i to warehouse at echelon II j (km)

d_{ik} distance from producer i to warehouse at echelon III k (km)

d_{ijk} distance from warehouse at echelon II j to warehouse III k (km)

d_{ijkl} distance from warehouse at echelon III k to distributor l (km)

d_{ijklm} jarak dari distributor l ke pengecer m (km)

Notasi Variabel

P_j Variabel cost at warehouse echelon II (Rp)

P_k Variabel cost at warehouse echelon III (Rp)

D_{ijklm} demand of urea fertilizer at kabupaten (ton)

X_j 1 if warehouse at echelon II j is open , otherwise 0

X_k 1 if warehouse at echelon III k is open, otherwise 0

Q_{ij} Quantity of urea subsidize fertilizer distribute from producer at ecehelon 1 i to warehpuse at echelon II j in one year, (ton/tahun).

Q_{ijk} Quantity of subsidize fertilizer distribute from echelon 2 IIj to warehouse at echelon III k in one year, (ton/tahun).

Q_{ijkl} Quantity of subsidize fertilizer distribute from echelon III k to distributor l in one year, (ton/year).

Q_{ijklt} Quantity of subsidize fertilizer distribute from echelon III k produsen i (at echelon II j) to distributor l at t periode in one year,(ton/period).

Q_{ijklm} Quantity of subsidize fertilizer distribute from distributor l (cooperated with producer i at echelon II j and echelon III k) to retailer m in a year, (ton/tahun).

Q_{ijklmt} Quantity of subsidize fertilizer distribute from distributor l (cooperated with producer i at echelon II j and echelon III k) to retailer m at t periode t in a year, (ton/periode).

Model Formulation

Amount of subsidy for subsidized urea fertilizer, the cost components in distribution system of subsidized urea fertilizer can be categorized into three parts, they are production cost, transportation cost, and holding cost. In this paper, we use the first approach in categorizing cost components.

The assumptions used in developing the model are :

a) The customer's demand at all retailers depend on time and deterministic
b) No stock-outs are permitted at all echelons
c) The entire repleinisment lot size is added to inventory at the same time (for distribution center, all distributors and all retailers)
d) Production capcity is large enough to supply all customer demands
e) Production cost perunit, ordering cost at distribution centers, distributors and retailers and transportation cost per unit are constant.

In the mathematical model development for determining amount of subsidy for subsidized urea fertilizer, the cost components in distribution system of subsidized urea fertilizer can be categorized into three parts, they are production cost, transportation cost, and holding cost. Besides those categories, the cost components in distribution system also can be divided according to each tier's, they are all costs at the first tier, second tier, third tier, and fourth tier. Those costs are charged to every stakeholders related to the procurement and distribution activities of subsidized urea fertilizer, which are producers, distributors, and retailers. In this paper, we use the first approach in categorizing cost components.

Total Facility Cost (OF)

Facility cost model developt in this research has two component, fixed facility cost and operational cost.

$$OF1=\sum_{j=1}^{g_i}\left(f_jX_j\right)+\left(1-X_j\right)*P_j\;;OF2=\sum_{k=1}^{u_{ij}}\left(f_kX_k\right)+\left(1-X_k\right)*P_k$$

Inventory Cost

Including all costs caused by storage fertilizer warehouses, which are summarized by considering average number of hold subsidized urea fertilizer, storage goods' value, and the percentage of holding cost.

Total invetory cost =

Producers inventory cost + Distributor's inventory cost + DC's Inventory cost + Retailer's Inventory cost

Biaya Inventori total (OI) =

$OI1 + OI2 + OI3.+ OI4$

$$OI_i=\sum_{i=1}^{n}\sum_{j=1}^{g_i}\left[\sum_{t=1}^{h}\frac{Q_{ijt}}{2n_1}+s_1)\right]\times C_i\times h_{ij}$$

$$OI_j=\sum_{i=1}^{n}\sum_{j=1}^{g_i}\sum_{k=1}^{u_{ij}}\left(\sum_{t=1}^{h}\frac{Q_{tijk}}{2n_2}+s_2)\right)\times C_i\times h_{ijk}$$

$$OI_k=\sum_{i=1}^{n}\sum_{k=1}^{u_{ij}}\left(\sum_{t=1}^{h}\frac{Q_{tik}}{2n_3}+s_3)\right)\times C_i\times h_{ik}$$

$$OI_l=\sum_{i=1}^{n}\sum_{j=1}^{g_i}\sum_{k=1}^{u_{ij}}\sum_{l=1}^{v_{ijk}}\left(\sum_{t=1}^{h}\frac{Q_{tijkl}}{2n_4}+s_4)\right)\times C_i\times h_{ijkl}$$

Subsidized urea fertilizer's demand pattern

The demand pattern of subsidized urea fertilizer is categorized as seasonal demand. It will be modeled with dividing a yaer into three periods that synchronized with the demand characteristics of subsidized urea ferilizer which are higher in harvest seasons and lower in dry seasons.

a) Number of subsidized urea fertilizer's shipment for every period.
b) Value of goods which are in storage.
c) Safety stock of subsidized urea fertilizer in producers' and distributors' warehouses which are determined in Trading Ministry Policy No. 03/M-DAG/PER/2/2006, which are 2 weeks of demand in the producer's warehouses and 1 week of demand in the distributor's warehouses. Safety stock values are determined by dividing demand of goods in an ordering period for every tier into one week and two weeks of demand. According to those formulas, the producers' safety stock and the distributors safety stock can be defined as follows:

$$S_1 = \sum_{i=1}^{n}\sum_{j=1}^{o_i}\sum_{t=1}^{f}\frac{2Q_{ijt}}{16},\ S_2 = \sum_{i=1}^{n}\sum_{j=1}^{o_i}\sum_{k=1}^{u_{ij}}\sum_{t=1}^{f}\frac{2Q_{ijkt}}{16}$$

$$S_3 = \sum_{i=1}^{n}\sum_{k=1}^{u_{ij}}\sum_{t=1}^{f}\frac{2Q_{ikt}}{16},\ S_4 = \sum_{i=1}^{n}\sum_{j=1}^{o_i}\sum_{k=1}^{u_{ij}}\sum_{l=1}^{v_{ijk}}\sum_{t=1}^{f}\frac{2Q_{ijklt}}{16}$$

Transportation Costs

Including all costs spent to distribute urea subsidized fertilizer from one tier to the next tier. Transportation costs are summarized with considering supply point and destination point, number of subsidized urea fertilizer, transportation modes used (land and sea), and the regular tariffs.

Total Transportation Costs = Producer's transportation cost + Distributor's Transportation Cost + DC's Transportation Cost + Retailer's transportation cost

Total Transportation Cost =

$$OT_i = \sum_{i}^{n}\sum_{j}^{g_i}\sum_{k}^{u_{ij}} Q_{ijk} \times (OTD_{ijk} \times d_{ijk}). +$$

$$OT_j = \sum_{i}^{n}\sum_{k}^{u_{ij}} Q_{ik} \times (OTD_{ik} \times d_{ik})$$

$$OT_k = \sum_{i}^{n}\sum_{j}^{g_i}\sum_{k}^{u_{ij}}\sum_{l}^{V_{ijk}} Q_{ijkl} \times (OTD_{ijkl} \times d_{ijkl}.) +$$

$$OT_l = \sum_{i}^{n}\sum_{j}^{g_i}\sum_{k}^{u_{ij}}\sum_{l}^{V_{ijk}}\sum_{m}^{r_{ijkl}} Q_{ijklm} \times (OTD_{ijklm} \times d_{ijklm}).$$

CONSTRAINT

1. **Demand Constraints**

   These constraints guarantee the sufficient supply in covering subsidized urea fertilizer's demand. In other words, these constraints guarantee the availability of subsidized urea fertilizer

2. **Supply Capacity Constraint**

   Supply capacity contrains guarantee that the amount of subsidized urea fertilizer distributed from one tier to the next tier must not exceed the inventory level on taht tier. These constraints are defined as follows :

   a) This equation guarantees the synchronization between number of produced subsidized urea fertilizer with the production capacity of each procducer.

   $$\sum_{i=1}^{g_i}\ \sum_{t=1}^{h} Q_{t_i} \le K_i$$

   b) This equation guarantees that the distributed subsidized urea fertilizer to third tier's warehouses will not exceed the inventory level in its second tier warehouses.

   $$\sum_{t=1}^{h}\sum_{j=1}^{g_i}\sum_{k=1}^{u_{ij}} Q_{tij} = \sum_{t=1}^{h}\sum_{j=1}^{g_i}\sum_{k=1}^{u_{ij}} Q_{tik}$$

   c) This equation guarantees that the distributed subsidized urea fertilizer to fourth tier's will not exceed the inventory level in the fourth tier in the same period

   $$\sum_{t=1}^{h}\sum_{k=1}^{u_{ij}}\sum_{l=1}^{v_{ijk}} Q_{tijkl} = \sum_{t=1}^{h}\sum_{j=1}^{g_i}\sum_{k=1}^{u_{ij}}\sum_{l=1}^{v_{ijk}} D_{ijkl}$$

   d) This equation guarantee that the distributed urea fertilizer to third tier will no exceed the inventroy level in the third tier

   $$\sum_{t=1}^{h}\sum_{k=1}^{u_{ij}}\sum_{l=1}^{v_{ijk}} Q_{tijkl} \le \sum_{k=1}^{u_{ij}} K_k.Y_k$$

   e) This equation guarantee that the distributed urea fertilizer in second tier not exceed the capacity at warehouse in second tier

   $$\sum_{t=1}^{h}\sum_{i=1}^{n}\sum_{j=1}^{g_i} Q_{tij} \le \sum_{k=1}^{u_{ij}} K_j.X_j$$

3. **Warehouse Capacity Constraint**

   a) Guarantee that fertilizer urea at tier I (*i*) no exceed warehouse capacity at tier 1 during time interval (*t*)

   $$\frac{Q_{ti}}{2n_1} + s_1 \le K_i$$

   b) Guarantee that fertilizer urea at tier 2 (*j*)no exceed warehouse capacity at tier 2 during time interval (*t*)

   $$\frac{\sum_{i=1}^{n}\sum_{k=1}^{g_i} Q_{tijk}}{2n_2} + s_2 \le K_j$$

ISBN : 978-602-97809-0-1

c) Guarantee that fertilizer urea at tier 3 (k)no exceed warehouse capacity at tier 3 during time interval (t)

$$\frac{Q_{tk}}{2n_3} + s_{3k} \le K_k$$

4. Binary Constraint

Binary constraint is guarantee that the value is one (1) or zero (0). There are 2 Binary constrain

$$\sum_{j}^{g_i} X_j = [0,1], \sum_{k}^{u_{ij}} Y_k = [0,1]$$

FINAL MODEL

In conclusion, the final model for integrated model of regionalization-distribution and cost subsidy for subsidized urea fertilizer in Indonesia is defined as follows:

Objective Function
Minimize total distribution cost
Z= OF + OT + OI

$$\text{Min } Z = \sum_{j=1}^{g_i} (f_j X_j) + P_j + \sum_{k=1}^{u_{ij}} (f_k X_k) + P_k +$$

$$\sum_{i=1}^{n} \sum_{j=1}^{g_i} \left[\sum_{t=1}^{h} \frac{Q_{ijt}}{2n_1} + s_1) \right] \times C_i \times h_{ij} +$$

$$\sum_{i=1}^{n} \sum_{j=1}^{g_i} \sum_{k=1}^{u_{ij}} \left(\sum_{t=1}^{h} \frac{Q_{tijk}}{2n_2} + s_2) \right) \times C_i \times h_{ijk} +$$

$$\sum_{i=1}^{n} \sum_{k=1}^{u_{ij}} \left(\sum_{t=1}^{h} \frac{Q_{tik}}{2n_3} + s_3) \right) \times C_i \times h_{ik} +$$

$$\sum_{i=1}^{n} \sum_{j=1}^{g_i} \sum_{k=1}^{u_{ij}} \sum_{l=1}^{v_{ijk}} \left(\sum_{t=1}^{h} \frac{Q_{tijkl}}{2n_4} + s_4) \right) \times C_i \times h_{ijkl} +$$

$$\sum_{i}^{n} \sum_{j}^{g_i} \sum_{k}^{u_{ij}} Q_{ijk} \times (OTD_{ijk} \times d_{ijk}). +$$

$$\sum_{i}^{n} \sum_{k}^{u_{ij}} Q_{ik} \times (OTD_{ik} \times d_{ik}) +$$

$$\sum_{i}^{n} \sum_{j}^{g_i} \sum_{k}^{u_{ij}} \sum_{l}^{V_{ijk}} Q_{ijkl} \times (OTD_{ijkl} \times d_{ijkl}.) +$$

$$\sum_{i}^{n} \sum_{j}^{g_i} \sum_{k}^{u_{ij}} \sum_{l}^{V_{ijk}} \sum_{m}^{r_{ijkl}} Q_{ijklm} \times (OTD_{ijklm} \times d_{ijklm}).$$

s/t

$$\sum_{i=1}^{o} \sum_{t=1}^{h} Q_{t_i} \le K_i ; \sum_{t=1}^{h} \sum_{j=1}^{g_i} \sum_{k=1}^{u_{ij}} Q_{tij} = \sum_{t=1}^{h} \sum_{j=1}^{g_i} \sum_{k=1}^{u_{ij}} Q_{tik} ;$$

$$\sum_{t=1}^{h} \sum_{k=1}^{u_{ij}} \sum_{l=1}^{v_{ijk}} Q_{tijkl} = \sum_{t=1}^{h} \sum_{j=1}^{g_i} \sum_{k=1}^{u_{ij}} \sum_{l=1}^{v_{ijk}} D_{ijkl} ;$$

$$\sum_{t=1}^{h} \sum_{k=1}^{u_{ij}} \sum_{l=1}^{v_{ijk}} Q_{tijkl} \le \sum_{k=1}^{u_{ij}} K_k . Y_k ; \sum_{t=1}^{h} \sum_{i=1}^{n} \sum_{j=1}^{g_i} Q_{tij} \le \sum_{k=1}^{u_{ij}} K_j . X_j$$

$$\frac{Q_{ti}}{2n_1} + s_1 \ (Q_{ti}) \le K_i ; \frac{\sum_{i=1}^{n} \sum_{k=1}^{g_i} Q_{tijk}}{2n_2} + s_2 \le K_j$$

$$\frac{Q_{tk}}{2n_3} + s_{3k} \le K_k ; \sum_{j}^{g_i} X_j = [0,1] ; \sum_{k}^{u_{ij}} Y_k = [0,1]$$

IV. NUMERICAL EXAMPLE

Solution for numerical example is using data from two largest producers in Java Island. Supply chain structure can be shown in figure 1. From the data we have a distribution structure as seen below :

TABEL 1
Distribution Structure

2 Plants (1st Tier)	2nd Tier Warehouses	3nd Tier Warehouses	Distributor
Plant A	2	2	27
Plan B	2	3	64
Total	4	5	91

After we have new regionalization-distribution and the optimal quantities supplied at each tier, we have the related costs of this model. Output of model solutions are created from LINGO 9.0 extended version. The optimal value is found at the 832[th] iteration. Solution building report can be shown in Figure 2 and the details of solution values can be shown on Table 2

TABEL 2
Optimal Quantities for Distribution Structure

2 Plants (1st Tier)	2nd Tier Warehouses	3nd Tier Warehouses	Distributor	Gudang Yang dibuka di Lini
Plant A	2	2	27	19
Plan B	2	3	64	17
Total	4	5	91	36

Total logistics costs have function to guarantee the smooth distribution and procurement activities
subsidized urea fertilizer, starts from producers at the first tier until their retailers at the fourth tier

V. CONCLUSION

This paper presents a development of integrated model of distribution regionalization and cost subsidy which part of production-distribution system problem. This model is considering subsidy factor as national parameter that will become a new emerging issue in production-distribution system. Supply chain performances will affect amount of subsidy given to producers and distributors.

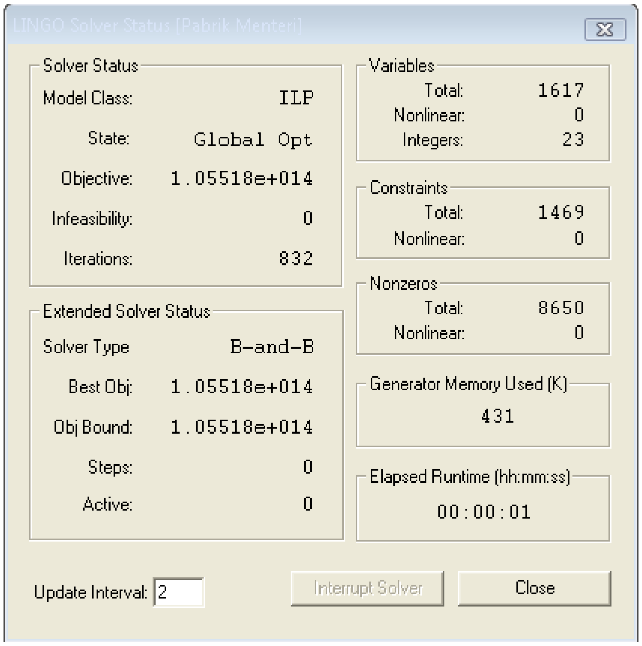

Fig. 2 Solution Building Report

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ISBN : 978-602-97809-0-1

Productivity AnalysisUsing Data Envelopment Analysis (DEA)

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Abstract - **Efficiency and productivity are among the most important keywords for a corporate business to compete. The measurements of these are essential to determine the level of efficiency and productivity at which a business process is running. PT XXX plant II operates three Kiln machines to produce slag cement, respectively coded as Kiln 1, Kiln 2 and Kiln 3. The data used to measure efficiency and productivity were the four year collection of data (from 2005 to 2008) of both the Kiln inputs (i.e. operation time, energy/electricity, feed, coal, and IDO), and its output, i.e. slag cement. The result of the DEA analysis showed that the efficiency of the Kilns could generally be considered perfect (efficiency = 1). During these 48 month period, there were only 12 occurrences of imperfect efficiency, spread in all the Kilns. The most efficient Kiln was Kiln 1, followed by Kiln 1 and Kiln 2. The TFP analysis also showed that the three Kilns in general experienced a positive rate of productivity (improvement index > 1). The most productive Kiln is Kiln T2, followed by Kiln T1 and Kiln T3.**

Keywords - **Efficiency, Productivity, DEA, TFP**

I. INTRODUCTION

The very fast advancement of science and technology in present day has lead to an even more tough competition among the corporate businesses. This is marked by the emergence of many new companies to share the market and the relatively constant or even decreasing level of demand. This situation requires each company to continuously innovate and improve their business processes. In this regard, the measurements of efficiency and productivity are essential to determine the level of efficiency and productivity at which the business processes are running because increasing productivity is a motor of economic progress and benefit of the company [1].

Data Envelopment Analysis (DEA) method can be used to measure and at the same time compare the efficiency and productivity of the comparable units (benchmarking) [2]. Therefore, this study used the DEA method for processing data. Efficiency generated by the DEA is the relative efficiency [3]. Since DEA is not a cost nor profit function, financial data that are often difficult to obtain may not be included [4]. There are two main models of DEA, namely the CRS model and its later development, the VRS model [5]. Because this study contains elements of time series, it can be transmitted by the analysis of Malmquist Productivity Index Method (MPI) [6]. MPI is useful to analyse total factor productivity (TFP), which can be split into two components, namely the efficiency change and technology change [3].

PT. XXX plant II operates three Kiln machines to process slag cement, namely Kiln 1, Kiln 2 and Kiln 3. They require multiple inputs i.e. operation time, energy/electricity, feed, coal, IDO, and labour to produce an output (slag cement). The measurement of efficiency and productivity in the Kilns is needed as evaluation for the company in managing its production factors (measurements are performed during four years i.e. 2005, 2006, 2007 and 2008). In other words, this study aims to determine the conditions on which the efficiency and productivity of Kiln 1, 2, and 3, has the highest efficiency and productivity.

II. THE CONCEPT OF EFFICIENCY AND PRODUCTIVITY

A. Efficiency Concept

According to popular scientific dictionaries, efficiency means savings, neatness, and accuracy [7]. This definition has a very broad sense that includes the sense of efficiency in all sectors. Thus, it is understood that the savings in everyday spending, savings in water usage, neatness in appearance, or accuracy in allocating the budget for example, are elements of efficiency we often find in daily life.

In the context of organization or company, one can simply say that a company produces efficiently if it produces output in maximum amount by using input within a certain amount, or uses input in a minimum amount to produce output in a certain amount. The output of a company can be seen from the number of products manufactured, the total revenue, profit, or from other revenues. Meanwhile the input can be seen from

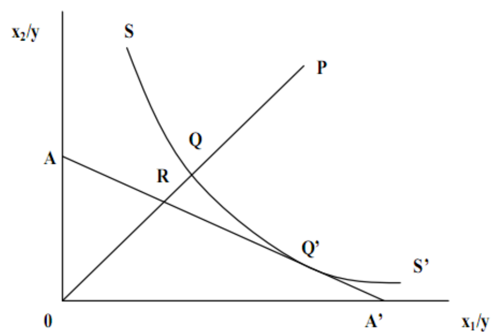
ISBN : 978-602-97809-0-1

the raw material usage, utilization of human resources, energy use, capital and other expenditures.

Efficiency is one of indicators in knowing overall performance of business process from a company. Farrell (1957) [8] states that the efficiency of a company can be divided into two kinds, namely technical efficiency and allocate efficiency. Technical efficiency refers to the ability of company to achieve maximum output from certain number of input or the ability of company to achieve certain number of output from a minimum input. Meanwhile the allocate efficiency shows the ability of company to use inputs with optimum proportions at the level of specific input prices. Both components are combined to produce a measure of the total efficiency or called economic efficiency [8].

The concept of economic efficiency measurement can be seen from the input side (input minimizing) or from the output side (output maximizing) [6]. Both of these approaches can be done and in the end will yield the same conclusions about the relative efficiency of a company against counterparts.

The approach from the input side can be explained as follows. Suppose there is a company that uses two types of inputs, namely x_1 and x_2 to produce one type of output namely y. The approach from input side of this situation can be described as follow:



Source: Coelli (1996)
Figure 1 Efficiency approach from input side

The curve that runs from S to S' is called the iso quant curve. This curve is actually a collection of points of the most efficient companies in group of counterparts (perfect efficient firms) or also called the most technically efficient companies. Meanwhile, the company at the point P is the company that includes the less efficient (imperfect efficiency) because it is located away from the isoquant curve. The efficiency of company P can be improved by reducing both type of inputs, x_1 and x_2, so that it approaches the isoquant curve and it is now on the point Q. The distance between P to Q is called the potential improvement, i.e. the amount of input quantities that can be reduced proportionally to produce the same amount of output quantities of efficient companies. So that the technical efficiency of company P in its counterparts group (TEp) can be measured by the ratio:

$$TEp = 1 - QP/0P = 0Q/0P$$

TE value ranges between 0 and 1. TEp Value = 1 indicates that the company has perfect technical efficiency. Meanwhile the value of TE that away from number 1 or close to number 0 is the less efficiency or imperfect efficiency.

Line AA' is the isocost line that shows price ratio between input x_2 to input x_1. Allocate efficiency (AE) of company P can be measured by the ratio:

$$AEp = 1 - RQ/0Q = 0R/0Q$$

Meanwhile economic efficiency (EE) of company P is the multiplication result between the technical efficiency (TEp) with the allocate efficiency (AEp), mathematically can be written:

$$EEp = TEp \times AEp = (0Q/0P) \times (0R/0Q) = 0R/0P$$

B. Productivity Concept

Semantically, the term productivity can be defined as the ability to produce [7]. This term first appeared in 1766 in a manuscript compiled by Quesnay from France. Littre (1949) in [9] defines productivity as the faculty to produce, similar to its semantic mean. In the early 20s, productivity is defined in general as the ratio between output and input [9].

Productivity can be divided into two kinds, namely: Partial Factor Productivity (PFP) and Total Factor Productivity (TFP) [9]. PFP is the ratio between the total output and one input element. TFP is the ratio between the total output and the aggregate of all inputs [3]. TFP counts all inputs simultaneously to measure productivity. Productivity measurement can be done in a variety of activities, from a small scope, such as work stations, machinery, division/section in an organization, company, to a broad scope, such as the productivity of a country even global/international productivity.

III. DATA ENVELOPMENT ANALYSIS AND MALMQUIST PRODUCTIVITY INDEX

A. Data Envelopment Analysis Method

Data Envelopment Analysis (DEA) was first introduced by Charnes, Cooper and Rhodes in 1978. DEA was proposed to address the limitations of frontier analysis ever presented by Farrel in 1957. Frontier analysis can only determine the efficiency of the company that uses two inputs to produce one output or produces two outputs by using one input. Meanwhile DEA can measure the efficiency of a company that uses multiple inputs to produce multiple outputs [10].

DEA is a non-parametric method used to measure the relative efficiency of a unit of activity (Ray, 2004) [6]. DEA is defined as a linear programming-based technique for measuring the performance efficiency of organizational units which are termed Decision Making Unit (DMU). DMU can include manufacturing units, departments of big organizations such as universities, schools, bank branches, hospitals, etc [6].

As a non-parametric analysis method, DEA does not include random error in its calculation mechanism [3]. DEA can only calculate in accordance with numerical data obtained. In other words, DEA can not calculate other factors that may actually influence the efficiency calculations, such as

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price differences between companies, regulatory differences, good or bad behaviour data, the extreme observations, and others. As a result, the DEA can only be used to measure the efficiency in general [3].

DEA method calculates technical efficiency for the entire DMUs. Efficiency score for a unit is relative depending on the level of efficiency of other units in the population. Each DMU is considered to have efficiency between 0 to 1. Value 1 indicates that the company has perfect technical efficiency. Meanwhile the value that away from number 1 or close to number 0 is the less efficiency or imperfect efficiency[11]. Furthermore, the DMUs that have value 1 is used in making envelope for efficiency frontier and the other DMUs in the envelope shows the level of imperfect efficiency [8].

The mathematical formulation for the DEA by the ratio [6]:

$$\max E_m = \frac{\sum_{j=1}^{J} v_{jm} Y_{jm}}{\sum_{i=1}^{I} u_{im} X_{im}}$$

$$\text{subject to}$$

$$0 \leq \frac{\sum_{j=1}^{J} v_{jm} Y_{jn}}{\sum_{i=1}^{I} u_{im} X_{in}} \leq 1 \; ; \quad n = 1, 2, \ldots, N$$

$$v_{jm}, u_{im} \geq 0 ; \quad i = 1, 2, \ldots, I ; \quad j = 1, 2, \ldots, J$$

Where:

E_m is the efficiency of the m[th] DMU

Y_{jm} is the j[th] output of m[th] DMU

v_{jm} is the weight of the j[th] output j of m[th] DMU

X_{im} is the input i[th] of the m[th] DMU

u_{im} is the weight of the i[th] input of the m[th] DMU

Y and X_{in} is the output j[th] and i[th] input, each of the n[th] DMU,

n = 1, 2, ..., N

The essence of DEA is to determine the weight (v and u) for each output and input of DMU. The weight has characteristic as follow.

1. No negative values
2. Universal, meaning that every DMU in sample must be able to use same set of weights to evaluate the ratio. The ratio value ranges between 0 and 1, as mentioned above.

DEA assumes that each DMU will choose the weights that maximize its efficiency ratio. Because each DMU uses a combination of different input to produce different output combination, so each DMU will choose a set of weights that reflects its diversity. The weight is not the economic value of inputs and outputs, but a determinant for maximizing the efficiency of a DMU [12].

This general formulation can be transformed into a linear program by the approach from output side (output maximizing) as follows:

$$\max z = \sum_{j=1}^{J} v_{jm} Y_{jm}$$

$$\text{subject to}$$

$$\sum_{i=1}^{I} u_{im} X_{im} = 1$$

$$\sum_{j=1}^{J} v_{jm} Y_{jn} - \sum_{i=1}^{I} u_{im} X_{in} \leq 0 ; \quad n = 1, 2, \ldots, N$$

$$v_{jm}, u_{im} \geq 0 ; \quad i = 1, 2, \ldots, I \quad j = 1, 2, \ldots, J$$

Meanwhile for the approaches from input side (input minimizing), the formulation above can be transformed into the following linear program:

$$\min z' = \sum_{i=1}^{I} u'_{im} X_{im}$$

$$\text{subject to}$$

$$\sum_{j=1}^{J} v'_{jm} Y_{jm} = 1$$

$$\sum_{j=1}^{J} v'_{jm} Y_{jn} - \sum_{i=1}^{I} u'_{im} X_{in} \leq 0 ; \quad n = 1, 2, \ldots, N$$

$$v'_{jm}, u'_{im} \geq 0 ; \quad i = 1, 2, \ldots, I \quad j = 1, 2, \ldots, J$$

DEA method that uses weights of input and output as u and v described above is a multiplier DEA. Meanwhile the DEA that uses weights with the symbols θ and λ is called DEA Envelopment [6]. Multiplier DEA and Envelopment DEA are the primal and dual theory in operations research. In Envelopment DEA, the terms input oriented and output oriented are used. These terms are equivalent to the term maximizing output and minimizing input in multiplier DEA. Envelopment DEA with the approach from input side (input oriented) is proportional to multiplier DEA with the approach from output side (output maximizing), and vice versa.

In summary, there are four types of DEA methods, namely [6]:

1. Output maximizing multiplier DEA
2. Input minimizing multiplier DEA
3. Output oriented envelopment DEA
4. Input oriented envelopment DEA

Here are the formula for the four types of DEA method:

Output maximizing DEA $\max z = V_m^T Y$ Subject to $U_m^T X_m = 1$ $V_m^T Y - U_m^T X \leq 0$ $V_m^T, U_m^T \geq 0$	Input oriented envelopment DEA $\min \theta_m$ Subject to $Y\lambda \geq Y_m$ $X\lambda \leq \theta_m X_m$ $\lambda \geq 0 ; \theta_m$ *bebas*
Input minimizing multiplier DEA $\min z = V'^T_m X$ Subject to $U'^T_m Y_m = 1$ $V'^T_m Y - U'^T_m X \leq 0$ $V'^T_m, U'^T_m \geq 0$	Output oriented envelopment DEA $\max z\ \phi_m$ Subject to $Y\mu \geq Y_m$ $X\mu \leq \phi_m X_m$ $\mu \geq 0 ; \phi_m$ *bebas*

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B. Malmquist Productivity Index

Malmquist Productivity Index (MPI) is basically a continuation of the DEA method which has been described above. The difference is that there is the element of time series in measurement of MPI because MPI contains the change of efficiency and technology. A company may be in the same level of productivity from year to year, or also change either increased or decreased caused by various factors. The difference in efficiency of an industry from year to year is called the technical efficiency change and the frontier curve shifts from year to year is interpreted as technical change [13].

This technical change in some resources is also called technological change. The multiplication of technical efficiency change index and technical change index is referred to as Malmquist Productivity Index (MPI) [3]. Thus, the MPI can be written in the formulation:

$$MPI = TEC \times TC$$

TEC and TC with the approach from the input side can be calculated by the following formula:

$$TEC_i^{t,t+1} = \frac{D_i^t(y^t, x^t)}{D_i^{t+1}(y^{t+1}, x^{t+1})}$$

$$TC_i^{t,t+1} = \left(\frac{D_i^{t+1}(y^{t+1}, x^{t+1})}{D_i^t(y^{t+1}, x^{t+1})} \times \frac{D_i^{t+1}(y^t, x^t)}{D_i^t(y^t, x^t)} \right)^{\frac{1}{2}}$$

Thus MPI can be transformed into the following formula:

$$MPI_i^{t,t+1} = \left(\frac{D_i^t(y^t, x^t)}{D_i^{t+1}(y^{t+1}, x^{t+1})} \right) \times \left(\frac{D_i^{t+1}(y^{t+1}, x^{t+1})}{D_i^t(y^{t+1}, x^{t+1})} \times \frac{D_i^{t+1}(y^t, x^t)}{D_i^t(y^t, x^t)} \right)^{\frac{1}{2}}$$

Where $D(y, x)$ is the input distance function.

MPI has several advantages as follows [3]:

1. MPI is a non-parametric method that does not require specification of the production function.
2. This index does not require the assumption of DMU behaviour such as cost minimization or profit maximization, so it is very useful when the purpose of the DMU is different or unknown.
3. The calculation of index does not require prices data.
4. MPI can be split into two components, namely technical efficiency change and technical change. This is very useful because the analysis could be done more specifically by the component.

IV. RESULT AND ANALYSIS

Here is the calculation of the efficiency and productivity by using DEAP software version 2.1.

TABLE 1
RELATIVE EFFICIENCY OF KILN 1, 2, AND 3 PER MONTH IN 2005

Month	DMU		
	Kiln 1	Kiln 2	Kiln 3
1	1.000	1.000	1.000
2	1.000	1.000	1.000
3	1.000	1.000	1.000
4	1.000	0.999	1.000
5	1.000	1.000	1.000
6	1.000	1.000	1.000
7	1.000	1.000	1.000
8	1.000	1.000	1.000
9	1.000	0.998	1.000
10	1.000	0.999	1.000
11	1.000	1.000	1.000
12	1.000	1.000	1.000

TABLE 2
RELATIVE EFFICIENCY OF KILN 1, 2, AND 3 PER MONTH IN 2006

Month	DMU		
	Kiln 1	Kiln 2	Kiln 3
1	1.000	1.000	1000
2	1.000	1.000	1.000
3	1.000	1.000	1.000
4	1.000	1.000	1.000
5	1.000	1.000	1.000
6	1.000	1.000	1.000
7	0.998	1.000	1.000
8	1.000	1.000	1.000
9	1.000	1.000	1.000
10	1.000	0.999	1.000
11	1.000	1.000	1.000
12	1.000	1.000	1.000

So forth for the year 2007, and 2008.

TABLE 3
MALMQUIST INDEX ANNUALLY FOR ALL KILN

Year	DMU	Efficiency Change	Technology Change	TFP Change
2006	Kiln 1	1.000	1.004	1.004
	Kiln 2	1.000	1.101	1.101
	Kiln 3	1.000	1.062	1.062
2007	Kiln 1	1.000	1.494	1.494
	Kiln 2	1.000	1.201	1.201
	Kiln 3	1.000	1.005	1.005
2008	Kiln 1	1.000	2.215	2.215
	Kiln 2	1.000	2.555	2.555
	Kiln 3	1.000	2.085	2.085

TABLE 5
INCIDENT OF IMPERFECT EFFICIENCY IN KILN 1

Year - Month	Relative Efficiency	Peer
2006 - 7	0.998	Kiln 3
2007 - 9	0.998	Kiln 3
2008 - 9	0.998	Kiln 3

TABLE 6
INPUT TARGETS FOR KILN 1 THAT HAS IMPERFECT EFFICIENCY

ISBN : 978-602-97809-0-1

Y - M	Input Variable				
	Opt time (hours)	Energy (kwh)	Feed (tones)	Coal (tones)	IDO (kltr)
06 - 7	711	6464422	344009	36392	321
07 - 9	707	6195456	352880	38837	0
08 - 9	655	5857086	341341	40007	5

TABLE 7
ESTIMATED WASTE (LOST INPUTS) WHICH OCCURRED IN KILN 1

Y - M	Variabel Input				
	Opt time (hours)	Energy (kwh)	Feed (tones)	Coal (tones)	IDO (kltr)
06 - 7	8	111494	599	805	225
07 - 9	5	73184	808	316	10
08 - 9	7	108877	722	84	32
Amount	20	293555	2129	1206	268
Amount in percent	0.0216	0.0357	0.0048	0.0258	0.4199

V. CONCLUSIONS

Several conclusions can be drawn from this study, as follows:

1. Efficiency condition of the three Kilns during 4 years from 2005 till 2008 in general can be said to have a perfect efficiency (efficiency = 1). From 4 years (48 months), there were only 12 occurrences of imperfect efficiency which were spread in all the Kilns. Kiln 1 has 3 events of imperfect efficiency, Kiln 2 has 8 events of imperfect efficiency and Kiln 3 only experienced 1 occurrence of imperfect efficiency. The occurrences of imperfect efficiency are still considered fair because the value of efficiency is still within the range between 0.995 up to 0.999. In other words, all the three kilns have very similar level of efficiency. The order of the most efficient Kiln to the least according to lost input value is Kiln 3, Kiln 1 then Kiln 2.
2. The efficiency for the three Kilns in general has not changed (change efficiency index = 1). As for the technological change, the three Kilns experienced a positive rate (change index > 1). This lead to a positive rate of productivity (change index > 1) because the change index in efficiency is always fixed, the index of TFP change is always the same with changes in the technology index. TFP changes on Kiln 1 and 2 in each year show an increase trend. As for Kiln 3, the trend shows up and down moves. The order of the most productive Kiln to the least according to the average value is Kiln 2, Kiln 1 then Kiln 3.

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

ICIEBM

Proceedings

The International Conference on Industrial Engineering and Business Management 2010

CHAPTER 5 :
Engineering Economy (EEC)

editor :
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Proceedings ICIEBM

ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

Development of an Effective Cost Management Method for Malaysian SMEs

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***Abstract* - Cost management is essential to manufacturing company for sustaining market share, competitive position and profit growth. In the past, it was found many SMEs had made mistakes during their cost management process. Two of these major mistakes were due to lack of knowledge in cost management and not knowing the right technique to use for monitoring all production costs. The two main objectives of this paper are: first, to present a case study on cost management method at a local SME; and secondly, to point out their mistakes and weaknesses of its cost management system. Later, the paper will present a case study of an effective cost management method practiced by a Japanese multinational company. Based on the findings of both case studies, the authors shall propose an effective costing management method, which may be applied to local SMEs for monitoring their production costs. The authors believed this costing management method will be able to help local SMEs to improve their cost management system, which eventually giving them the opportunity to achieve more profitable sales and sustainable competitive position in global market place.**

***Keywords* - cost, management, effective, SMEs, competitiveness**

I. INTRODUCTION

Cost management is essential to manufacturing company in order to maintain profitable sales and sustainable position in current competitive global market. An effective cost management will be able enhance a company business competitiveness and survival especially during current global economic crisis. Practising continuous cost improvement activities had helped many companies to become more competitive and enhanced their ability to survive.

The two main objectives of this study are: first, to compare the cost management systems in a local SME, Company X and a Japanese MNC, Company Y; and second, to determine the mistakes and weaknesses of local SME. This study also present an effective cost management system adopted from Company Y. A comparison study is a good technique to investigate and later adopt the Japanese MNC's costing method to improve local SMEs cost management method. Comparison study was used in this paper to encourage and familiarize more researchers and manufacturers with this technique. Due to the lack of knowledge in cost management, many SMEs were making mistakes during managing their manufacturing cost. Every manufacturer is expected to control and monitor all the costs incurred during a product manufacturing process. However, some SMEs do not know how or having the right technique in monitoring all costs which are involved in the production process. Having conducted cost improvement activities without studying the cost that significantly affecting the performance in terms of sales and profit may result in high production cost. Previous research made by Hamid et al. [1] shown that SMEs are commonly facing with financial issues. Hopefully, this method will be able to help local SMEs improve their cost management system and provides SMEs with the opportunity to achieve more profitable sales and sustainable position in current competitive global market.

II. LITERATURE REVIEW

SMEs play a very important role in the country's economic development. Saleh & Ndubisi [2] in their study cited a statistic from SMIDEC Malaysia for year 2006. This statistic shows that 93.8% of companies in the manufacturing sector are SMEs and they contributed 27.3% to total manufacturing output, 25.8% to value-added production, own 27.6% of fixed assets and employ 38.9% of the country's workforce. It is forecasted that by 2020, the value-added products from SMEs will be worth RM 120 billion or 50% of total production in the manufacturing sector. Due to these reasons, it is why the authors believe that it is crucial to focus research on improving local SME performances. Referring to Table 1, it shows the financial issues faced by the SMEs. These problems illustrate how weak and inefficient cost management and control in local SMEs [1].

TABLE 1 FINANCIAL PROBLEMS FACED BY SMES

Financial problem	Percentage (%)
Lack of capital	22.3
Poor financial record	16.5
High product cost	36.9
High overhead cost	26.2
Overdue account receivables	24.3
Difficulties in obtaining loans	17.5

Source: Hamid et al. [1]

In the study made by Harri et al. [3] for the past few years have seen rising interest in network economy. The first reason is globalization. The world has been shrunk by information technology and open economies. The second reason is that companies have to take care of costs to meet the descending price rate of the market. Competition in the mature lines of business requires continuous productivity improvements. A firm that fails to reduce costs as rapidly as its competitors will find its profit margins squeezed and its existence threatened. The competitive environment demands the development of sophisticated cost management practices to keep costs down [3].

In a study made by Govindarajan and Shank [4], strategic cost management can be defined as the use of cost information to help formulate and communicate strategies, to carry out tactics that implement those strategies and finally to develop and implement controls that can monitor success at achieving strategic objectives.

While total cost management (TCM) is a business paradigm for managing all company resources and activities that consume those resources with a focus on stimulating and managing changes [5]. The study also explains the TCM paradigm. Companies can consider the entire environmental impact of their products by looking at substitutes for inputs that are hazardous and for processes that can reduce the generation of waste. TCM offers a systematic approach to continuously improve operations and reduce waste generation throughout the product life cycle. Firms will find such integration desirable to reduce costs, reduce liability, and minimize adverse community concerns over their operations.

III. METHODOLOGY

Case study methodology was used in this research. This study will formulate an effective cost management which is adopted from Company Y through a comparison study. Data collection will be based on a sample of cash flow sheet and profit loss statement by Company X. Study of cost management will be based on these sheets. As for comparison, a production costing sheet used Company Y had been used. Analyzing a sample cash flow sheet and profit loss statement provided by Company X, a few weaknesses of cost management and cost control method in the company is being identified. In addition, the authors shall conduct a structured interview with a few top management personnel in Company X. Further in this process, a production costing sheet currently used by Company Y will be use as part of comparison process to adapt this cost control method in SMEs. This too will be supported by interviews made with a few top management personnel in Company Y. Through the comparison study and interpreting a production costing sheet, it was found that various costs were measured and monitored continuously in order to maintain better control of production and manufacturing expenditure.

IV. RESULTS AND DISCUSSION

A. Introduction

The results of the case study will be separated into two sections. Firstly is analysing and reviewing the weaknesses that were found in the sample of costing sheets used in Company X. By analysing these costing sheets, it will provide the authors the understanding on the cost management implementation in this SME Company.

Secondly is to analyse and review the best points that can be found in a sample of production costing sheet used by Company Y. Through this analysis, the authors were able to understand good practices on cost management in this MNC.

B. Analysis of Company X

1) Cash flow sheet: Cash Flow Sheet used by Company X to project its cash flow expectation. This Cash Flow Sheet divided into 3 sections, which comprise of:

- Section 1 – Cash Inflow
- Section 2 – Cash Outflow
- Section 3 – Net Cash Flow

Cash inflow involves operating activities, which produce earning of income and sales for the company. Cash inflow activities are includes the trade debtors, sales of scrap, fixed deposit interest and other sales.

While cash outflow activities involved supporting and financing major processes such as operational activities and administration. Cash outflow for operational activities consist of trade supplies, creditors, old debt, ageing and wages. As for administration, cash outflow activities included administrative matters; inter company, dividend and taxes.

Once the cash inflow and outflow estimates are developed the net cash flow can be determined.

2) Profit and loss statement (P&L): P&L statement is also known as a Statement of Profit and Loss, or an Income Statement or an Income and Expense Statement. In Company X, Profit and Loss Statement is used as a financial statement that summarizes the revenues, costs and expenses incurred during a specific period. These records provide information that shows the ability of Company X to generate profit by increasing revenue and reducing costs.

The statement of profit and loss follows a general form, begins with an entry for revenue and subtracts from revenue the costs of running the business, including cost of goods sold, operating expenses, tax expenses and interest expenses. The bottom line (literally and figuratively) is net income (profit).

Revenue would be from the total sales of product, new project sales and sales of scrap iron. Meanwhile, cost incurred are comprise of cost of goods sold, production cost, sales tax, and other overheads such as administration expenses, bank charges, bonus for employees, company vehicles expenses, machine depreciation, management fees, building maintenance, office equipment maintenances, collateralized loan obligation profit, management royalty, medical fees, professional audit fees, security expenses and utilities expenses.

ISBN : 978-602-97809-0-1

C. Review and discussion of Company X

The use of Cash Flow Sheet together with Profit and Loss Statement as part of managing manufacturing cost is a good technique and practice used by Company X to monitor the performance of its company. However, there are weaknesses found in this cost managing technique. Cash Flow Sheet and Profit Loss Statement only allow us to monitor overall expenses in and out of the company without focusing on the cost or expenses that are critical or directly influencing the performance of the company. Improvement activity cost conducted may not be focusing the right problem because actual problems of cost incurred are not being shown clearly in both Cash Flow Sheet and Profit and Loss Statement.

Based on interviews made with a few management personnel of Company X it was found that Company X sales and income fully depends on its customer demand volume. This means that the more quantity of product required by its customer, the higher sales volume would be for Company X. Company X also practises the concept of more types of products being produced by the company the better its sales would be. In terms of cost improvement, company X believes cost is improving when more types of products produced at higher volume with lower rejection or defects rates.

The most obvious weakness in this cost management technique can be seen when Company X's customer unable to request high volume of product. Demand of product may decrease eventually, hence results in decreasing sales for the company. This would jeopardise the company cash flow especially when Company X overhead costs remain the same, regardless how much or less it sales value would be. Since Company X depends on volume and sales from its customer, the company has to bare and sustain the production cost that they have invested previously such as increasing number of workers, number of machines, working hours through overtime and increasing consumption of its material to cope with its high volume demand from its customer. In the long term Company X may need to cope with the burden of having high overhead, since there is no effective cost monitoring technique is being practice for its cost management system.

D. Analysis of Company Y

In Company Y, the usage of Production Costing Sheet is essential to help production and operation to monitor closely the cost that had incurred during the production of its product. Figure 1 shows an example of a Production Costing Sheet currently being used in Company Y for every product produced.

E. Review and discussion on Company Y

Referring to Figure 1, an analysis was made on the sample of Production Costing Sheet. It shows that this costing method measured and monitored on the usage of material and the cost involved. It also observed the usage of manpower and number of person required for every process, number of processes involved to complete a product, and also usage of processing time and its processing cost in manufacturing a product. Generally, the material, product cycle time, number of processes, number of manpower and the processing costs are only estimated during product development. However, in Company Y, Production Costing Sheet is designed and used widely to monitor every possible cost that would be incurred during product manufacturing.

Month : Nov-08

		MASS PRODUCTION		MOCK	
Drawing No	Color	YEN	RM	YEN	RM
CA07124-0701	Silver	212.00	8.7408	204.00	8.4109

Ex change rate :

0.04123	Yen
3.398	USD

Man Hour : (RM) 45

PROCESS			MP	C/T	Y.Rate	Material	M. Cost	Process	P. Cost	Total Cost
Process 1	Child Part A		1	6	100.0%	0	0.000	0.075	0.075	0.075
Process 2			4	11.25	96.6%	0	0.000	0.563	0.582	0.582
	Child Part A				96.6%	0.718	0.743	0.931	0.963	1.706
	Child Part B				96.6%	0.312	0.323	0.189	0.196	0.519
	Child Part C				96.6%	0.153	0.159	0.529	0.547	0.706
	Child Part D				96.6%	0.3200	0.331	0.202	0.209	0.540
	Child Part E		1	2	96.6%	0.5160	0.534	0.025	0.026	0.560
Process 3			3	12	96.7%		0.000	0.450	0.465	0.465
Process 4			1	4	99.3%		0.000	0.050	0.050	0.050
Process 5			1	3	100.0%	0.0345	0.035	0.038	0.038	0.072
										0.000
Total						2.054	2.124	3.051	3.152	5.275
Over all						2.054	2.124	3.051	3.152	5.275
Ratio / Selling price							24.3%		36.1%	60%
						Material	Material	Process	Process	

Management Fee: 3%
Royalty : 6%

Target Profit %	10%	
Actual Profit/loss %		33.7%
Profit/Loss		2.679
Cost/pc		5.28
Target Price	Minus 9%	7.954
Selling Price		8.74

Fig 1. Production costing sheet for Company Y

Basically, it helps production managers by giving them the overall data on the performance of cost for each product. For example, the Production Costing Sheet stated process yield rate on every process junction. Process yield rate are quality performance of a product. The higher the process yield rates are better and higher quality product are produced. Most of the materials involved are also affected with this process yield rate. It shows that if process yield rate are lower, it means more materials are required in order to meet the quantity demand. More defects are been produced due to lower and incompetent process yield. Such situation will involve more materials to be use, hence giving an additional increment on material cost due to higher consumption.

Cycle time of each process is also being considered. Through this cycle time, processing cost is been calculated and monitored throughout the manufacturing process. If a process involves high cycle time, therefore the cost of processing too will increase. Most Japanese MNC practises work study, lean manufacturing, and time study to improve and shorten processing time. Some would consider on turning the process into an automated line to reduce time and usage of manpower. These are some examples on how to improve cost in the production line.

The usage of manpower is also being emphasized in the Production Costing Sheet. It is known that the more workers are required to perform in a process, manpower rate and cost would be increased. Overall, the Production Costing Sheet give a good view on what type of cost and how much cost are being used in term of material, processing hour, manpower usage and process yield rate.

This Production Costing Sheets also helps the manager to focus and pinpoint on which item that incurred most cost to the production. Cost improvements are being made based on the result shown by the Production Control Sheet because these items and cost are directly influencing to the profit or loss made by the product produced.

In Company Y, the Production Costing Sheet is one of the effective cost managing techniques implemented in order to improve cost, hence able to generate better profit and sales. Both company, X and Y, use Cash Flow Sheet and Profit and Loss Statement as part of their cost managing tools. However, as an addition, Company Y develops and uses Production Costing Sheet as a supportive tool to control and monitor cost more effectively in its production.

V. Conclusion

In this study, Company X was used as a case study to identify how it practices cost management system. Through analysing its Cash Flow Sheet and Profit and Loss Statement it was found that Company X is very dependent on quantity and sales demand from its customer. In Company X, costs controls are based on cash inflow and cash outflow. In other words, the company try to improve sales by reducing any expenses of outflow cash either from operational or administration. It practices a method of cost down or cutting some expenditure to improve its cost consumption. Other method of cost management implemented by Company X was to increase sales as much as possible through increasing product volumes manufactured and number of various products produced. This will lead Company X to invest more on increasing the number of manpower, increasing the number of machines and increasing working hours through overtime. In the long term this may become a burden to this local SME, when there is a sudden drop of sales and demand from its customers.

The practise of using Cash Flow Sheet and Profit and Loss Statement is vital to a company. However it must be supported by other cost management tools and technique to ensure effective cost monitoring activities is being implemented in the company.

This is the reason why this study had chosen a Japanese MNC as a comparison in order to improve the cost management method in our local SME. In Company Y, besides using Cash Flow Sheet and Profit Loss Statement to support its cost monitoring, it also uses Production Costing Sheet during manufacturing its products. This is to monitor the detail operational costs that were incurred in every product manufactured. The Production Costing Sheet has the same method for product costing used during product development stage. This Production Costing Sheet was used in the production line to monitor the performance of production costs on monthly basis. Cost improvements are made based on the result shown by the Production Control Sheet. These improvements were done through methods such as implementing Lean Manufacturing, JIT (Just-in-time), Work Study and Time Measurement Study.

In Company Y, the Production Costing Sheet is one of the effective cost management tool implemented in order to improve cost control, hence able to generate better profit and sales. By simplifying the tool's technique and method in Production Costing Sheet, it will able to assist local SMEs to implement and practiced effectively to help local SMEs to maintain more effective control of their products' production expenditure, hence generating better profits and sales.

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Buy or Lease Decision
A Case of NMR Spectrometer Investment of PT X

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Abstract. **A decision whether to invest or not to invest on a project or equipment is critical for every entity especially for the profit one. In this research, a study to determine the feasibility of investing on NMR Spectrometer is carried out. The study has been conducted based on three aspects that are market demand, technical, and financial aspects. The aspects are the input for the NPV, IRR, and Payback Period calculation. Based on the analysis, the investment on this equipment is worth to do. The NPV is greater than zero, the IRR is 36%, and it will take 4.11 years to payback the investment. In addition, sensitivity analysis was conducted to see changes of the NPV when the cost increases while the total revenue decreases. The result also showed the eligibility of the investment.**

Keywords: NPV, Payback Period, make or buy decision, sensitivity analysis

I. INTRODUCTION

Chemical industry is one of fast growing industries in Indonesia. PT X which produces lead is one of the companies that moved to this area. The increasing competition among tin manufacturing industries combines with declining of tin reserves in one side, and increasing market demand on the other side cause the price of tin ore is difficult to control.

The purpose of this study is to check whether the NMR investment is feasible to run or not in the sense that if the company buy the equipment it will give the benefits the company listed. For the purpose, the research is conducted on the quality control laboratory of PT X and a research center that already have NMR (the NMR is Spectrometer 400 MHz frequency standard). To do so, two alternatives to consider; lease NMR from laboratory that provides testing service or buy its own equipment. The later option is intriguing. Even though the spectrometer is expensive, but possibility of getting profit from having the tool, lowering the testing costs as well easier quality control and flexible time to use are tempting the company to conduct a feasibility study of the NMR investment.

The data are secondary. Costs such as labor costs and electricity costs are set by the company. Maintenance costs are determined by the company as well. On the other hand, profit is estimated based on the current research center utilization and forecast demand on testing.

II. THEORY

Business Feasibility Study is a study of a business plan that not only analyzes the business worth to be executed or not, but it also performs during routine operational in order to achieve maximum benefit for a period not specified. The Study aims to avoid investing for activities that were not profitable. Aspects of feasibility studies which affect business, namely:

- Market aspect. This aspect is at the core of a feasibility study. In this aspect examined whether it will be enough market demand to absorb the products of the business. It is also examined the project's ability to compete in the market, and achieved external factors affecting product demand and market competition in the atmosphere
- Technical aspect. The aspect is including economic production capacity of the project, type of technology and production equipment proposed for use, selection of location and layout of projects, procurement of raw materials, auxiliary materials and supporting facilities.
- Economic aspects, including the calculation of the investment budget required to build and operate the project, the structure and source of investment financing, and the prospect of the project to produce profits.
- Organizational and management aspects such as, relationship in the company, organizational structure, powers.
- Legal and environmental aspects, in this aspect can be seen whether the effort will be having a valid legal basis and whether proper legal environment.

Investment Appraisal Methods and Criteria

Method to evaluate whether a project is feasible or not is many. Some popular ones are listed below:

- **Net Present Value Analysis.** This analysis computes the net revenues of the whole life of the project and then equate the value to the present value. A project is considered profitable if the NPV value is greater than 0. if there are several alternative investment projects, the best alternative is the one with the highest NPV value.
- **Internal Rate of Return Analysis.** Instead of calculating the value, in the term of money earned, of a project, IRR basically calculates the percentage of profit of the project. A project is accepted if its IRR is greater than MARR (Minimum Attractive Rate of Return) set by the company. MARR usually set a bit higher than the interest the company pay to the bank for financing their project.
- **Analysis of Time Returns (Payback Period).** This analysis is used to determine how long a project will reach breakeven point. The shorter the payback period the more attractive a project. Compare to two methods mentioned earlier, this method has deficiency due to abandoning the time value of money and neglecting cash flow after reaching the time of return.

Sensitivity Analysis

One project is feasible if the calculation using one or more methods mentioned above turns out to be more than what one sets. But in reality, assumptions, estimations and calculations are not free from errors or mistakes. A project is also facing risks that sometimes are not seen in advance. Sensitivity analysis is the way to check how a factor(s), for instance costs, profits, life time of the project, influence the outcome of the calculation. Sensitivity analysis gives an interval outcome of the calculations, instead of a single number, so project decision maker will have the minimum (the least) and the maximum results of the project.

III. RESULTS AND DISCUSSION

For the purpose of the study three aspects are examined, demand, technical, and financial aspects.

3.1 Market Demand Aspect

Future demand is estimated based on the company's existing samples tested to lab center and the predicted volume of samples due to company's line of business expansion. The method used to predict is qualitative, due to the fact that the company had never had NMR before and there is no historical data for the sample test requests. Basis for determining the amount of demand is influenced by the number of samples, the number of batches per day, and the increase production capacity. The forecast demand obtained is the number of samples for the next 10 years. It has a tendency to rise proportional to the production capacity increases. Figure 1 shows the sample request test for 10-year of production.

The results of this forecast are then used to estimate incomes and expenses.

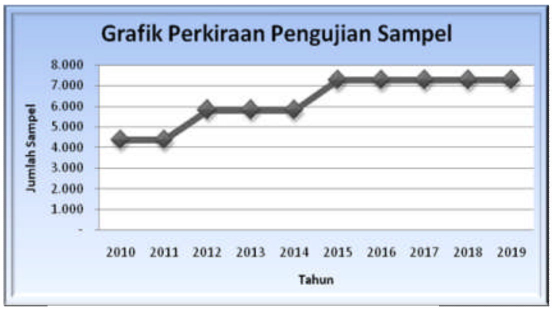

Figure 1: Request Sample Test Graph

3.2 Technical Aspects

Technical aspect analysis is aimed to assess the feasibility of investments based on views of technology. On the technical aspects, there are several parameters such as identification of the need of the equipment, equipment specifications and layout tools. Specifications include machine tool measurement range, the price of equipment and accessories for operational needs such liquid helium. Technical aspect is also including maintenance; service after sale is a parameter to consider. As for maintenance equipment needed partners who provide service contract after the applicable warranty period runs out, the selected partner is also a partner who appointed directly by the manufacturer as an authorized agent instruments in Indonesia. Based on equipment specifications, NMR Spectrometer with 400 MHz frequency is selected. This spectrometer is able to analyze a variety of chemical such as the 1H, 13C, 19F, 31P to 15N, 39K to 109Ag.

Based on the tool characters and specification, the layout plan of equipment is then determined. The information is also used for human resource planning (operator) determination. From the technical aspect point of view, purchasing the NMR is feasible.

3.3 Financial Aspects

The analysis is divided into two main parts, the analysis of the make or buy decision and analysis of financial feasibility parameters.

Analysis Make or Buy Decision

Based on cost estimates for the 10 years of production for the alternative one (i.e. purchase the NMR and do their own testing), for the first year, the company gets margin of Rp 1,245,189,012 compared to using a service of other testing lab subcontractor. If the cost is assumed fixed, the average saving is Rp 1,245,189,012 per year. This huge savings is reasonable due to owning the equipment, the company do not have to pay for lab tests, sample shipping costs each year and it only needs to pay for the purchase of raw materials means. Figure 2 shows a comparative analysis of the total cost (total expenses) between alternative 1 and alternative 2.

Figure 2 Graphic Comparison of Total Cost Alternative 1 and Alternative 2

Based on the cost comparison, the best alternative is the one that gives the greatest benefit. In this case is buying the equipment and do the testing yourself. However, due to the decision to purchase this tool involving large capital investment, which is critical to the company's long term well being, therefore other financial aspects, such as projected income, cash flow estimation and investment parameters should be taken into consideration.

Financial Parameters

For the financial calculation, straight-line depreciation method is used. The calculated estimates of income and total expenses can be seen on the results of the calculation of the income statement. Based on the calculated parameters of the financial aspects, the investment is worth to do. Its' NPV is Rp7, 699,572,725.17 (much away from 0), and the level of IRR is 36% (above Marr). While the pay-back period is 4.11 years. That period is not long for such of investment.

3.4 Sensitivity Analysis

Sensitivity analysis is a method to analyze the risk of an investment. Feasibility analysis uses a lot of estimated data and assumption that bear uncertainty. The uncertainty can lead to reduction of profit and increment of firm losses. Sensitivity analysis is performed toward two parameters at the same time, i.e. the increase in total cost and the decrease of total revenue. Tabel 1 and figure 3 below are summarizing the results.

Table 1 Sensitivity Analysis

Skenario 3		TOTAL COST NAIK				
		10%	20%	30%	40%	50%
TOTAL REVENUE TURUN	10%	Rp 5.960.060.078,06	Rp 5.546.253.817,42	Rp 5.132.447.556,78	Rp 4.718.641.296,14	Rp4.304.835.035,50
	20%	Rp 4.624.193.584,90	Rp 4.210.387.324,26	Rp 3.796.581.063,62	Rp 3.382.774.802,98	Rp 2.968.968.542,34
	30%	Rp 3.288.327.091,74	Rp 2.874.520.831,10	Rp 2.460.714.570,46	Rp 2.046.908.309,82	Rp 1.633.102.049,18
	40%	Rp 1.952.460.598,58	Rp 1.538.654.337,94	Rp 1.124.848.077,30	Rp 711.041.816,66	Rp 297.235.556,02
	50%	Rp 616.594.105,41	Rp 202.787.844,77	Rp (211.018.415,87)	Rp (624.824.676,51)	Rp (1.038.630.937,15)

In this scenario, a decrease in total revenue and increase total cost by 50%, the investment is not attractive anymore (the NPV is less than 0 which is negative Rp 1,038,630,937.15

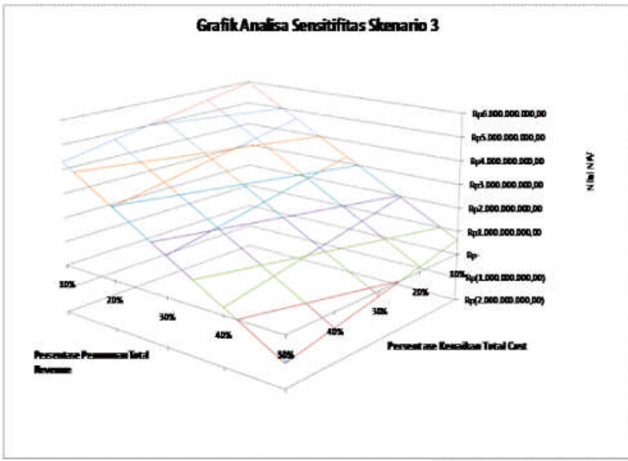

Figure 3 graphs Sensitivity Analysis

IV. CONCLUSION AND SUGGESTION

4.1 Conclusion

Calculations on the NPV and IRR turn out to be Rp7, 709,732,831.87 and 36%. The results show that NMR investment is profitable to do. Additionally, the payback period is quite short, i.e. within 4.11 years the project will reach its breakeven point. Furthermore, sensitivity analysis shows that the investment is still feasible to run if either one aspect of investments (total cost or total revenue) decreases. If both aspects decrease, the decision to invest on this NMR spectrometer is not attractive anymore.

4.2 Suggestion

It should be noted that all aspects on this calculation are considered deterministic. In fact, they are not. Costs, revenues, taxes, and interests are subject to change.

Future calculations should take this issue. Probabilistic approach is better to use to get more realistic results

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ISBN : 978-602-97809-0-1

Life Cycle Cost Analysis of Natural Gas Based Vehicles in Indonesia

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***Abstract* – Environmental impacts of using gasoline as vehicle fuel as well the depletion of crude oil reserve, turn researchers to find alternative vehicles that used non gasoline fuels. This paper analyzes the comparative value between gasoline based and natural based vehicles in term of economic value. Life cycle cost analysis has been conducted to assess four vehicles, gasoline, hybrid, natural gas, natural gas hybrid in Indonesia. By comparing their costs, it is possible to know the social benefit and the related tax structure. The result showed that the tax structure in Indonesia does not promote the alternative vehicles utilization. A change in taxation scheme is necessary to maximize the utility of existing technology extensively**.

***Keywords* – life cycle cost, vehicle, alternative fuel, tax**

I. Introduction

Nowadays, transportation systems are still dependent highly on fossil fuels. This condition leads to many problems such as air pollution that later becomes the source of diseases in urban society. Another issue related to using oil as transportation fuel is its scarcity. This issue may lead to price shock or supply disruption that might have negative economic impact.

In last few years, considerable efforts have been undertaken to replace or reduce the utilization of fossil fuels with alternative fuels. In 1986, Indonesian government had actually started adopting CNG technology by creating 20% tax policies of using natural gas fuel [1]. However, due to gasoline price was still relatively cheap and CNG pump stations were located in limited locations, hence the interest to use the natural gas did not get bigger. Now, there are other alternative fuels exist in Indonesia, such as: bio-solar, natural gas, electric and hybrid. These fuels are expected to be an alternatives that provide more benefit to society. The question is how to determine the advantages and disadvantages each alternative vehicle technology in an objective perspective?

In this paper, life cycle cost analysis is used to determine the relative benefit among the existing technologies. The costs will include the initial cost, operational cost, tax structure, and pollution cost. Comparing the cost, it is possible to analyze the social benefit and the related tax structure thus a better policy to maximize the social benefit extensively can be proposed.

II. Methodology

In the following section the methodology of life cycle cost analysis will be described. The calculation model is adapted and modified from [2]. The model compute the initial cost, operation cost (fuel cost), tax, and external cost (pollution damage) in term of societal and consumer life cycle cost.

The societal life cycle cost is the total cost including external cost without tax. Consumer life cycle cost is the sum of initial cost and operation cost with tax. The technology with the lowest societal life cycle cost is the most beneficial to the society from the standpoint of the policymakers. The lowest consumer life cycle cost will be the most preferable from the standpoint of the consumers. That is, the taxation scheme plays important role to determine the consumer preference. Figure 1 presents general methodology of life cycle cost analysis.

ISBN : 978-602-97809-0-1

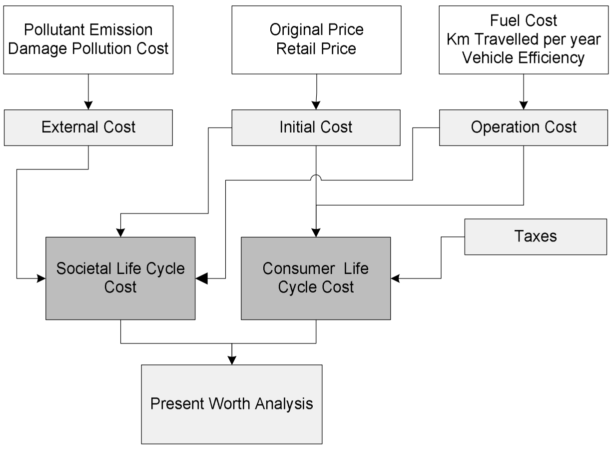

Fig 1. Life Cycle Cost Analysis Methodology

Life cycle cost is calculated using the present worth analysis (PWA) which is defined as the current value of all future costs based on the interest rate to accommodate the time value of money. The PWA is calculated using the following equation [3]:

$$PWA = A_0 \times \frac{(1+r)^n - 1}{r \times (1+r)^n}$$

Where PWA is the present worth value, A_0 is amount of recurring cost, r is the real discount rate, *and* n is the time period analysis (in years) based on vehicle lifetime. The real discount rate 1.38% was used to eliminate the inflation factor within analysis. To simplify the calculation, life cycle cost of each technology has been calculated relative to gasoline based vehicle.

III. Parameter and Assumption

A. Initial Cost

Four alternative vehicles will be compared and analyzed: Gasoline Vehicle (GV), Gasoline hybrid electric vehicle (GHEV), Natural gas vehicle (NGV), and Natural gas hybrid electric vehicle (NGHEV). Camry-like car was used to make the comparison equal. The initial cost of natural gas vehicle was modified from gasoline vehicle by installing conversion kit. Hybrid vehicle has to change the batteries in about 8 years, or half of the car lifetime. Table I summarizes parameters and their values used in this analysis. The initial cost including tax for every vehicle is showed in figure.2. Figure 2 indicates that all alternatives vehicles have initial cost more than gasoline based vehicle. Moreover among the three alternative, natural gas vehicle takes the smallest initial cost, while natural gas hybrid has the biggest initial cost.

TABLE I
Parameter Assumption

Parameter	Value	Unit
Vehicle Price Base	20000	USD
Vehicle Lifetime	15	years
Value of 1 Dollar	10000	IDR
Real Interest Rate	1.38%	per year

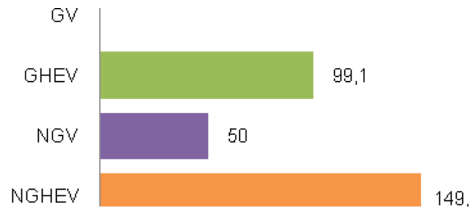

Fig. 2. Vehicle Initial Cost (in million IDR) - relative to gasoline

B. Operation Cost

The operation cost is estimated from fuel cost used by vehicle to travel in a certain distance. A set of possible distance is categorized to achieve better comprehension in policy making process (see table II). All non-fuel operation costs, such as: maintenance, insurance, parking, and charges, are assumed about the same.

TABLE II
Traveler Class

Traveler Class	Km traveled per year
Low Traveler	15000 – 30000
Medium Traveler	30000 – 60000
High Traveler	> 60000

C. External Cost

The External costs included in this study is just the damage pollution cost. Data from the Australian Greenhouse Office [4] was used for the estimation of air pollutant emission. Valuations of environmental damage cost are based on studies carried out by Litman, et al [5] and modified using benefit transfer method [6] for the case of Indonesia (see figure 3). Figure 3 shows that all the three alternative vehicles have negative damage pollution costs that mean these three technologies are environmentally friendly.

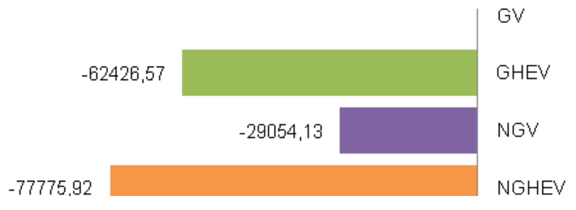

Fig. 3. Damage pollution cost per year (IDR) - relative to gasoline

IV. RESULTS

A. *Societal Life Cycle Cost*

Figure 4 clearly shows that hybrid and gas vehicles have a lower total cost relative to gasoline. This result shows that the alternative technologies have been able to provide an attractive option both in terms of economic and environmental impact to human beings to used (as also seen in figure 3).

Fig. 4. Societal Life Cycle Cost (in million IDR) - relative to gasoline

The result shown on figure 4 is a bit different with Goedecke [7]. Goedecke found that the societal life cycle cost of hybrid vehicle is higher than the gasoline vehicle positively. The reason is utilizing different value in mileage traveled per year. He used 20000 km traveled per year as basic parameter while this study use 30000 km. As will be shown in the next section, mileage traveled per year is a sensitive parameter that will give different result in each different value.

B. *Consumer Life Cycle Cost*

Figure 5 shows that from the consumer perspective, alternative vehicle such as hybrid and natural gas have not become an attractive option in Indonesia. Yet the comparison in societal life cycle cost showed that technological developments had been able to provide attractive options in terms of economic and environmental impacts. From the composition of consumer life cycle cost, the factor which affects this result is the prevailing tax structure.

Fig. 5. Consumer Life Cycle Cost (in million IDR) - relative to gasoline

V. DISCUSSION

At the current tax structure, it appears that the alternative vehicles have not become attractive options to consumers in Indonesia. By analyzing the sensitivity of mileage parameter, it is known that alternative vehicles can only benefit the long-distance traveler class (> 60 000 km per year).,except for the natural gas vehicle NGV. Its traveler distance is 30,000 km per year. Moreover, the sequence of the consumer preference also tends to vary (inconsistent) toward the mileage parameters (see figure 6).

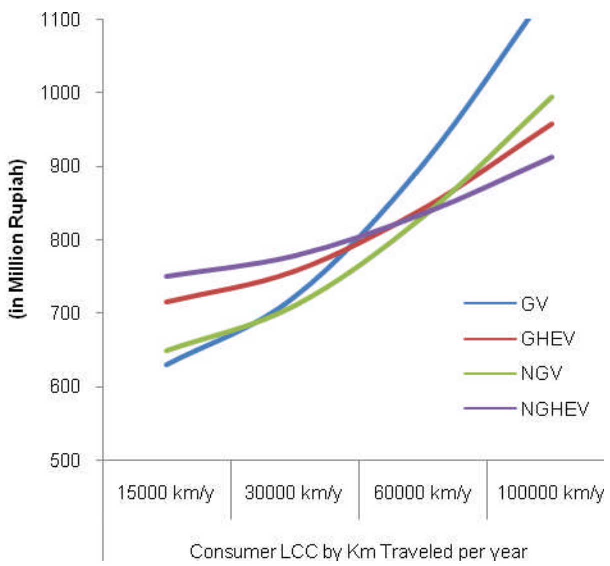

Fig. 6. The sensitivity analysis of consumer life cycle cost based on mileage parameter

If we assume that the consumer interest in comparative technology is at the excess of IDR 20,000,000 then we need to cut the taxes by 20% for hybrid vehicles and 10% for natural gas vehicles (see figure 7). This tax scheme tends to give a consistent result with consumer preferences in each class (see figure 8).

Fig. 7. Consumer Life Cycle Cost (in million IDR) under the new tax scheme - relative to gasoline

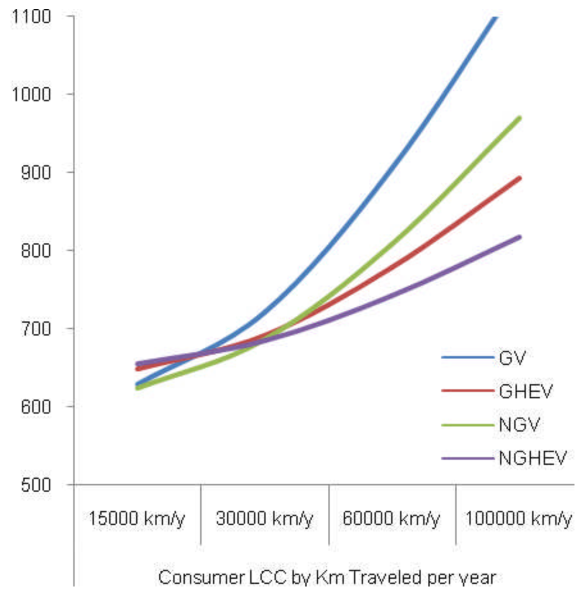

Fig. 8. Consumer Life Cycle Cost (in million IDR) under the new tax scheme - relative to gasoline

20% tax cut for hybrid vehicles and 10 % tax cut for gas vehicles proposals are similar to the tax structure established currently in Thailand [2,7]. It tends to give the same impact in the comparison of consumer life cycle cost. The tax cuts are expected to be an incentive for society to further invest in alternative vehicles.

VI. Conclusions

1. Hybrid technology and gas technology have lower damage pollution cost than the gasoline
2. From the societal life cycle cost perspective, the technology has been able to provide an attractive option for human beings to use widely, both in terms of economic and environmental impact.
3. The current tax structure makes the alternative vehicles have not yet become an attractive option for Indonesian consumers.
4. 20% tax cut for hybrid vehicle and 10% tax cut for gas vehicle are needed to make them an attractive option for Indonesian consumers
5. Selection of mileage per year value is a sensitive parameter in life cycle cost comparison. It will be better to use more than one value in its sensitivity analysis.

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ISBN : 978-602-97809-0-1

TESTING FOR LONG-RUN RELATIONSHIPS IN THE ASEAN5 GDP: 1990 - 2006

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Abstract **- The ASEAN nations have flagged the possibility of economic integration and so we examine the relationship that exists between the GDP of the five founding nations of ASEAN (the ASEAN5) from 1990 to 2006. Quarterly ASEAN5 GDP in both real and nominal USD are examined. Two sub-periods are employed in analysis to allow for the impact of the 1997 crisis. We find that ASEAN5 GDP is cointegrated and that there is evidence of a relatively stable long-term relationship between the ASEAN5 nations.**

Keywords **- ASEAN, Cointegration, VECM**

I. INTRODUCTION

This paper examines the relationship that exists between the GDP of the five founding nations of ASEAN i.e. Malaysia (Mal), Singapore (Sing), Thailand (Thai), Indonesia (Ina), and the Philippines (Phil). These five ASEAN countries are referred as the 'ASEAN5' in this study. The ASEAN leaders agreed to establish an ASEAN Community by 2020 during the ASEAN's Ninth Summit in Bali in October 2004 [1] and integration created by such community is hoped to promote more intra-ASEAN trade, to facilitate economies of scale, and to encourage domestic, intra-ASEAN and foreign investment in the region. In order to assess the feasibility of this goal, it is important to test for co-movement in GDP among the ASEAN5 countries. If there is no long term relationship evident in the GDP growth of these countries, then economic integration could be difficult.

The Southeast Asian region has witnessed strong economic growth for almost three decades with annual growth rates of 4.0% in Malaysia, 4.7% in Singapore, 4.8% in Thailand, 4.7% in Indonesia and 0.8% in the Philippines over the period from 1970 until before the 1997 crisis. Excluding the Philippines, these ASEAN5 countries have experienced higher GDP growth rates than most developed countries over the same period. For example the growth rate for the USA was 2.2%, Japan 3.0% and Australia 1.6%, over the same period. We note that the growth rates for the ASEAN5 decline considerably after 1997 (Asian crisis) though these growth rates are still high relative to those reported for the USA and Japan over the same period (http://www.unicef.org/infobycountry/index.html). Further,[2, 3] suggest that the ASEAN5 countries rely on internal factors for growth rather than external factors and this argument is supported in their study of the causal relationship between exports and economic growth of the ASEAN5. Regardless of the source of this growth, we are interested in identifying the level of co-movement that exists between the ASEAN5 country GDP.

This study is to some extent related to the concept of convergence which states that countries with relatively similar conditions tend to converge and that countries with very different conditions do not converge. But, this study is not concerned with measuring economic development or welfare using measures such as GDP per capita, which is commonly the focus of convergence tests [4-9]. Reference [10] test for the existence of convergence among the ASEAN5. They find no evidence of income convergence among ASEAN5 countries, as well as no evidence of catching up by the ASEAN5 to the USA, except for Singapore. Indeed, Singapore and the Philippines are found to diverge from the mean growth rate expected to apply for the group over the period of their study. Yet, the lack of convergence does not necessarily rule out the possibility that ASEAN5 GDP countries is moving together over time, particularly in the sense of the growth rates being cointegrated. While cointegrated variables may diverge after a shock they are eventually "drawn back" towards the long-term equilibrium relationship. Such behaviour could lead to rejection of convergence, where change takes place over a reasonably long period of time.

We test for cointegration in the GDP of the ASEAN5 countries. We focus on GDP rather than GDP per capita because it is an indicator of the aggregate economic growth of a country in a macro-economic sense [11]. There is little research dealing with this aspect of GDP growth across the ASEAN countries even though it is an important area of research [12-14]. Quarterly observations of both nominal and real GDP in USD are used in analysis and separate analysis is provided for both the pre and post 1997 Asian crisis periods, spanning the period from 1990 to 2006.

We find evidence of cointegration using the Johansen test, with at least one cointegrating vector evident in the data though there is evidence of more than one common stochastic trend in the data. The paper is organized as follows. Section II, describes and summarizes the data. Section III explains the methodology employed in this study. Section IV presents the empirical results and discussion of the analyses, and section V is conclusion of the study.

II. DATA

Quarterly gross domestic product (GDP) is collected for the ASEAN5 countries for the full period from the first quarter in 1990 to first quarter in 2006. The use of quarterly data facilitates analysis of the dynamic relationship that exists between ASEAN5 country GDP [15]. Datastream is the main source of data for this study though alternative sources are use when necessary.

Due to the 1997 crisis, we also divide the sample period into the pre-crisis and the post-crisis sub-periods. The pre-crisis period is from quarter one in 1990 to quarter two in 1997 and the post-crisis period is from quarter three in 1998 to quarter one in 2006. We use the natural logarithm of real GDP in the discussion that follows. Analysis of the full period is not reported and available upon request.

III. METHODOLOGY

This study use the Augmented Dickey Fuller (ADF) test, the Phillips-Perron test, and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test to test for the existence of a unit root in the series whilst the Johansen test [16-20] is used to test for cointegration in the ASEAN5 GDP. The Johansen tests are based on the model:

$$\Delta X_t = \theta_1 + \theta_2 T + \sum_{k=1}^{k} \theta_{3k} \Delta X_{t-k} + \theta_4 X_{t-1} + \varepsilon_t$$

where X_t is a (p x 1) vector of ASEAN5 natural log GDP values as at time t, Δ is the operator from time t-1 to t, θ_i is a parameter vector, and T is a time trend. The Johansen tests focus on the parameter matrix θ_4 and the number of linearly independent vectors in this matrix. This is generally written in the form:

$$\theta_4 = \alpha' \beta$$

The coefficient α is an (p x j) matrix of speed of adjustment terms and β is a (j x p) matrix of cointegrating vectors with j being the number of cointegrating vectors and p-j being the number of common stochastic trends. In this study p=5 given that there are five countries in this analysis. Further, based on the Schwarz information criterion (SC) one lag term (k = 1) is included in the estimated error correction models and cointegration tests. The VECM is estimated over the two sub-periods, the pre-crisis period and the post-crisis period.

Based on [21], a complete convergence of GDP is assumed when there are p-1 cointegrating vectors among p ASEAN5 GDP series, that implies a single shared common stochastic trend exist. Further, a finding of less than p-1 but at least one cointegrating vector implies some partial convergenceof the series, whereby zero cointegrating vector indicates the existence of several common trends but no shared common trends. This situation suggests no long run convergence of the series.

IV. RESULTS & DISCUSSION

There is some variation in the average growth rates within this study period with the mean GDP for the ASEAN5 decreasing after the crisis. This is consistent with the negative impact of the 1997 Asian crisis though it should be noted that the impact of the crisis differs based on the extent of vulnerability that have been accumulated over the years for each country. Thus some countries are affected more than the others.

Variation across the ASEAN5 countries (real and nominal GDP) is also evident from Figure 1 and Figure 2. There is considerable variation in nominal USD as shown in Figure 6-2. The most striking feature from both graphs is the impact of the 1997 crisis on the level of GDP in these economies. The severity of the crisis, that started as a debt crisis and became a full-fledged development crisis, is described by [22] as ‘a tragedy nonetheless, almost as cruel as war’.

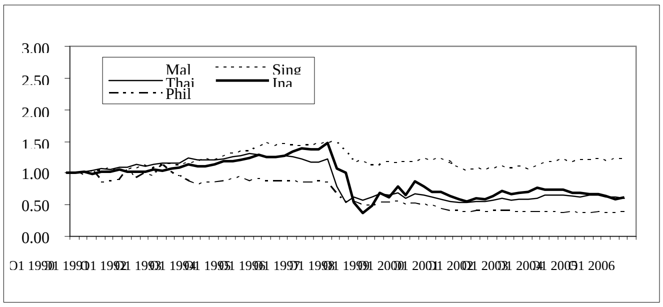

Fig. 1 Log ASEAN5 GDP in real USD

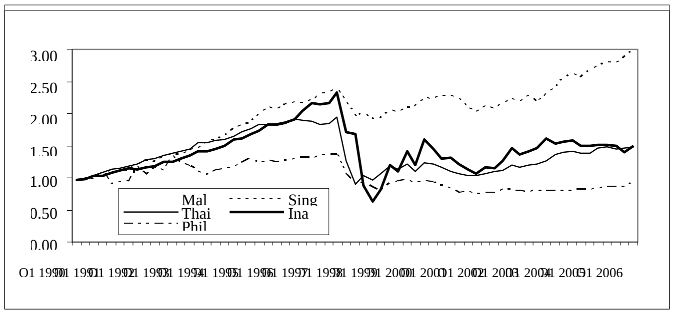

Fig. 2 Log ASEAN5 GDP in nominal USD

The biggest fall in GDP occurs for Indonesia, while the least affected country is Singapore. Singapore's stability may be due to its stable currency which only declined by about 20% after the crisis and was supported by its strong fundamentals, mirrored by US$21,500 GDP per capita in 1997. Between July and October 1997 the Thai baht fell by nearly 40%, the Malaysian ringgit by 40%, the Philippines peso by about 27% and the Indonesian rupiah by about 40% [23].

It is important to test stationarity of GDP time series before conducting Johansen cointegration tests. In this chapter three unit root tests are employed, the ADF test, the P-P test and the KPSS test. There is some variation, in the pre-crisis and post-crisis results. However, the order of integration for all series in the pre-crisis and post-crisis period is assumed to be one, supported by the full period results (the results are available upon request).

Table I (A, B, C, D) presents cointegration test results for models with the inclusion of seasonal and crash period adjustment. As mentioned in the methodology section, trace statistics are relied upon in testing for the number of cointegrating relationships in this study.

The results in Table I(A,B), the pre-crisis period, no cointegrating vector is identified for either real or nominal USD, implying that five common stochastic trends exist among the ASEAN5 GDP over this period. A substantial increase in GDP linkage among the ASEAN5 is found in the post-crisis period (Table I (C,D) with three cointegrating vectors (two common stochastic trends) existing for both real and nominal GDP.

TABLE I
COINTEGRATION TESTS

A. Pre-Crisis Periods in Real USD

H_0	H_A	Eigenvalues	λ_{max}	λ_{trace}
$r = 0$	$r > 0$	0.57	23.69	56.98
$r \leq 1$	$r > 1$	0.37	12.96	33.29
$r \leq 2$	$r > 2$	0.35	11.98	20.33
$r \leq 3$	$r > 3$	0.17	5.19	8.35
$r \leq 4$	$r = 4$	0.11	3.16	3.16

B. Pre-Crisis Periods in Real USD

H_0	H_A	Eigenvalues	λ_{max}	λ_{trace}
$r = 0$	$r > 0$	0.63	27.48	59.43
$r \leq 1$	$r > 1$	0.39	13.62	31.95
$r \leq 2$	$r > 2$	0.35	11.97	18.32
$r \leq 3$	$r > 3$	0.15	4.39	6.35
$r \leq 4$	$r = 4$	0.07	1.97	1.97

C. Post-Crisis Periods in Nominal USD

H_0	H_A	Eigenvalues	λ_{max}	λ_{trace}
$r = 0$	$r > 0$	1.00	171.97*	294.31*
$r \leq 1$	$r > 1$	0.94	79.88*	122.34*
$r \leq 2$	$r > 2$	0.61	27.67*	42.46*
$r \leq 3$	$r > 3$	0.29	10.09	14.79
$r \leq 4$	$r = 4$	0.15	4.70	4.70

D. Post-Crisis Periods in Nominal USD

H_0	H_A	Eigenvalues	λ_{max}	λ_{trace}
$r = 0$	$r > 0$	1.00	214.80*	331.10*
$r \leq 1$	$r > 1$	0.93	77.24*	116.30*
$r \leq 2$	$r > 2$	0.56	23.75*	39.05*
$r \leq 3$	$r > 3$	0.38	13.73	15.31
$r \leq 4$	$r = 4$	0.05	1.58	1.58

The findings suggest that the ASEAN5 economies have become more integrated in the period following the crisis, since there is no statistically significant linkage detected among the ASEAN5 growth rates before the crisis period. The results also suggest that the growth rates of GDP in the ASEAN5 countries display partial convergence in the full period, with this effect concentrated in the post-crisis period. The overall results imply that the GDP of the ASEAN5 countries is cointegrated at present. Yet, while the variables move towards equilibrium in the long run, they do not share a single stochastic trend.

The linkages among the GDP growth of ASEAN5 seem to have strengthened in the later period of the study, consistent with greater economic alignment since the crisis. This point is emphasised by [24], who supports the view that the crisis has acted as a catalyst that triggered major changes in the ASEAN economic integration process. Inasmuch, there appears to be no significant difference between the results reported for either real or nominal ASEAN5 GDP.

Cointegration test results reported in the previous section indicate that some important changes have occurred during the study period and, in particular, after the 1997 crisis. In order to examine individual country relationships more closely, separate VECM results are analysed. The results show that there is no statistically significant speed of adjustment effect in the pre-crisis period. In the post-crisis period, three cointegrating vectors exist in the system. These results suggest that an endogenous system exists between the ASEAN5 with links existing between each of the countries. The short-run causality interactions among ASEAN5 GDP growth are examined. The results indicate that in the pre-crisis period, more temporal causality relationships prevail and the relationships are evident in both real and nominal GDP.

It is noted that Singapore GDP is affected by GDP of others within the ASEAN5, although Singapore's GDP growth does not appear to lead other ASEAN5 GDP movements. Further, the Philippines' GDP growth appears to be independent of the other ASEAN5 members in temporal causality analysis. Bidirectional causality links are prominent in the post-crisis period. Here, the short-term linkages occur for almost all cases in real and nominal GDP. The economies of ASEAN5 do appear to have become more closely linked in the post-crisis era.

The existence of three cointegrating relationships in the post-crisis period is consistent with partial convergence of the series and this suggests that ASEAN has been effective in its endeavours to reduce the misalignment of growth in wealth among its members. Yet the GDP of ASEAN5 countries is still quite disparate. The finding of stronger GDP growth linkages in recent years among the ASEAN5 suggests that ASEAN is making progress towards realising the creation of its own economic community.

V. CONCLUSION

This study finds that the GDP growth of the ASEAN5 is cointegrated over the post-crisis period though there is no cointegrating relationship documented in the pre-crisis period. Similar results are obtained using both real and nominal GDP for each of the ASEAN5. This supports the argument that economic links among the ASEAN5 increased in the post-crisis period.

ACKNOWLEDGMENT

I wish to convey my gratitude to Professor Richard Heaney of School of Economics, Finance & Marketing, RMIT University, Melbourne, Australia, for his guidance in producing this research.

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ISBN : 978-602-97809-0-1

An Empirical Investigation on Bankers Acceptance of Information Technology

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Abstract: **This study examines the extent to which bankers adopt information technology, information technology usage, and the underlying factors that affect information technology acceptance from the perspective of Malaysian bankers. The results of the study suggested that TAM was able to provide a reasonable depiction of bankers' intention to use information technology. Perceived usefulness, management support and external computing support were found to be a significant determinant of IT usage and acceptance of Malaysian bankers**.

Keywords: **Information Technology (IT), Banking, Technology Acceptance Model (TAM), Technology acceptance, Malaysia.**

1. INTRODUCTION

The objective of this study is to examine the determinants that influence IT acceptance by Malaysian bankers. Specifically, we will examine the extent to which bankers adopt IT, IT usage, and the underlying factors that affect banker's acceptance of IT. To achieve this objective, we employed technology acceptance model (TAM) and modified it to reflect the Malaysian banking context. In general, TAM was one of a number of studies that have helped in providing theoretical frameworks for research in the adoption of information technology and information systems over the last two decade and has been used extensively as the basis of a range of empirical studies. Such a research will help IT vendors and external consultants a better understanding of IT usage pattern of Malaysian bankers and contribute to the field of knowledge on IT awareness and usage among Malaysian bankers.

The rest of paper has been organized as follows: the next section of this paper review related literatures, followed by a discussion on the methodology employed as beliefs and intentions [18]. Davis introduced TAM as an adaptation of TRA, specifically designed to explain computer usage behavior in organizations. The TAM model suggested that perceived usefulness (PU) and perceived ease of use (PEoU) of IT drive users' attitudes and intentions to adopt that technology (figure 1). PU refers to the benefit a technology can bring and produce better outcomes [3]. 'Useful' refers to 'capable of being used advantageously'. In contrast, PEoU is referring to the perception about the degree of effort needed to use a particular system [3]. In this case, 'ease' is conceptualized as 'freedom from difficulty or great effort.' In general, if a system is easy to use, it requires less effort on the part of users, thereby increasing the likelihood of adoption and usage. Conversely, if systems that are complex or difficult to use are less likely to be adopted, since it requires significant effort and interest on the part of the [23]. 'Attitude' towards the behavior refers to an individual's feelings or emotions about using the technology, whereas "intention to use" was understood in terms of the likelihood that an individual would use the technology in the future [15].

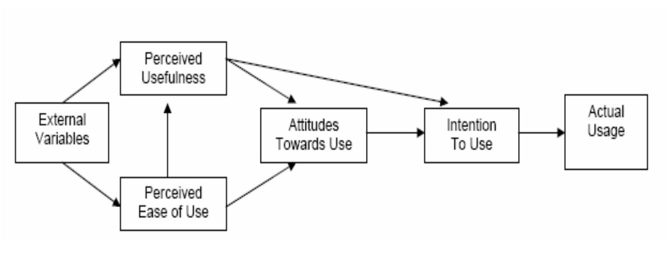

Figure 1: Technology Acceptance Model (TAM)

Social Pressure

Social Pressure is defined as the degree to which an individual perceives that important others believe he or she should use the new system for obtaining a higher social status or a more important position in their

ISBN : 978-602-97809-0-1

organization. The study of microcomputer usage by [9] found that social norms have significant effects on system usage. Reference [20] and [21] also indicates the importance of social norms on the rate of the diffusion of innovations.

Perceived Enjoyment and Fun

Perceived enjoyment and fun means that individuals that themselves experience immediate pleasure and fun from using the machine and perceived any activity involving using the computer to be enjoyable in its own right [5]. A number of studies on perceived enjoyment [5], [12], [24] have noticed that perceived enjoyment significantly affects intentions to use computers. Study by [12] on the effect of perceived enjoyment and usefulness on usage in a field study of Finnish computer users found strong relationships between perceived usefulness and usage, but weak, insignificant links between enjoyment and usage. In contrast, [24] noted that perceived enjoyment correlates positively with frequency of Internet usage and daily Internet usage.

Perceived Complexity

Perceived Complexity is defined as the degree to which an innovation is perceived as relatively difficult to understand and use [20]. Study by [1] investigates the associations of five perceived attributes of computer technology namely relative advantage, compatibility, complexity, trialability and observability to its adoption and use. The findings found that each attributes was hypothesized to positively correlate significantly with computer adoption and use, except complexity. Complexity as a negative attribute was hypothesized to negatively correlate with computer adoption and use. The study done by [2] found that the more complex the technology, the less relevant experience and subsequently a weaker link exists between perceived usefulness and behavioral intention to use.

Internal Personal Computing Support

Internal Personal Computing Support is referred to the technical support provided by individuals or groups with computer knowledge internal to the company [26]. Study by [14] on the factors affecting personal computer acceptance in small firms and founds that the intra-organizational (internal computing support and training, and management support) and extra-organizational (external computing support and training) variables were hypothesized to influence adoption.

Management Support:

Management Support is referred to the perceived level of general support offered by top management [26]. Reference [10] found that there is a relationship between management support and perceived usefulness. According to [14] management support is able to ensure sufficient allocation of resources and act as a change agent to create a more conductive environment for IT success. Lack of organizational support is noted to adversely affect effective utilization of computers [4], [6].

External Personal Computing Support

External Personal Computing Support is referred to the technical support provided by friends, vendors, consultants or educational institution external to the company. Study by [7] found that the experience and capabilities of the consultants plays an important role in information system success.

III. RESEARCH MODEL

According [26], although the TAM serves as a prevalent explanation of attitude, intentions, and actual use of new systems, it may be too parsimonious, which implies it should be supplemented and extended with other constructs. Therefore, this study integrates the primary constructs of TAM (perceived usefulness and perceived ease of use) with other constructs to predict the bankers' attitude toward information technology such as social pressure, perceived enjoyment and funds, perceived complexity, internal personal computing support, management support and external computing support to the TAM. The research model examined in this study is illustrated in figure 2.

Perception Drivers

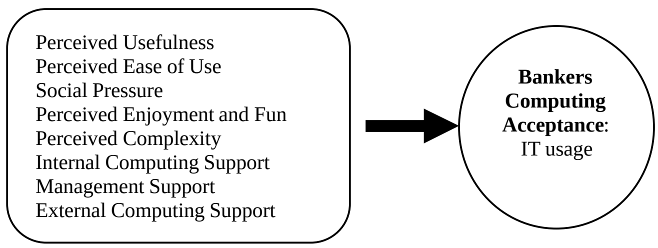

Figure 2: Factors Affecting Personal IT Usage

From the previous study we proposed the following hypothesis to reflect the research model:

H1: Perceived usefulness has a direct effect on personal technology acceptance.

H2: Perceived ease of use has a direct effect on personal computing acceptance

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H3: Social pressure has a direct effect on personal computing acceptance.

H4: Perceived enjoyment and fun has a direct effect on personal computing acceptance

H5: Perceived complexity has a direct effect on personal computing acceptance.

H6: Internal computing support has a direct effect on personal computing acceptance

H7: Management support has a direct effect on personal computing acceptance.

H8: External computing support has a direct effect on personal computing acceptance.

IV. METHODOLOGY

A survey method has been conducted in this study. A total number of 200 survey questionnaires was developed and distributed to bankers' deployment located in Klang Valley area. The questionnaire consisted of two sections. Section one was designed to identify the demographic characteristic of the respondents whilst section two contains a series of questions about the perceived usefulness, perceived ease of use, usage, social pressure, perceived enjoyment and fun, perceived complexity, management support, internal computing support and external computing support. Perceptions towards IT were measured using Likert scales statements, to which respondents were required to state their level of agreement or disagreement. A five interval Likert scale was used where scale indicates: 1 as strongly disagrees; 2 as disagree; 3 as neither disagrees; 4 as agree; and 5 as strongly agree. Of the two hundred survey questionnaires that were distributed, seventy four responses were received (a response rate of 37%). After eliminating those which could not be used, this resulted in 69 forms being available for analysis (a net response rate of 35%). The final data inputs were loaded into a statistical package (SPSS 17.0) for doing various statistical analyses.

In the study, IT usage was measured in terms of current usage or actual usage behavior of bankers. The questionnaire listed ten different types of software applications such as spreadsheets, word processing, database, statistical analysis, internet, electronic mail, programming languages, graphics, application packages and power point [10]. Individuals were asked to indicate the amount of time spent on computer per day using a six point scale ranging from (1) "almost never) to (6) "more than 3 hours per day". Frequency of use, which has been used by [10], provided a better indicator of the extensiveness of usage than measure of time spent. Frequency of use was measured on a six point scale ranging from (1) "less than once a month" to (6) "several times a day"

V. DATA ANALYSIS AND FINDINGS

Descriptive Statistics and Demographics Profile

The detailed sample is depicted in Table 1. Basically, the respondents of the research consisted of 33 (47.8%) male and 36 (52.2%) female. In terms of age, 15 % of the respondents were 25 years and less. Another 76.8% were between the ages of 26 to 45 years old. Only 7.2% of the respondents exceed the age 45. With respect to the level of education, respondents were primarily people with tertiary education. The professions that were most common among respondents were clerical and officer, together making up 73.9 percent of the surveyed sample. A total of 40.6 percent of the survey respondents reported income within the range of more than RM 36,000.

Table 2 lists the job tasks that the respondents most often used a computer for and the most frequently used software. The highest use job task was producing report, followed by letters and memo and data storage. The computer software used order was word processing, spreadsheets and electronic mail. The result indicates that the majority of end users managed routine jobs such as paper work and data maintenance. The system heavily used is word processing (81.2%) and spreadsheet (68.1) and programming language is the least system used (5.8%). This implies that bankers in Malaysia do not use the computer for advance functions such as business analysis, planning, decision making and so on. They also rarely used professional software for specific purposes such as statistical analysis or programming languages.

Table 1: Demographic Characteristics of the Survey Participants

Demography	Frequency	Percentage (%)
Gender:		
Male	33	47.8
Female	36	52.2
Age:		
18-25	11	16.0
26-35	28	40.6
36-45	25	36.2
46-55	5	7.2
Marital Status:		
Single	17	24.6
Married	50	72.5
Divorced	2	2.9
Education:		
Masters	2	2.9
Degree/Professional	16	23.2
Degree	13	18.8
Diploma	16	23.2

ISBN : 978-602-97809-0-1

Certificate Others	22	31.9
Profession:		
Clerical	27	39.1
Officer	24	34.8
Professional Staff	4	5.8
Middle/Top Management	14	20.3
Annual Income:		
Less than 12,000	8	11.6
12,000 – 24,000	20	29
24,001-36,000	13	18.8
More than 36,000	28	40.6

Table 2: Information Technology Usage

	% of Respondents
Variety of Systems Used	
Spreadsheets (e.g., Excel, Lotus 1-2-3)	68.1
Word Processing (e.g., Word)	81.2
Database (e.g., dBase)	14.5
Statistical analysis	11.6
Internet	66.7
Electronic Mail	66.7
Programming Languages (e.g., COBOL, Visual basics)	5.8
Graphics	7.2
Application packages (Accounting or payroll packages)	17.4
Power Point	37.7
Specific Job Tasks where system is applied	
Producing report	84.1
Letters and memos	73.9
Data storage/retrieval	68.1
Making decisions	27.5
Analyzing trends	23.2
Planning/forecasting	27.5
Analyzing problems/alternatives	17.4
Budgeting	29
Controlling and guiding activities	44.9
Electronic communications	65.2
Frequency of Use	
Less than once a month	1.4
Once a month	1.4
A few times a month	1.4
A few times a week	4.3
About once a day	2.9
Several times a day	88.4
Amount of Time per Day	
Almost never	4.3
Less than ½ hour	2.9
From ½ hour to 1 hour	1.4
1-2 hours	4.3
2-3 hours	5.8
More than 3 hours	81.2

Reliability analysis

In this study the Cronbach's Alpha reliability index was calculated to measure the internal consistency of scales. Since alpha can be interpreted as a correlation co-efficient, it ranges in value from 0 to 1. The result of reliability analysis shows that the value for alpha is 0.83. It was greater than the benchmark of 0.60 recommended by [6] and [17]. This illustrate that all measure had high internal consistency and adequate reliability.

Hypothesis Testing

Multiple regression analysis was performed to test the relationships between the construct variables and IT acceptance. The linear regression analysis of the original model reveals that the R-square of the model is 0.396. This means the model explains 39.6% of the variance in the dependent variable, actual use of the system. The model is statistically significant as the p-value for the model is 0.00.

Table 4: Regression results

Usage	R	R2	Standard Error	Standard Coefficient Beta	Significance
	0.629	0.396			
(Constant)			0.748		.000
Perceived Usefulness			0.030	.561	.000
Perceived Ease of Use			0.053	-.086	.566
Social Pressure			0.069	-.037	.797
Perceived Enjoyment and Fun			0.041	.090	.446
Perceived Complexity			0.037	-.038	.719
Management Support			0.036	.378	.037
Internal Computing Support			0.048	-.133	.426
External Computing Support			0.041	-.321	.045

H_1: Perceived Usefulness

The regression coefficient (beta) for perceived usefulness is 0.561 (p= 0.000, p<=0.05). The regression result indicated that the null hypothesis can be rejected. Therefore, the alternative hypothesis stands. This study finds that there are relationships between perceived usefulness and usage. This result is similar to [4], [11] and [16] that perceived usefulness is positively related to usage.

H_2: Perceived Ease of Use

The regression coefficient is -0.086, and the significance level is 0.566 (P>0.05). Therefore null hypothesis cannot be rejected. Ease of Use is not related to personal computing acceptance. The result was inconsistent with [4], [14] and [23] that perceived ease of use is a dominant factor in explaining perceived usefulness and system usage.

H_3: Social Pressure.
The regression coefficient is -0.37, and the significance level is 0.797. This is greater than 0.05 significance level. Therefore, the null hypothesis cannot be rejected. Social pressure is not related to personal computing usage.

H_4: Perceived Enjoyment and Fun
The regression coefficient is 0.90, and the significance level is 0.446. This is greater than 0.05 significance level. Therefore, the null hypothesis cannot be rejected. Perceived enjoyment and fun is not statistically significantly affecting the use. This result is similar to the result as in [12] and [8] that enjoyment is not related to the use of information system and has no statistically significant effect on the acceptance of data processing system.

H_5: Perceived Complexity
The regression coefficient is -0.38, and the significance level is 0.719. This is greater than 0.05 significance level. Therefore, the null hypothesis cannot be rejected. Perceived complexity is not related to personal computing usage. These results suggest that perceived complexity is not a factor that would affect personal computing acceptance. This result is similar to result as in [1] that perceived complexity is negatively related to computer adoption and system usage.

H_6: Management Support
The regression coefficient (beta) for the first hypothesis perceived usefulness is 0.378 and the significance level is 0.037 ($p<=0.05$). The regression result indicated that the null hypothesis can be rejected. Therefore, the alternative hypothesis stands. Management support is positively influences use of IT.

H_7: Internal Computing Support
The regression coefficient is -0.133, and the significance level is 0.426, which is greater than 0.05 significance level. Therefore, the null hypothesis cannot be rejected. Internal computing support is not related to personal computing usage

H_8: External Computing Support
The regression coefficient (beta) for the first hypothesis perceived usefulness is -0.321 and the significance level is 0.045 ($p<=0.05$). The regression result indicated that the null hypothesis can be rejected. Therefore, the alternative hypothesis stands.

VI. CONCLUSIONS

The objective of this study is to examine the extent of IT usage, usage pattern and usage determinants in Malaysian banking industry by using TAM. The result of this study appeared to suggest that perceived usefulness, management support and external computing support are criteria that determine the extent of IT usage and acceptance of Malaysian bankers. This result refers to the fact that bankers are likely to use computer because they believes that using the system will enhance their job performance, increase their performance and productivity. Thus, the greater the perceived usefulness, the more likely that personal computer will be adopted by the Malaysian bankers.

The study also found that there is a relationship between management and external computing support on IT usage. Management Support is referred to the perceived level of general support offered by top management whereas external personal computing support is referred to the technical support provided by friends, vendors, consultants or educational institution external to the company. Management support is able to ensure sufficient allocation of resources and act as a change agent to create a more conductive environment for IT success.

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ISBN : 978-602-97809-0-1

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The International Conference on Industrial Engineering and Business Management 2010

CHAPTER 6 : Ergonomy (ERG)

editor :
Arya Wirabhuana, Muchammad Abrori, Kifayah Amar

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

Redesign Of Work Facilities Using Rapid Upper Limb Assessment (Rula) and Anthropometry Method
(Case Study CV. Laksana Home Metal Industry)

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Abstract - **The study was conducted at Laksana Home Metal Industry in Bandung. The research was specifically done in the assembly station. Interview results indicate physical complaints of workers due to the provided work facilities was not ergonomic and therefore workers prefer to use a low chair or sit on the floor during the job. In order to identify the physical complaints experienced by the workers, the Nordic questionnaire was used. In addition, to analyze the level of danger of the position and posture of the workers The RULA method was used. The result shows the need to improve posture/position while working. This can be done by upgrading work facilities by redesigning furniture according to the anthropometric data of workers.**

Keywords - **Nordic Questionnaire, RULA, anthropometry**

I. Introduction

Human work performance is the main factor which determines the effort to increase industrial productivity [1]. One factor that can improve work performance is the availability of ergonomic facilities. In an effort to improve the service work performance, the research was carried out on employees in the assembly station of Laksana Home Metal Industry. The station assemble DP LK (Distribution Point Laksan) boxes, which was specifically chosen because it was the company's main product.

The current work facilities available are still modest desks and chairs. Preliminary observations showed workers feel uncomfortable and often experience pain in the neck, back and spine. In result, workers often perform the work without using the desk and chairs provided by the company. Workers prefer to use a low chair or sit on the floor. Example of one working position with the short seat facility can be seen in Fig. 1.

Working in a crouched position in a long time frequently may lead to complaints or musculoskeletal disorder. Work facilities that are not ergonomic can cause rapid fatigue of workers, causing a lot of mistakes or suffer disability. To avoid unfavorable posture and position, ergonomic measures need to be considered. One of the ways is to reduce the necessity of operator to work in a bent position in activities that are often long term. To overcome this problem, the workstation should be designed primarily with attention to its facilities such as desk, chairs, etc in accordance with the anthropometric data [1].

Fig. 1 Example of the position/posture of the worker

The purpose of this study are:

1. Analysis and measurement of the level of risk the position / posture of the current working method by using RULA (Rapid Upper Limb Assessment).
2. Redesign work facilities in accordance with the anthropometry data in order to minimize complaints of work facilities that are not ergonomic

II. Books Review

A. *Rapid Upper Limb Assessment (RULA)*

Rapid Upper Limb Assessment (RULA) provides a calculated rating of musculoskeletal loads in task where people have a risk of neck and upper limb loading. The tools

ISBN : 978-602-97809-0-1

provides a single score as a snapshot of the task, which is a rating of the posture, force and movement required. The risk is calculated into a score of 1(low) to 7 (high). The score is grouped into four action levels that provide in indicated of the time frame in which it is reasonable to expect risk control to be initiated [2]. The procedure of using RULA is explained in three steps:

1. The posture or postures for assessment are selected
2. The posture is scored using the scoring sheet, body part diagram and tables
3. These Scores are converted to one of the four action level.

B. Anthropometry

Anthropometry is a collection of numerical data related to the human body characteristics, size, shape, and strength in which the application of such data is to handle design problems [3].

Humans in general vary in shape and dimension in terms of body size. There are several factors that will influence the size of the human body, so the design must consider such factors such as age, gender (sex), ethnic and body position/ posture. [1].

III. RESEARCH METHODOLOGY

Problem solving steps in this research begins by conducting field observations, interviews and the use of Nordic questionnaire to identify the complaints experienced by workers. The level of danger of the working posture is measured by the RULA method. The data process uses the Ergofellow software

Calculation results will become the benchmark in the improvement plans for upgrading work positions by redesigning facilities for the station assembly work. Facility improvements are done by identifying the needs of the working facilities in the form of desk, chairs and Box cart in accordance with the body dimensions of workers. The design of the facility is done by identifying the body dimensions (anthropometry) that is required and considered the required percentile values on each dimension. Anthropometric data processing uses ergostat software.

IV. WORK POSTURE ASSESSMENT WITH RULA METHOD

Work facilities that are available in the current assembly station consist of: chair with backrest (1 unit), chair without a backrest (2 units), low chair (2 units) and desks (2 units) as shown in Fig.2.

Used Nordic questionnaire consist of four parts: respondent respondent data, employment data, data of body parts that often have complaints and data as a result of physical complaints. The questionnaire results showed that all workers at the assembly facility have complaints.

Based on the study of the labor movement in the assembly station, there were 21 series of activities undertaken, namely the following. :

1. Taking boxes
2. Taking rubber snails
3. Installing rubber
4. Taking glues
5. Using glues
6. Taking rubber packings
7. Installing rubber packings
8. Taking drills
9. Taking bolts
10. Setting up key holder
11. Installing the cable and earth clamp bracket
12. Installing the cradle terminal
13. Taking bracket buffer
14. Taking bolts
15. Installing bolts
16. Taking drill
17. Installing bracket buffers
18. Taking covers
19. Installing body box And cover
20. Closing the body box and cover
21. Setting boxes slugs

Fig. 2 Facilities provided by the Company

Analysis for each activity is divided into two groups. Group A analyze the upper arm position, lower arm, wrist, and rotation of the wrist. While group B analyzes the position of the neck, back and leg. The analysis was done by determining the angle from the position of workers which were obtained from documentation of the worker movement [Fig. 3]. The next step is to determine a score for each position with reference to the RULA table[4]. In this study the use of Ergofellow software helps calculate the score of each work activity. Calculations example for the activity of taking boxes are as follows:

Fig. 3 Body Posture on the activity of taking Box

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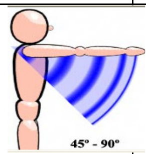
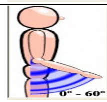
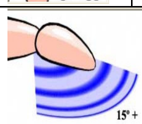
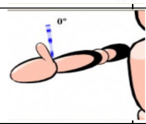
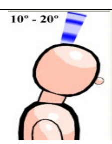
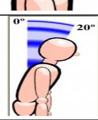
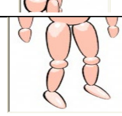
TABLE I
GROUP A: POSITION RIGHT ARM AND RIGHT WRIST

Position and angle of movement	**Figure**	**additional**	**score**
Upper Arm (60^0)		-	3
Lower Arm (10^0)		Working across	2
Wrist($>15^0$)		-	3
Wrist Twist Mainly in handshake			1
Score results based on table			4
Muscle use	Movement <1 minute		-
Force/load	< 2 Kg		0
Scores / total value			4

Furthermore, the measurement for the position of the neck back and legs can be seen in Table II.

TABLE II
GROUP B: POSITION NECK, BACK AND LEGS

Position and angle of movement	**Figure**	**additional**	**score**
neck(20^0)		twist	3
trunk(15^0)		Side bend	3
legs and feet (balance posture)		Leg and feet are well supported in an evenly balanced posture	1
Score results based on table			4
muscle use	Movement <1 minute		-
force/load	<2 Kg		0
Scores / total value			4

The final result with RULA method for the activity of taking Boxes:
• Total value of right arm and right wrist position = 4
• Total value of the neck, back and legs position = 4
• Grand score use table = 4
Results: The need to investigate and change immediately

Analysis for the 21 activities mentioned above were made for both right and left side of the body, therefore obtained 42 as the final score. Calculations recapitulation is presented in Table III.

TABLE III
THE FINAL SCORE RULA AND ACTIONS RECAPITULATION

Score	**sum**		**Action level**	**Action**
1	-	-	1	Posture is acceptable if it is not maintaned or repeated for long periods
2	-			
3	3	12	2	Further investigation is needed and changes may be required
4	9			
5	4	20	3	Investigation and changes are required soon
6	16			
7	10	10	4	Investigation and changes are required immediately
Total	42	42		

From the Table, it can be seen that the actions needed to be performed varies from level 2 until level 4. The most action that is required is the 3rd level which indicates that investigation and change of body posture is needed immidieatly.

V. FACILITIES DESIGN AND ANALYSIS

A. Facilities Design

Before the design of the facility can be done, it requires identification of the requirements by interviews and brainstorming with operators of the assembly station and also company owners. Based on the brainstorming it was identified that that the operators needs are namely:

1. Desk and boxes for components
   Box component, which is required for storing parts and equipment that are relatively small. The size of the box is adjusted to the size, number of the components, and tools that will be use to work. Box components are wanted to be placed on the desk so it's easily seen to take necessary components.
2. Work Chair
   Comfortable chair is needed so reduces back soreness. Also, chairs equipped with wheels are needed for easy moving if necessary when taking the tools beyond the reach of the hand.
3. Box cart
   two units of box carts are needed. One Box cart is needed for body parts component and cover, while the second is to place the products.

ISBN : 978-602-97809-0-1

Data processing of the body's dimension is conducted by the uniformity of data test, data adequacy test, the calculation for the specified percentile value, and increased value of clearances. In order to help data processing the Ergostat software is used. After the calculation, then the product specifications can be obtained, which can be seen in table IV.

TABLE IV
PRODUCT SPECIFICATION RECAPITULATION

No	Work Facilities	Measurement	Body Dimensions and Used Percentile	Product Specification (cm)
1.	Desk	High	PH $_{(P95)}$ + SEH $_{(P95)}$	81
		Long	2(ULL $_{(P50)}$ + SB $_{(P95)}$	195
		Width	ULL $_{(P95)}$	82
		Arch Length	SB $_{(P95)}$	49
		High footrests	¼ X PH $_{(P95)}$	15
2.	Work chair	Seat height	Ph $_{(P50)}$	48
		Width	HB $_{(P95)}$	44
		Seat length/depth	Pl $_{(P50)}$	45
		High Lean	Ssh $_{(P5)}$	59
		Long Lean	SB $_{(P50)}$	44
3.	Box cart	Long	2x Width Product Components	45
		Width	4 X Long Product Components	65
		High Leg box cart	PH$_{(P95)}$	53
		box cart high	6 X High Product Components	65

Description:

SB = Shoulder Breadth (*Bideltoid*)
PH = Popliteal Height
SSH = Sitting Shoulder Height
HB = Hip Breadth
PL = Buttock-Popliteal Leight
SEH = Siting Elbow Height
ULL = Upper Limb Leght

Design of work facilities and anthropometric dimensions are shown in Figure 4 to 7.

B. Analysis

Product specifications need to be accommodated between the working facility dimensions and the anthropometric dimensions so it will reduce the disturbance for the workers, such as unwanted interference ache, pain and even injury. The proposed design of work facilities consist of: desk, office chair and box cart.

- Desk and box components

The proposed materials are *nyatoh* wood because of its endurance and resistance to termite attack. The desk is designed semicircular to facilitate the need to reach needed components or tools. Box components are made crooked or the front shorter than the rear. This is aimed to make components and equipments easily seen and removed if necessary.

- Work chair

The proposed materials are *nyatoh* wood. The back seat is given cushion in order to give support to the back and alleviate stress on back muscles while seated. On the chair leg, wheels are given to facilitate the movement of workers.

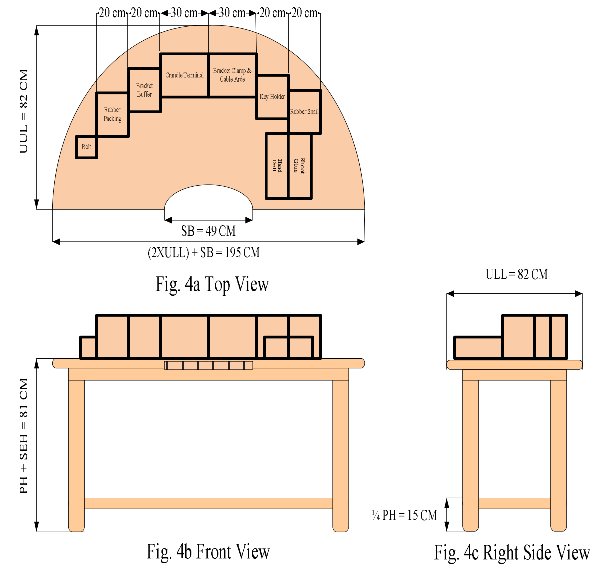


Fig. 4 Design desk

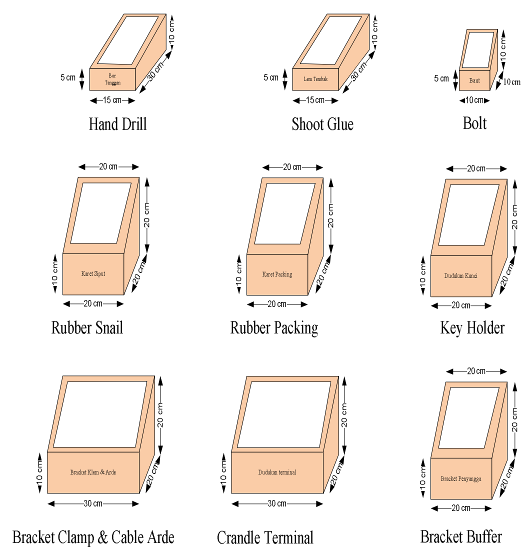


Fig. 5 Design Box for Components and Tools

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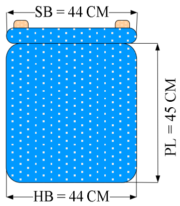

Fig. 6a Top View

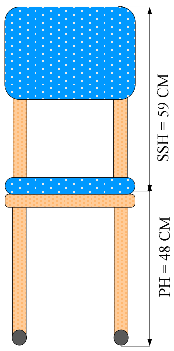

Fig. 6b Font View

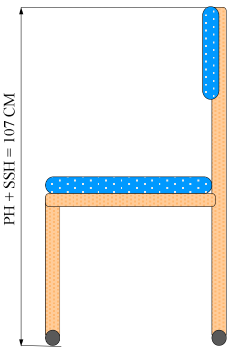

Fig. 6c Right Side View

Fig. 6 Design work Chair

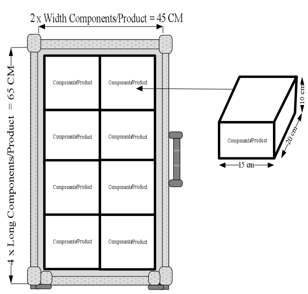

Fig 7a Top View

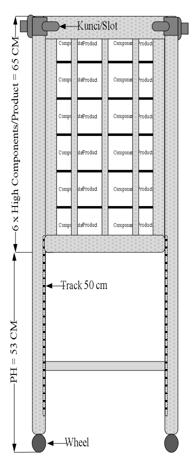

Fig 7b Front View

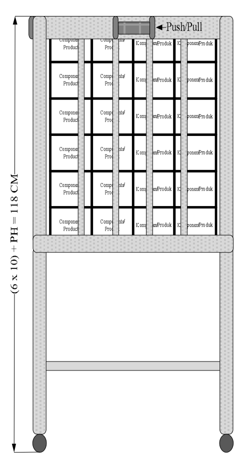

Fig 7c Right Side View

Fig 7 Design Box Cart

- Box cart

The proposed materials is aluminum due to its strong material, durable, lightweight and can be protected from rust. The boxes railway legs are added wheels to facilitate workers to take and place the component / product. Boxes door are added with rail in order to open and close by raising and lowering the door and then slot / lock for security. On the left side and right of the baskets are placed handles to pull and push the box.

Benefit analysis:The redesign is done in regards with the capabilities and limitations of the workers in doing the job. This is demonstrated by paying attention to body dimensions used in determining the specifications of the working facilities. With the availability of ergonomically desk and chairs the positions / postures of workers is then in the upright position (not bent), and labor angle position is not expected to be harmful if working in long term. In this redesign, work tools and material are placed in the front and near from the workers. This is consistent with principles of Motion economy.

Redesigning of the facility is expected to minimize complaints due to the use of work facilities that help employees work more comfortably, efficiently, effectively, and improve productivity.

VI. CONCLUSIONS

Results of interviews and Nordic questionnaires showed complaints on the neck, right shoulder, upper back and lower back. To reduce complaints experienced by the workers, there is an immediate need to improve work attitude and posture. This is indicated by the calculation recommendation using RULA method with three levels of action that requires soon investigation.

The improvement of the facilities are carried out by redesigning the desk, work chair and box carts according with the worker's body dimensions identified by the anthropometric approach. This is hoped that the design makes workers feel secure, comfordesk and healthy in doing their jobs

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

Ergonomic Macro Analysis of Hand-Phone Usage by College Students in Bandung, Indonesia

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Abstract **– The growth of technology help to make human life easier. In communication, there is e-mail, voice mail, or hand-phone enable people to communicate everytime and everywhere, as if the world became borderless. There is an interesting phenomenon in Japan called *oya yubi sedai* (thumb generation or thumb tribe). It is influenced by the people who grow with hand-held device to communicate, such as: hand-phone, which make the thumb getting more nimble and stronger than other fingers.**

It is interesting to investigate whether the phenomenon in Japan occurs in Indonesia too or not. By observing the range of age between 20 to 25 years old where the phenomenon of *oya yubi sedai* occurred, college students are chosen to represent it.

Macro ergonomics approach chosen since the characteristic of social-engineering system, i.e. personal, technology, environment, and organization or management sub-system are included. Analysis will be based on social-engineering system, which include the four sub-systems and the interactions among sub-systems.

***Keywords: oya yubi sedai*, hand-phone, ergonomics, social-engineering system, macro ergonomics.**

I. INTRODUCTION

The growth of technology help to make human life easier. In communication, there is e-mail, voice mail, or hand-phone enable people to communicate everytime and everywhere, as if the world became borderless.

However, there is consequences occured because of the growth of technology. According to Sutalaksana [1], individualism is a common thing in developing society as the result of High Technology Products (HTP).

There is an interesting phenomenon in Japan. Twenty-five years old or younger people called themselves as *oya yubi sedai* (thumb generation or thumb tribe). According to Plant [2], in nowadays generation the thumb has become more nimble and stronger than other fingers. It is influenced by the people who grow with hand-held device to communicate, such as: hand-phone.

The usage of hand-phone in Indonesia is getting more and more in the society. It is interesting to investigate whether the phenomenon in Japan occurs in Indonesia too or not. By observing the range of age between 20 to 25 years old where the phenomenon of *oya yubi sedai* occurred, college students are chosen to represent it.

Macro ergonomics approach chosen since the characteristic of social-engineering system, i.e. personal, technology, environment, and organization or management sub-system are included [3]. Besides, there are interactions among the sub-systems. The usages of new technology as condition of usage of macro ergonomics are present here. Macro ergonomics approach uses social-engineering system without removing the originality of ergonomics itself, which is human-centered [4]. Analysis will be based on social-engineering system, which include the four sub-systems and the interactions among sub-systems.

This research want to answer the questions whether there is influence of usage of hand-phone by college students in Bandung, Indonesia, either in positive and negative way and if the influence are present, it will be investigate what kind of influence there are. Furthermore, it will use the macro ergonomics to analyze the usage of hand-phone by college students in Bandung, Indonesia.

II. RESEARCH METHODOLOGY

The phases of research methodology are as follows:

1) Identify Problem and Purpose of Research: the researcher would like to know the hand-phone usage influences. Using macro ergonomics, the purpose of the research proposed according the influence occured in society.

2) Preliminary Study: the purposes of preliminary study is to have principal theories and application related to the problem, included: macro ergonomics and the usage of hand-phone. The references are several books, journals, and articles in internet.

3) *Determine object and sample of research:* object of the research is college students. Sample taken from college students in various high education institution in Bandung, Indonesia.

4) *Build Hypothesis of Research:* the hypothesis of research is: the usage and the present of hand-phone give positive and negative influences to the college students in Bandung, Indonesia.

5) Construct of Questionnairre I: its purpose is to get the variable and sub-variable of research that will be used later to direct the research.

6) Identify of Variables and Sub-variables of Research: according to the hypothesis and the result of questionnairre I, there are two variables of research: positive and negative influences. Variable of positive influence is divided into three sub-variables: simplicity and flexibility of communication, helper of daily activities outside of communication, and personality development. Variable of negative influence is also divided into three sub-variables: health disturbance, personal disturbance, and social (society) disturbance.

These sub-variables will become the factors of the research and also become the reference of other proposed statements to measure the variable.

7) *Construct of Questionnairre II:* statements of questionnaire II is developed according the determined variables and sub-variables. Purpose of the questionnaire II is to see the consistency of result in questionnaire I and II. The result is used to conclude the research hypothesis.

8) *Distribute Questionnairre II:* the distribution of questionnairre II conducted to 30 respondents. Questionnairre II are not directly distributed to the all respondents. It is distributed first to the 30 respondents in order to test its validity and its reability.

9) Do Validity and Reability Test of Questionnaire II: purpose of this phase is to make sure that the questionnairre has been able to measure each variable (valid) and to make sure that the result of questionnaire can be trusted (reliable). There is two phases of validity test: factor analysis and statement analysis, both use Pearson Product Moment. Reability test uses KR-21 Method [5].

10) Revise the Questionnaire II: the invalid statements are removed from the questionnaire.

11) Distribute Questionnaire II to the Rest of Respondents of the Same Sample: revised questionnaire II is distributed again to the rest of respondents who have been given questionnaire II. The rest of respondents of the same sample are not included in 30 preliminary respondents who has been given questionnaire to test its validity and its reability.

12) Distribute Questionnaire II to Different Sample of the Same Population: revised questionnaire II is distributed again to the different sample of the same population: college students in Bandung, Indonesia which is outside of the first sample. The main idea is to know whether the questionnaire II can be applied to other sample, as long as the sample is in the same population.

13) Distribute Questionnairre III: in questionnaire III, there are set of questions about important feature or service of hand-phone for college students. The result is expected to help analysis of the needs of college students of hand-phone.

14) *Collect and Process the Data:* the result of questionnairre II is gathered. The result is converted to numbers and processed further in order to have conclusion of this research.

15) Make Analysis: the result of questionnaire is analysed with macro ergonomics.

16) Make Conclusion: after analysis phase, the conclusion of the research are made and it become the result of this research.

III. Collecting and Processing Data

The result of collectiong and processing data is as follow:

1. There is no difference answer from two group of respondents (from the same sample of the same population and from different sample of the same population). It can be concluded that this research has external validation.
2. The respondents agree that there are positive and negative influences of hand-phone usage.
3. The positive influence of the usage of hand-phone by college students in Bandung, Indonesia can be summarized as follows:
   - simplicity and flexibility of communication related to the main function of hand-phone: to make communication easier,
   - helper of daily activities outside of communication related to the influence to the daily life with the available features in the hand-phone, and
   - personality development related to the influence occured to the respondents of having hand-phone, such as: increase of responsibility, etc.
4. The negative influence of the usage of hand-phone by college students in Bandung, Indonesia can be summarized as follows:
   - health disturbance related to anxiety of the healt of respondents because of the usage of hand-phone, such as: the radiation influence of hand-phone.
   - personal disturbance related to influence of hand-phone to personal freedom of respondents, such as: privacy disturbance.
   - social (society) disturbance related to influence of hand-phone to society life, such as: social jealousy between people who possess and do not possess it.

IV. Analysis of Macro Ergonomics

The phases to do macro ergonomics are as follows:

1) Determine involved sub-systems:

- Personal sub-system, i.e. college students in Bandung, Indonesia.
- Technology sub-system, i.e. hand-phone with all of offered features and services.
- Organization or management sub-system, i.e. information process and flow of hand-phone until it can reached the user of hand-phone.
- Environment sub-system, i.e. the environment of college students and the development technology of hand-phone in Bandung, Indonesia.

2) Analyse of occured interactions among sub-systems:the occured interactions are:

- Interaction of technology and personal sub-system: the occured interactions are in form of positive and negative influences experienced in daily life of college students.

The posive influences show that compatibility of each characteristic of sub-system, while the negative influences occur because of incompatibility of both characteristics.

- Interaction of technology and environment sub-system: supported by the hand-phone technology growth in Bandung, Indonesia, college students are more familiar with hand-phone. That is why hand-phone in the end can be accepted by college students.
- Interaction of technology and organization or management sub-system: education to users of hand-phone, particularly about new features and services is necessary. It can be delivered through various sources, such as: personal, commercial, public sources, or through the experience of the users. It can take of any form, such as doing exhibitions, advertising in printed and electronic media, giving of manual books, etc.
- Interaction of technology, personal, environment, and organization or management sub-systems: word of mouth information have major role in interaction of all sub-systems.

3) Macro ergonomics approch of negative influences of hand-phone usage by college students in Bandung, Indonesia: the negative influence occured since there is incompatible relation between sub-systems. In order to minimize it, the correction is proposed according to human-centered as the core of ergonomics.

4) Correction of personal sub-system to other sub-systems: correction based on *human-centered* is insufficient since there is negative influence occurred because of the characteristic of personal sub-system itself. Therefore, personal sub-system should be corrected with the characteristic of other sub-systems.

5) *Comparation of the phenomenon of* oya yubi sedai *in Japan and in Indonesia:* the respondents still consider the Short-Message Service (SMS) as the most important feature. It is also supported by the Siemens Mobile Lifestyle Survey stated that more than 50 % of teenagers and adult in Indonesia prefer sending the SMS than reading.

V. Conclusions

As conclusion of the research, the usage of hand-phone by the students in Bandung creates the positive and the negative influences as well. The negative influences occured are minimized by the application of human-centered as the core of ergonomics.

However, from the research concluded that the application of human-centered is insufficient. It is as the result of the negative influences from characteristic of the personal sub-system itself. In that case, there should be some correction to the personal sub-system in order to minimize the negative aspect of the hand-phone usage.

Moreover, the negative influences are unavoidable. It is as a consequence that shoud be accepted by the students in order to be able to use the hand-phone.

Some of the phenomenon of *oya yubi sedai* occured in Japan also occurs in Indonesia, although in a few different type of phenomenon.

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

Design an Application Program of Anthropometric Data Management as a Supporter of Research and Design of Products Based on Ergonomic

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Abstract - **The use of anthropometric data is increasingly important in research and design of products based on ergonomic. This is because one of the principles of ergonomic products is in accordance with the user's body anthropometry. Anthropometric data itself is different for each individual, depending on the variability category consisting of age, gender, ethnicity, socio economic and body position. The difference factor for each body anthropometric data can also be caused by disability, type of work, and condition of pregnancy in women. However to this day, the various anthropometric data are not documented well. This becomes an obstacle for the research and design of product based on ergonomics when it needs proper data. In some countries there had been a software or application program which is designed as a media of anthropometric data management. But it is only capable of storing children anthropometric data categories to analyze the growth and development and nutritional status of children. So, this research aims is to design an application program which capable of storing and managing all categories of anthropometric data.**

***Keyword*: anthropometric data, applications programs, variability**

I. BACKGROUND AND PURPOSE

Anthropometry increasingly has an important role in research and design of products based on ergonomic principles, particularly in the areas of health, sport, industry, and even areas of information technology. The more important aspects of ergonomics in the design process of working facility is as a support of improvement production services [1].

To design ergonomic products, researcher must consider the use of anthropometric data based on the variability. This is because the different anthropometric data due to several factors that affect the size of the human body, i.e: age, gender, ethnicity, socio economic and body position [2]. The other factors should be due to disability, job type, and condition of pregnancy in women [3]. However, these various anthropometric data are not documented well. So that this becomes an obstacle for the research and design of product based on ergonomics when it need proper data. Until this day, the documentation of anthropometric data only using Microsoft Excel application and paperwork which are susceptible to viruses and lost data. Its caused the researcher have to collect new data when do their activity in research and design the product based on ergonomic. So that, the research becomes take longer time and prolix.

Based on the problem above, creating application program for manage anthropometric data is need to consider, especially in Indonesia. Like in some country, there are some anthropometric data application programs which have been created, i.e: 'WHO Anthro', RAPIL and WEAR ([4], [1], [5]). However, these programs function just for collecting children anthropometry data to analyze nutritional status and activities of child development, so it can not support the activities of research and design products based on ergonomic generally.

The purpose of this research is to design an application program of anthropometric data management as a supporter of research and design of product based on ergonomics that can accommodate all the variability categories of anthropometric data, then data contents can be updated at any time in accordance with the recent conditions, and can conduct statistical tests including normality test, uniformity test, adequacy test and percentile data.

II. METHODOLOGY

The methodology used in this study consists of five main procedures. There procedures are done as a general procedure for designing the application program. The procedures performed are described in the following paragraphs.

A. Identification and Analysis The Needs of Anthropometry Information

The initial steps is done in this study is direct observation to identify and analyze the user wishes to an application program as detailed as possible. Observation is also done to the user and the use of anthropometric data in research or design of products based on ergonomic.

While direct observation is used to analyze the needs of anthropometric data information to be done as proposed by the Simarmata (2007), is reviewing the existing documents, such as anthropometric data available, written instructions, description of anthropometric data applications or programs or software ever designed before, interviews with the end users of anthropometric data, review the collection and storage systems of existing anthropometric data to determine the needs of its database which more organized and automated. And to transform the needs to better structure, specific techniques are used for example with a flowchart, OOA (object-oriented analysis) and DFD (data flow diagram) [6].

B. Designing Database

After identificatifying and analyzing information needs,the next step is to design anthropometric database. In designing the database, are carried out several steps, i.e.:

1. Determination of entity and attributy
   Both of entity and attributy are basic in database design. Entity is an individual which represents something real and can be distinguished from other, while the attribute is a characteristic of this entity [7]. Entities in this study are the individuals who are measured their anthropometric data and the anthropometric data itself. These entities are designed in the form of tables that compile the database and completed by its attributes.
2. Table normalization
   Normalization is the decomposition of complex table structures into normal form, according to the rules of data dependency.
3. Determining the relationships among tables
   The relation among the tables is drawn to determine the relationship between the tables of entities used in application programs.
4. Making Data Dictionary
   The data dictionary is created based on tables that already have been normalized and the relationships among tables. This data dictionary includes the table's components and its data types, size, description, and sample data.

C. Designing Queries and User Interface

Queries are used to classify, process and manage data in certain order, so the data can be transformed to be better information. Query is a tool of data processing. This query-base on SQL (Structured Query Language), a language commonly used in the database.

The next step is to design the program interface so that users can interact with application program easily. Basic of making interface is form, which is used by end-user to input the data. There are two steps to be taken in designing the user interface, i.e.:

1. Designing the input interface
   Input interface is a page to enter data. This page is created to help users to input data into the database.
2. Designing the output interface
   The next step is design the output interface. Output generated includes report forms and output forms. Output form presents the categorization rule-based anthropometric data query and statistical calculation anthropometric data. Output is still in form. While the report form is a form of output from that later can be used as a printout.

D. Preparation Application Program

Making an application program is to write the program code in accordance with the user interface and anthropometric database system that has been designed, so that the program be accessed by various anthropometric data users. The database and application programs are built with Microsoft Access 2007 and Visual Basic as used by Joyce (2008) in her research about design anthropometric database and human factor. The reason using Microsoft Access 2007 is due to its good and easy accessibilty. Access is used to organize and analyze large amounts of data in spreadsheets and graphs and can also store data from various spreadsheets in a single database, making it more simple. While the reason of using Visual Basic 6.0 is one programming language from Microsoft that provides important components when designing user interfaces based on data from a Microsoft Access database. Besides that, it also allow an easy manipulation of scheme interfaces with only a coding of specific instructions in a short time [8].

E. Testing Programs Application

Testing is an intensive process of executing the program to find errors. Testing is not only to obtain the correct program, but also to ensure that the program is free of errors for all conditions [9].

The testing program in this application uses unit and system testing method. Unit testing is testing of components outside of the system and performed one by one for each component. While the system testing is comprehensive testing of application programs, including the unit itself, the working principle, and the programming code wheather it is able to work as expected goal or not.

Media for testing the application program is in the form of questions that represent the program performance success criteria, as being done by Indra Pramana (2001) in the "Design of Academic Information System Software University of Indonesia." The testing process is conducted by the application program designer, both units and systems testing [10].

III. RESULT AND DISCUSSION

Results and discussion section discuss the results of this research, and everything that can be discussed as a consideration of future research.

On the stage of identification of anthropometric data information needs database are generated compiler entities that consist of personal and anthropometric data. Personal data is an individual data measured their body anthropometry.

ISBN : 978-602-97809-0-1

This personal data has five characteristics or attributes which also as bookmark that it has variability of anthropometric data, i.e. sex, age, pregnant or not, disable or not, and ethnicity. The attribute of personal data is shown at Fig.2. Then, the anthropometric data entities contain data attribute of individual body parts to be measured. The number of attribute is limited until 66 data as in [3]. It is represented in Fig.3. Besides some entities, this stage also analyze the anthropometric data processing generally namely statistical calculation that consist of uniformity test, adequacy test, normality test and percentile data [11].

The result of database design stages are generated anthropometric database to storage and process anthropometric data. The database is formed by relating the two entities mentioned before. Then, at designing a query stage generate some certain anthropometric data categories according to the needs of research or product design. Interaction media between user and application program is an interface directly designed by using Visual Basic. After all of interface requirements are finished, program then being coded. It is performed on application program designing stage. This application program is named as "Prolaktri" which stands for “Program Aplikasi Pengelolaan Data Antropometri”. This name is like a previous anthropometry application program, RAPIL [1] and WEAR [5]. The main interface of application program is shown at Fig.1.

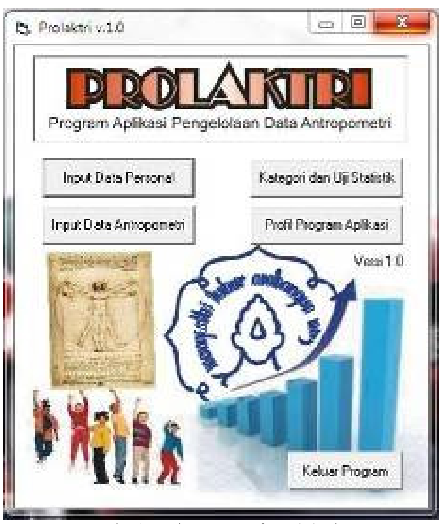

Fig.1 Main menu of Prolaktri

Application program designed then being tested to determine its performance. This stage is done together with the process of verification and validation. Unit testing is done by giving a question about the program performance success criteria. The result is explicitly found that the program can work well. It is performed by the ability of each component of the program that can work without an error, e.g. edit button, print, save, and so on. Then the result of system testing is the program can work well, too. Testing of this system include test the input, storage, process, and output the anthropometric data. Especially for statistical data processing, it is done by comparing the results from manual calculations by Ms. Excel and Prolaktri’s. It is found that there is no difference in the result of calculation, it is shown at Fig.4 on appendix page.

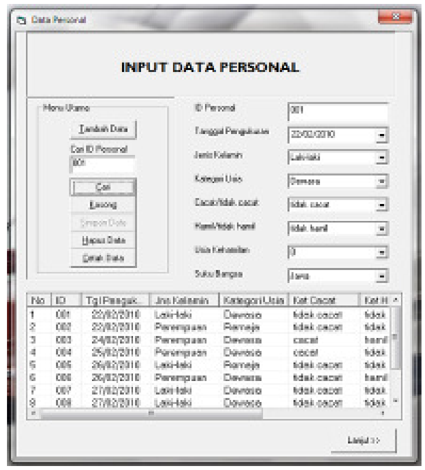

Fig.2 Form of personal data input of Prolaktri

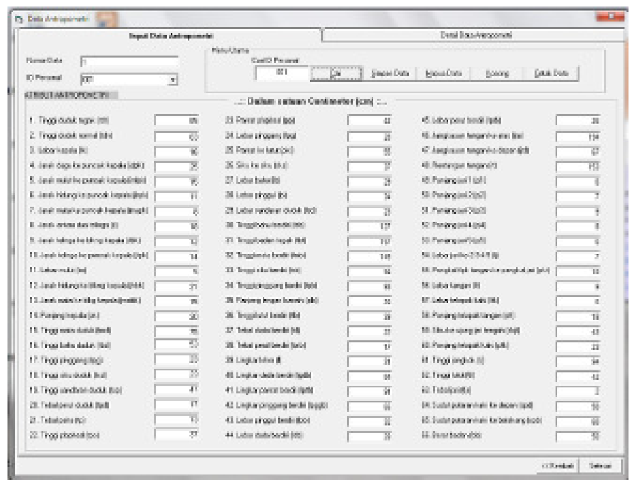

Fig.3 Form of anthropometric data input of Prolaktri

Although it can be stated well after verification and validation, this application program still has some limitations, e.g. there is no graphical analysis for calculation of anthropometric data results as in [4]. The calculation results are displayed only in form of table. This is done in order to minimize memory usage because the application program has already had a lot of statistical test formula and repeated processes. Applications program will be more accessible by many users, if it is developed further with technology based on websites. Preliminary design of this application program is carried out based on stand alone that must be installed on each computer which will be used to access the anthropometric data. But the weakness of this system is that if it met a computer that its operating system did not support. So that it should be considered to be developed in the form of websites, because the design of databases has any qualified web-based application program development.

ISBN : 978-602-97809-0-1

IV. CONCLUSION

Designing the anthropometry application program "Prolaktri" can do input process the, storage and processing of all categories of anthropometric data variability and then issuing the results in a report form. Anthropometric data stored can also be updated any time in accordance with the latest conditions. Furthermore, the application can help calculate a more practical statistical test calculation with the same results as the manual calculations.

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APPENDIX

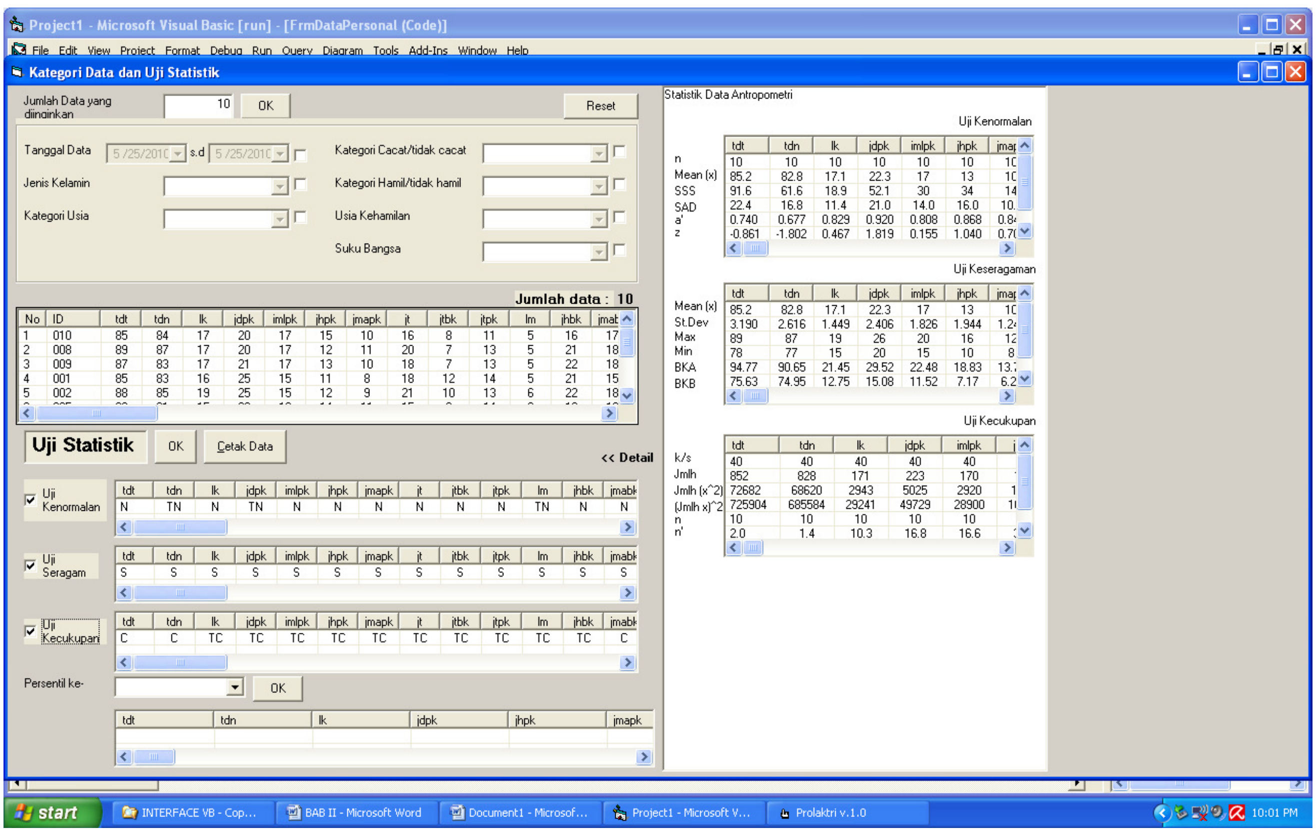

Fig.4 Form categorize data process and statistical test of Prolaktri

ISBN : 978-602-97809-0-1

BEHAVIOURAL INTENTION TO USE IRIS AUTHENTICATION APPROACH FOR PUBLIC AUTHENTICATION AMONG USERS OF PUBLIC TERMINALS: WHERE DOES AGE COME IN?

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*Abstract***The moderating effect of age on technology adoption and diffusion is not a strange issue. This has been looked into in various ways both for the diversities in the adoption models and theories employed and domains of usage of the technology in question. In this paper, the influence age in determining the factors of user's readiness to use iris authentication technology in public domains is determined to further validate the moderating effect of age on technology adoption as revealed by previous authors. A quantitative research is designed to survey the Automated Teller Machine (ATM) users. A total of 351 usable questionnaires were considered for the analysis. A survey instrument is developed based on the underpinning theory (Unified Theory of Acceptance and Use of Technology (UTAUT)) additional items were also selected from relevant literatures on iris authentication implementation barriers. Age is hypothesized to moderate the effect of the independent variables on behavioural intention to use iris authentication in public zones.**

Keywords: moderating, diversities, technology adoption, diffusion, instrument, public authentication.

INTRODUCTION

It is recently revealed that the victims of ATM unauthorized withdrawals in Nigeria have teamed up and they have sued the central bank of Nigeria (CBN), 24 Nigerian commercial banks and the interswitch (the company responsible for inter connectivity among both Nigerian banks and internationally to pay a sum of fifty (50) billion naira as the general damages for the withdrawals, 2.5 million naira as the money lost to the withdrawals, 100 million naira as the cost of litigation and lastly 10 million naira as the cost of providing notice to the defendants [22]. It was recently revealed that the Lagos state government where the more than 80% of the ATM fraud occurred has accused the banks for their nonchalant attitudes in reacting to the reported ATM frauds [23]. The banks are also confused on the next line of action which makes them to withdraw about 20 million ATM cards from their illiterate customers [24] thinking that the vulnerability is due to their lack of education. Several researchers have proposed biometric identification as the alternative to the inherent problems of both token-based and knowledge-based authentication. Specifically, it was revealed that the only promising solution to the alarming ATM fraud in Nigeria is biometric authentication [25]. It then becomes necessary to determine the acceptance of such authentication technology.

This study is carried out using the Unified Theory of Acceptance and Use of Technology (UTAUT) developed by [17] as the underpinning theory, for the purpose of examining technology adoption in a more unified approach compared to the earlier theories adoption theories which are specifically designed for specific domains. The model integrates the Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) of the Technology Acceptance Model (TAM) referring to them as Performance Expectancy (PA) and Effort Expectancy (EE) respectively. In addition to these two variables are included: Social Influence (SI) and Facilitating Condition (FC). Thes added variables make the model to be more suitable for this work since most of the problem faced by users of public terminals while authenticating their identity in

ISBN : 978-602-97809-0-1

public places have a lot of social influences considering the presence of other people. The model equally contains four demographic variables i.e gender, age, experience and voluntariness of use. UTAUT has been tested against eight preceding technology acceptance models and it was found to outperform them[17], [2], [18]. The eight models include the Theory of Reasoned Action (TRA) [1], the Technology Acceptance Model (TAM) [7], Motivational Model (MM) [6], Theory of Planned Behaviour (TPB) [1], Combined TAM and TPB (C-TAM-TPB) [17],Model of PC utilization (MPCU) [17], Innovation Diffusion Theory (IDT) [12]and Social Cognitive Theory (SCT) [4]. The four constructs of UTAUT take care of all the dimensions of the earlier technology acceptance and adoption models and that is why it is suitable in all domains of technology acceptance [2]. UTAUT have been used and validated in many areas of technology acceptance [2], [18].

Age was also included as a moderating variable for the six dimensions involved in this study. Such inclusion was traced to series of academic justifications and evidences [15],[19],[20]. The sources acknowledge the significant role of age in technology adoption and diffusion studies. Similarly, it was posited that studying on moderating effect of gender without considering age present and incomplete study environment [20]. According to the author, the two variables are jointly interpreted in most cases.

Also two variables are Attitude and Anxiety are added based on the reviewed literatures. The construction of the variables has been well discussed in [9]. The composition of the questionnaire items for this study includes Performance Expectancy (PE) with 7 items, Effort Expectancy (EE) with 5 items, Social Influence (SI) with 6 items, and Facilitating Condition (FC) with 6 items, Anxiety (ANX) with 5 items and Attitude (ATT) with 4 items while the dependent variable is Behavioural Intention (BI) with 4 items.

I. METHODOLOGY

The research design for this study is a quantitative survey design since the unit of analysis is individual ATM users [14]. The population sampled is Nigerian users of ATM in Lagos state with highest recorded number of identity crimes where 351 responses were considered usable following the stratified random sampling approach. Data reliability and validity were examined as discussed in the subsequent sections. Out of 500 questionnaires distributed, 420 were retrieved which were screened to 351 based on a number of criteria.

A. *Reliability of the Instrument*

A pilot study was conducted among 31 ATM users base on the position of [10] that, a minimum of 30 respondents is considered adequate for a pilot study with 18 males and 13 females. Eleven of the respondents fall between age 16 and 30, 12 are between age 31 and 45 while the remaining 8 are above age 45. The construct reliability is tested using cronbach's Alpha with the following average values for each of the constructs: performance expectance (0.882), effort expectancy (0.878), attitude (0.909), social influence (0.969), facilitating condition (0.788), anxiety (0.967) and behavioural intention (0.838). The reliability testing for all the constructs are greater than 0.7 required [14], [13]. This means that all the constructs of the instrument are considered reliable and acceptable and therefore justify the consistency of its items to measures the variable in question.

Based on the frame work a survey is conducted among 420 Nigerian ATM users using stratified random sampling approach in the city of Lagos using the traditional offline approach. 400 questionnaires were returned back showing 95% response rate where 351 were considered usable after series of screening.

B. *Data Validity for main actual study*

The Exploratory Factor Aanalysis (EFA) was performed as initial analysis employing the principal component method and Principal Factor Analysis (PFA) was used as the factor extraction method where the variance is shown in descending order. The decision to either remove an item or not is based on loading less than 0.3, double loading and wrong loading [14], [13], [10].All This led to many items being dropped and only the well loaded items are retained.

II. RESULTS

A. *Results of One-way ANOVA*

Based on evidences from previous literature, it was hypothesized that
The influence of all the independent variables on behavioural intention to use iris-based authentication in public zones is moderated by age.

One-way ANOVA is considered suitable for measuring such moderating effect since the groups are more than two [13], [10]. It is established that the level of significance in both Levene's test of homogeneity and the overall ANOVA test serves as the basis to determine the existence of a significant differences between groups [10], [13], [21]. The authors also agreed that the significance level of ($p<.05$) in Levene's test of homogeneity means that the mean scores are statistically the same while ($p<.05$) in the overall ANOVA test shows the the effect of such difference is significant. The analysis is done as follow and the results are described in Table 1.

TABLE I
ANOVA RESULT

Variable	Sig (Homogeneity)	Sig (Overall ANOVA)
Performance Expectancy	.539	.398
Effort Expectancy	.049	.038
Social Influence	.474	.350
Facilitating Condition	.039	.273
Attitude	.572	.080
Anxiety	.045	.027

B. *Moderating effect of Age on PE*

A one-way between-groups analysis of variance is conducted in exploring the effect of age on behavioural intention to use iris-based authentication as measured by PE. The respondents are divided into categories of age (Category 1: 16- 30 years of age (young); Category 2: 31 – 45 years of age (middle aged) and Category 3: Above 45 years of age (old)). It is found out that there is no statistically significant difference at the $p > .05$ level in both the Levene's test of homogeneity of variance and overall ANOVA test with (sig. = .539 and .398) respectively as shown in Table 1. This implies that there is no significant impact of age on user's perceived PE towards behavioural intention to use iris-based authentication in public zones. Thus, this domain proves contrary to that of [17].

C. Moderating effect of Age on EE

The result of one-way between-groups analysis of showed that there is statistically significant difference at the $p < .05$ level in both the Levene's test of homogeneity of variance and the overall ANOVA test with (sig. = .049 and .038) respectively as shown in Table1. This implies that there is significant impact of age on user's perceived EE towards behavioural intention to use iris-based authentication in public zones. This further validates UTAUT in this regard [17].

D. Moderating effect of Age on SI

A one-way between-groups analysis of variance is conducted in exploring the effect of age on behavioural intention to use iris-based authentication as measured by SI. It was found that there is no statistically significant difference at the $p > .05$ level in both the Levene's test of homogeneity of variance and overall ANOVA test with (sig. = .474 and .350) respectively as shown in Table 1 which is in contrary to the earlier finding of[17]. This implies that there is no significant impact of age on user's perceived SI towards behavioural intention to use iris-based authentication in public zones.

E. Moderating effect of Age on FC

It was found out that there is statistically significant difference at the $p < .05$ level in the Levene's test of homogeneity of variance with (sig. =.039). This notwithstanding, the overall ANOVA test with (sig. of .273)as shown in Table 1 implies that there is no significant impact of age on user's perceived FC towards behavioural intention to use iris-based authentication in public zones in contrary to the earlier finding in [17].

F. Moderating effect of Age on ATT

A one-way between-groups analysis of variance is conducted in exploring the effect of age on behavioural intention to use iris-based authentication as measured by ATT. It is found out that there is no statistically significant difference at the $p > .05$ level in both the Levene's test of homogeneity of variance and overall ANOVA test with (sig. = .572 and .080) respectively as shown in Table 1. This implies that there is no significant impact of age on user's perceived ATT towards behavioural intention to use iris-based authentication in public zones.

G. Moderating effect of Age on ANX

A one-way between-groups analysis of variance is conducted in exploring the effect of age on behavioural intention to use iris-based authentication as measured by ANX. It was found out that there is statistically significant difference at the $p < .05$ level in both the Levene's test of homogeneity of variance and the overall ANOVA test with (sig. = .045 and .027) respectively as shown in Table 1.This implies that there is significant impact of age on user's perceived ANX towards behavioural intention to use iris-based authentication in public zones.

III. CONCLUSION

Since the results of the ANOVA showed that only EE and ANX found to be moderated by age of the respondents in measuring behavioural intention to use iris authentication in public places. To further buttress this point, the effect of age on those variables has been revealed by quite a number of authors [17], [8], [15], [16].The fact that other dimensions of BI considered in this study are not moderated by age can be attributed to the peculiarity of the domain of study and for the mere fact that the most prominent factors in the study are more of social issues. At the same time it is recommended that future studies should consider this from multi-cultural point of view before the findings can be generalized for all cultures since the study is conducted within a single cultural setting. The findings of the study revealed the need not to overlook anything in adoption study since there can be series of deviations from the existing findings with the same adoption model. This in most time is caused by the difference in the domain of study. Therefore, there is need to consider the moderating effect of age on behavioural intention to use any information technology using UTAUT from different domains and different locations and culture.

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ISBN : 978-602-97809-0-1

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CHAPTER 7 :
Technology and Knowledge Management (TKM)

editor :
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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

Conceptual Model of Land Use Mapping Application of Citarum River based on Geographic Information System

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Abstract – **The Annual Floods phenomenon often occur in West Java Area, especially in Bandung city. This is because the Bandung city was passed by the Citarum River, has a quite critical conditions and indicates the status of D or very bad condition. Citarum River state currently doesn't have reasonable function as a river because it has various problems which are quite complex. One cause is the existence of spatial land structure of land which less well. Both floodplain designation or adesignation in the river watershed. Problem Solving method in this research using web-based Geographic Information System as a user interface into the system. The aim of this study was to develop a Geographic Information application which related to the land use of the Citarum River. Thus, through this application can be mapped in the land around Citarum in order to be improved by related institutions. This forward results of this research is a web application that provides comprehensive information in the form of spatial information and spatial attributes of land use in the Citarum River.**

***Keywords* – Geographic Information System, Citarum Watershed, land use**

I. INTRODUCTION

Flood is one of the problems which often occur when the rainy season arrived in the Citarum River area. This phenomenon occurs regularly recorded almost every rainy season comes. As a result, the area around Dayeuhkolot, Banjaran, and BaleEndah often inundated.

This incident caused by many complex problems. Some of these causes are fairly rapid population growth, lack of wisdom of human behavior in managing natural resources like deforestation, disposal of household waste, livestock, industry, the misuse of town planning, etc. According to data from Central Bureau Statistics in 2009 and Statistics of West Java Governor, that the total population in the Citarum river Watershed as much as 15.303.758 from total population in West Java as much as 41.483.729.

The problem raised is the existence of abuse of spatial planning and land use are still not well ordered in the immediate area of the Citarum River. The following data from the National Planning Board, with the title "Roadmap for A Better Future Citarum River" in problem identification in the Citarum and its efforts to follow up:

TABLE I
IDENTIFICATION OF PROBLEMS AND IMPROVEMENT EFFORTS IN THE CITARUM RIVER

Num	Problem	Follow Identify Needs
1.	**Fishery** • Increasing fishing labor and ponds contribute to the increasing of water pollution caused by fish feces and food remains.	Need the rules to control fish farming by paying attention to space and land administration
2.	**Critical Land and Sedimentation** • About 8 million cubic meters of mud and soil every year into the river • Critical Land and high levels of erosion in the upstream river	Need a land conservation
3.	**Groundwater Extraction** • Decrease in soil due to groundwater extraction	Groundwater Conservation
4.	**Flood** • Several major record floods caused by overflow of Citarum	Need structural approach (dredging and widening river, creeks Citarum rehabilitation, construction of dykes and water reservoirs, etc.) and non-structural (greening, community based programs, etc) in dealing with floods.

(**source**: *RoadMap for A Better Future Citarum River*)

Based on data from Regional environmental management Agency (*Badan Pengelolaan Lingkungan Hidup Daerah - BPLHD*) West Java, the cause of Bandung concave flood are inhabitant pressure, the change of cover upstream and downstream function, rubbish inadequate, erosion on upstream and sedimentation on downstream, building on demarcation river or water agency, water control system and drainage inadequate, geophysical of river effect, river or water agency capacity inadequate, soil degradation, crosspiece buildings on the river. That condition is an indicator of land use which are increasingly slumped from year to year. The conservation in the area of critical land conservation must be done. (*Pikiran Rakyat, 30 Desember 2009*). The land use data, shown in Fig 1.

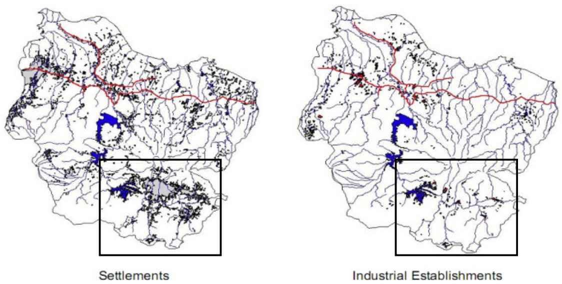

Fig 1 Land Use in Bandung City
(**Source** : *Report of Citarum Integrated Water Resource Management Project*)

According to a report with title "Integrated Citarum Water Resource Management Project" that state of development of residential areas and industrial estate development will increase each year. Bandung is one area that has the densest population (urban areas). If the residential and industrial development is not in good condition, with meanings that do not pay attention to aspects of catchment areas / water catchments, then it will result in flooding. Therefore, it should be known and mapped patterns of urbanization because it will significantly influence on the water supply system. The point is that the construction of residential and industrial areas with no consideration of land use which would threaten both water quality and will cause other problems, namely floods.

Flood conditions that occurred cannot be separated from a variety of complex problems above. Things that will need to be considered for the government or society is considering land use issues because they saw an increasing number of population with a limited amount of land. The existence of good control prior to the placement of land or land that already exists; it is rightly a priority in the response to flooding in the Citarum.

Solutions that can be taken to overcome the problem is to map the condition of the existing land use in the Citarum watershed using geographical information systems. The combination of spatial data and attribute data can be used to enter, store, manipulate, analyze, and produce an information society and government especially Department of City Area Bandung.

Poerbandono, et al in “Spatial Modelling of Sediment Transport over the Upper Citarum Catchment” state that bearing in mind limited knowledge of some governing factors due to lack of observation, the overall result shows the potential of latest GIS features for spatially modeling regional sediment transport. J. D. Meigh and J.M. Bartlett in “Integrated river basin management in Southeast Asia” state that Water Aspect Land-use change increases runoff in upper citarum is is expanding city and annual crops on hill soils.

Objective

This research aims as follows:

1. Designing the visualization of Citarum River based on geographic information systems.
2. Map the spatial and land use around the Citarum River.
3. Provide recommendations and conclusions of the map object in the Citarum River Watershed that is selected by the user that will be implemented significantly.

Research Benefit

Results from this study may provide some benefits as follows:

1. Provide information on the condition of good order that exists around the Citarum river Watershed.
2. Assist the Public Works Department to map the existing conditions on the Citarum River in the spatial placement of land.
3. As a means of governmental decision-making for the Bandung City in the reconstruction of existing land at Citarum river.

Research Boundaries

So that the problems under study are not too wide, then the specified limits in this study as follows:

1. Mapped region is the Citarum River Watershed through the city of Bandung.
2. The data used are secondary data.
3. Not yet implemented directly (only a conceptual model only).
4. Not considering the cost factor.

II. LITERATURE REVIEW

2.1 GIS

GIS or Geographic Information System is a computer-based system that provides the following four sets of capabilities to handle gereferenced data such as input, data management (data storage and retrieval), manipulation and analysis, and output (Aronoff, 1989).

In general, GIS work based on the integration of five components: hardware, software, data, humans, and methods. For this study, the data used is the model of raster data and vector data models. Vector data model uses position information points, lines, and polygons stored in the form of x, y coordinates, while the raster data model consists of a set of grid / cell as the result of scanning or image map / picture.

Here is stage when working with GIS, shown in Fig 2.

(illustration by Firmansyah Wahyudiarto)
Fig 2 Stage when working with GIS

In the process of input data including tables, reports, field measurement, other digital maps, maps (thematic, topographic, etc.), satellite imagery, aerial photographs, and other data. While for the process include data processing (lay

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outing and editing process). The final result (output) in the form of maps, tables, reports, and digital information in softcopy form.

2.2 Scope (Sub-System GIS)

1. **Data *Input***
   The task of this subsystem are to collect and prepare spatial and attribute data from various sources, and is responsible for converting or transforming the original data formats into a format that can be used by GIS.

2. ***Data Manipulation & Analysis***
   This subsystem determines the information obtained and generated from the GIS, and manipulation to produce the expected information. The data type needed, analyzed in various ways in order to fit with systems used.

3. ***Data Management***
   This subsystem organizes the data both spatial and attribute data into a database, so easily summoned, to be updated, and in-edit.

4. ***Data Output***
   This Sub-system display all or part of the database in both softcopy and hardcopy forms such as: tables, graphs, and maps.

The end result of GIS conceptual model of the Citarum watershed is a geographic information system that has the ability to display spatial data and relevant information and details about the condition of the Citarum watershed land use. Ultimately, GIS is capable of providing output in the form of recommendations and conclusions from the data processing in the input and process.

2.3 Software

- **Map Server**

Map Server is an application based on open source and freeware that is able to display the spatial data (georeference) such a map on a web platform. This application was first developed at the Minessota University, the United States for ForNet project (a project for the management of natural resources), which sponsored by NASA (National Aeronautics and Space Administration). NASA's support continued with the project developed TerraSIP for land data management. Currently, due to its open (open source) and freeware developers done the MapServer developers various countries.

At the most basic form, a scalar MapServer CGI (Common Gateway Interface). The program will be executed on a web server and based on certain parameters (particularly configurations in the form *. map files) will generate data then will be sent to a web browser, either in the form of Picture / maps or other forms.

- **Postgre SQL**

PostgreSQL is a Relational DataBase Management System (RDBMS) that helps a data model consisting of a collection of named relations (relation name) and contains an attribute of a specific type. The system offered PostgreSQL can be sufficient to process applications data. Additional features that are not owned by another database management system such as constraint, triggers, rules, and transaction integrity. With the existence of these privileges, the user can easily implement and deliver this system. Various features of Postgre SQL is more than capable of making a database of other databases from various viewpoints.

III. CONCEPTUAL MODEL

In the design of geographic information systems, need to be attention the problems input, process and output. Components are used as input in this geographic information system that is attribute data and spatial data. Attribute data is data in the form of a location information. While spatial data is spatial data in the form of explicit coordinates on a geographic location.

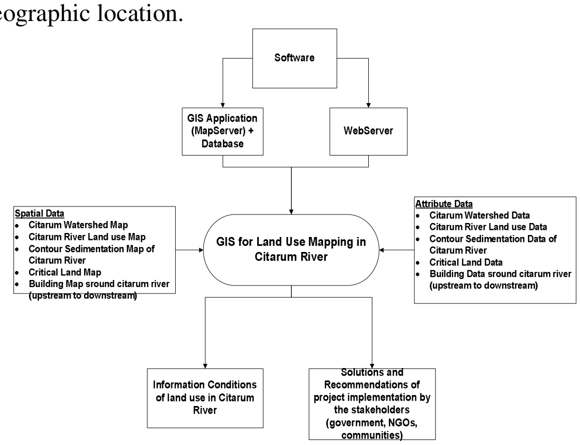

Fig 3 Conceptual Model

In geographic information system mapping of land use in the Citarum river Watershed there are two types of data needed spatial data and attribute data. In this study, the spatial data used in the form of Citarum watershed map, map land use in the Citarum, river sedimentation contour maps, maps of critical land, and maps of buildings around the Citarum watershed. While the data attributes represents information possessed by the existing spatial data such as name, address and other information. This information is embedded in spatial data so that will be processed and integrated through the MapServer software.

Later, the system will be built using the web based GIS application that uses a database system / database that is integrated in the web servers. Input provided by the form of land use data usage, the area of critical land and building data that exists around the Citarum watershed.

IV. METHODOLOGY

ISBN : 978-602-97809-0-1

In this section described the steps to solve the problem is shown in Picture 4.4.

4.1. Problem Formulation

In this stage, the authors identify existing problems. It is behind this research is the existence of cases of flooding that occurs every year in the city of Bandung as a result of the Citarum river overflow. An issue raised in this research is how to design a geographical information system that can map the state of governance of land use in the Citarum river Watershed. So via this mapping can then be carried out land reform plan through the good condition of existing or future development.

4.2. Goal Setting

Based on existing problems, the formulation above, we conducted an advanced stage of setting goals that are expected to answer the problem. This research aims to design a conceptual model of a geographic information system mapping of land use in the Citarum river Watershed.

4.3. Literature Study and Software Study

Literature study conducted to understand the concepts and workings of GIS. Software studies aimed to understanding the use of software that support in this research so that it can decide the appropriate software to be implemented in this study. Literature study conducted by reading books and articles related to geographic information systems. Studies of software writers to do are to compare software like Carto Web, GIS Grass, ALOV and others.

4.4. System Analysis

There are four identification processes, namely:

1. Input Identification

Identification of inputs is divided into two; there are spatial data and attribute data.

1.1. Spatial Data

a. Citarum Watershed Map
b. Citarum Land Use Map
c. Sedimentation River Contour Map
d. Critical Land Map
e. Buildings around the Citarum watershed map

1.2. Non-Spatial Data

a. Citarum watershed data, including :
- Data on behalf of the rivers that exist in the Citarum
- Data of the river, from upstream to downstream.

b. Land Use Data of Citarum River, including :
- Data on existing buildings around the Citarum River
- Data about the condition of the buildings in the Citarum river Watershed

c. Critical Land Data, including :
- Rehabilitation data of land that is ever done
- Data that has been applied to agricultural systems

d. Sedimentation River Contour Data :
- The thickness of the mud
- Historical data dredging (if any)

e. Building data around Citarum Watershed

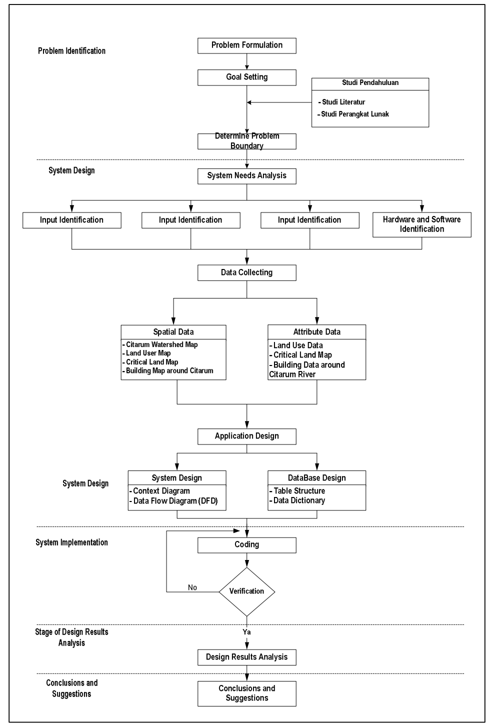

Fig 4 Systematic Problem Solving

***2.* Output Identification**

Output from this geographic information system will provide information and recommendations about the state of the Citarum River Watershed. Going forward, the government is able to provide a comprehensive solution to flood management through the improvement of existing land use in the Citarum River Watershed.

3. *Hardware* and *Software Identification*

Identify hardware and software in this study is very important because it aims to determine the performance and capabilities of the hardware and software to run the system so that later the system can work well.

Minimum specifications required to build GIS Citarum river Watershed is as follows:
- *Pentium IV* Processor
- RAM 256 Mb (512 *Recommended*)
- VGA 32 Mb

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- *Harddisk* 5 Gb

4. **User Identification**
Identification was carried out to find out who the users who will use this system. A user of geographic information systems is the part of local government in particular Bandung Public Works Department and the Department of City as an admin. While the normal user can be a regular staff can only display data.

4.5. Data Collection

The data needed in the design of geographic information system is spatial data that has been mentioned above and its accompanying attribute data.

4.6. System Design

At this stage of the design and development using information that has been obtained previously. In designing this system, carried out early depiction of the system and its relationship with the environment, input and output, data flow, and preliminary design GIS interface that will be created.

TABLE 2.
SOFTWARE USED

Type	Description
GIS Server	MapServer
Server Side Scripting	PHP
Client Side Scripting	JavaScript
Database Server • Non-Spatial Data • Spatial Data	 PostGreSQL PostGIS Extn of PostgreSQL

Here is a design diagram that will be created, shown in Fig 5

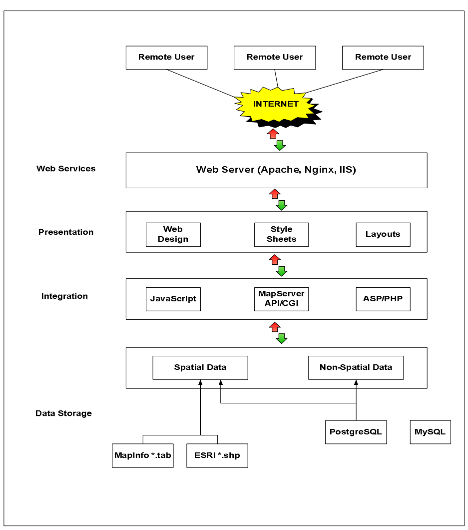
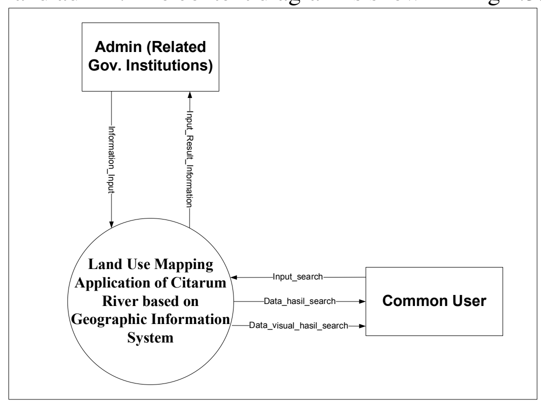


Fig 5 Design Diagram

4.6.1 Context Diagram

Context diagram is a diagram that shows the relationship between the entities that are outside the system with the system. In this context diagram also depicted input and output systems. In a geographic information system entities which have a normal user and admin. The context diagram is shown in Fig 4.3.



Context Diagram of Land Use Mapping Application of Citarum River based on Geographic Information System

Fig 6 Context Diagram

4.6.2 Data Flow Diagram

Data flow is shown in a system data flow in data flow diagram. This flow diagram consists of several levels depending on what the process is in a system. In the design of geographic information systems in land use of Citarum river Watershed have the processes, namely:

1. Processing of information by admin (government agencies related)
2. The process of finding and tracking land use around the Citarum watershed.
3. Process visualization of search results object.
4. The process of providing recommendations and solutions to existing problems in the use of the land use around the Citarum watershed.

The following will describe data flow diagram of the processes that exist in this geographical information system which shown in Fig 6.

4.7. Coding

In the encoding phase of this stage will be done by translation process of the system design into the form of applicative syntax form that can be read and executed by the web server via Internet. Program code that was built through the map server, php and javascript programming languages can be run either through a web platform. The output is a GIS application that can be run independently by the user via the Internet.

4.8. Verification

At this stage, testing whether the coding has been done before has been able to provide the appropriate output is a visualization of existing land use in the Citarum Watershed and also recommendations to users (stakeholders) when choosing a particular object. If there are errors, then the code-checking process to produce output in line with expectations.

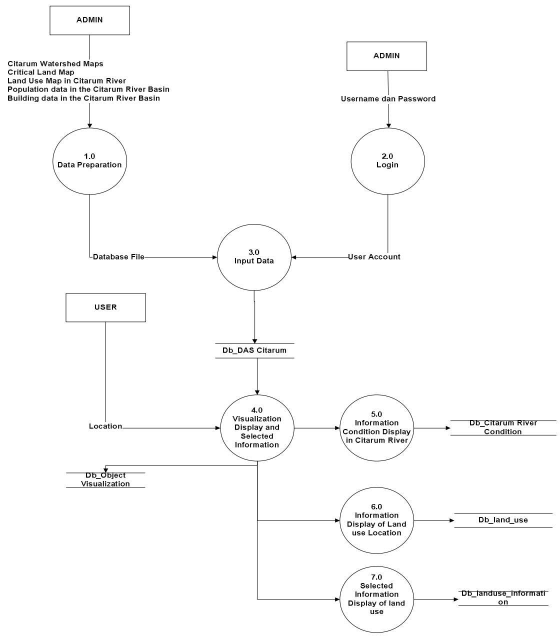


Fig 4.4 *Data Flow Diagram* (DFD) 1st level

4.9. Design Analysis Results

At this stage, an analysis of the application process has been completed. The process of data analysis, process analysis, analysis of hardware and software, and analysis of deficiencies or excess application. From the results of the analysis will be done to fix the deficiencies of the application to get the application running in accordance with specifications.

4.10. Conclusions and Suggestions

This phase represents the final phase of this study which have several steps will be taken before a conclusion on what has been investigated. While the advice contains recommendations from the authors about the possible development of the existing system so the next researcher can produce a better system.

V. CONCLUSION

Based on conceptual model of geographic information systems Citarum river Watershed, it can be concluded that :

1. The system can display the condition of spatial information and land use existing at the Citarum Watershed is visually displayed through an interactive map.
2. This system can be used as an operational tool and also help in making decisions about improvements that need to be made in settlement of land in the Citarum River Watershed.
3. This system has the ease of application usage, design and interactive applications that are interesting, completeness and functionality provided in accordance with the specifications are expected in the conceptual model.

Suggestions

1. To develop better system can be added to existing objects and other features to support the utility of geographic information systems in land use in the Citarum River Watershed.
2. Providing recommendations for complete, accurate, and comprehensive, it needs the cooperation between the admin with the other agencies involved in processing and presenting information on land use data in the Citarum River Watershed.

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ISBN : 978-602-97809-0-1

Design of Monitoring Modern and Traditional Retail using Geographic Information System

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***Abstract* - The existence of traditional retail and modern retail has caused some problems not only in the context of competition in retail business, bul also in the context of extensive town-planning and social order. The government holds the interest to keep assessing every program in strategic policy concerning the continuity of trader business and extensive society social activity. Geographic information system holds predominance over mapping system accuracy. The integration between tabular data and spatial data is expected to support the effective process of planning and supervising of traditional retail and modern retail. The use of GIS eases the users to analyze the existing data and information for decision making. This research develops a conceptual model of geographic information system that is expected to be used to support decision making process for the planning and supervising of modern retail by considering the existence of traditional market or retail based on Peraturan Daerah Kota Bandung no 2 tahun 2009 (Bandung local ordinance no 2/09).**

***Keywords* — monitoring, Geographic Information System, business, traditional retail, modern retail**

I. INTRODUCTION

Background

Retail industry is a strategic industry that plays important role in Indonesia economy. Retail industry provides the second biggest contribution in generating Gross Domestic Product (GDP) after manufacture industry. In addition, retail sector is the second sector that absorbs the highest workforce in Indoneisa, with 18.9 million people, under the agriculture sector with 41.8 million people.

The retail industry development has made great strides since 1990, particularly in modern retail. According to Indonesia Retail Trader Association (Asosiasi Pengusaha Ritel Indonesia-Aprindo), in 2004, the national retail turnover was 400 trillion rupiahs, with the increase of 15% from the previous year. In 2005, the increase was 25% with national retail turnover up to 500 trillion rupiahs. In one hand, the existence of modern retail has given real contribution in absorbing workforce and learning alternative to the costumer. This is certainly an achievement to Indonesia's economy advancement. On the other hand, the modern retail industry development thrusts the existence of traditional retail. Research conducted by AC Nielsen Indonesia on figure 1 shows that in terms of market share of the modern retail and traditional retail from 2000 to 2008, there was a decline in the market share of traditional retail.

In accordance to the claim made by Indonesia Market Trader Association (Asosiasi Pedagang Pasar Seluruh Indonesia-APPSI) West Java that the turnover of traditional market in West Java decreases 30 % each year due to the inadequacy of the market condition. Whereas out of 720 traditional markets in West Java, only 10% are in relatively good condition. In addition, the graphic below describe the decline of traditional retail market share.[7], [8].

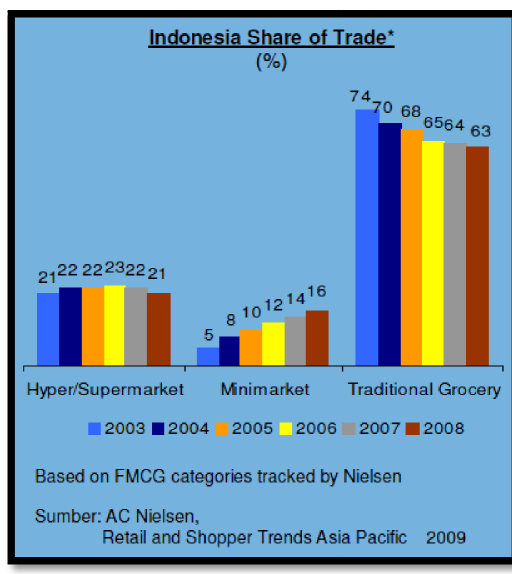

Fig 1. The development of market share

Similar condition is encountered by Bandung city. According to the commerce method data from industrial and commerce agency of West Java province, there are 147 units of modern market and 50 units of traditional markets in Bandung. The number of modern markets is clearly higher than that of traditional markets. This fact indicates the significant development of modern market.

ISBN : 978-602-97809-0-1

The Business Competition Supervision Commission (Komisi Pengawas Persaingan Usaha-KPPU) evaluates the number of minimarket outlets in some areas is abundant or over-investment, therefore it threatens the growth of traditional markets. The competition between traditional retail and modern retail has become unequal. However, the main issue is not only in the context of competition in retail business, the issue of retail existence is more complicated as this bisnis site designation touches wider social order relating to public facilities such as the highway, parking area, school, hospital, housing, etc.

Several previous studies of marketing strategy claim that the location is the important key to develope the business and Geographic Information System (GIS) is the tool to analys the result. For example Sita Mishra (2009)- GIS in Indian Retail Industry-A Strategic Tool**.** Stated that the retail problem can be solved by Geograhic Information System (GIS). GIS software can help the decision maker to understand their customers, analyze their competitors, evaluate current market position, identify optimal expansion and for innumerable other benefits. GIS software to understand their customers, analyze their competitors, evaluate current market position, identify optimal expansion and for innumerable other benefits. Retail location decisions are said to be the most fundamental decisions because it facilitates getting the merchandise to the ultimate consumer at the right place, at the right time, in the right quantities, and at the right price. Or Abdulkader A. Murad (2003)**-** Creating a GIS application for retail centers in Jeddah city. Stated that determining the location of a retailer must be well planned. Strategic retail locations can determine the timeliness of product delivery and customer characteristics that will determine the demand. One tool that is used to provide solutions to the problems above is to use Geographic Information System.

Concerning the aforementioned problem, a geographic information system application is required for intensive planning, managing and supervising order to ensure relocation program, revitalization or other program policies, by remain referring to area layout framework and Bandung's urban plan, including area zoning regulation.

Research Problems

1. How to make geographic information system that can be used as the tool of planning and supervising analysis of modern and traditional retail business?
2. How to make geographic information system that represents the market share of and the business competition condition of modern retail industry?
3. How to make sistematic geographic information system in order to be used decision making in determining the programs of market expansion, relocation or revitalization of retail business?.

Research Objective

Developing geographic information system that supports decision making process for the planning and monitoring of modern retail by considering the existence of traditional market or retail based on Peraturan Daerah Kota Bandung no 2 tahun 2009 (Bandung local ordinance).

Research Advantages

1. Providing accurate information on market share status (Geography, demography) and potential factors for retail business.
2. Assisting in determining business location and retail market expansion that are suitably developed, viewing from market share and area zoning regulation that has predetermined.

Research Limitation

The limitations of this research are as follows :

1. The discussion is limited to conceptual model. Application design is only on system planning level, not on application building.
2. The kinds of retail as the objects of this research are:
   - Modern retail: hypermarket, supermarket and minimarket.
   - Traditional retail: traditional market, wholesale store and small house store.
3. The reseach area is Bandung city.
4. Distance is the only factor accounted.
5. Retail area designation is based on Bandung local ordinance number 2/2009 on the arrangements of traditional market, shopping certer and modern store.

II. Literature Review

Geographic Information System. [1]

Geographic Information System (GIS) is 'An organised collection of computer hardware, software, geographic data, and personnel designed to effectively capture, store, update, manipulate, analyze, and display all forms of geographically referenced information (ESRI). The key component of Geographic Information System can be divided into four main components namely hardware (digitizer, scanner, Central Processing Unit (CPU), hard-disk, etc.), software (Mapserver, Idrisi, ARC/INFO, ILWIS, MapInfo, etc.), organization (management) and user. The appropriate combination among these four main components will determine the success of Geographic Information System development project.

The main objective of utilizing GIS is to ease obtaining information that has been processed and stored as the attribute of an area or object. The main characteristic that can be utilized in GIS is data which is attached to an area and constitutes unspecified basic data (Dulbahri, 1993).

MapInfo [4]

MapInfo Professional is a software designed for applications in the field of mapping with the purpose of visualizing and analizing the data input geographically faster and providing the necessary information in the process of decision making. MapInfo is favored by a lot of GIS users as it caontains interesting characteristics namely user friendly, low price, interactive and riveting display and customized feasibility by using available script language. MapInfo, as a GIS software that has the ability in analizing data, displays the following geographic information :

1. Tools to perform geographic data input and transformation.
2. Data Base Management System (DBMS).
3. Tools that support geographic query, analisis dan visualization.
4. Graphical User Interface (GUI) to ease access in geographic tools.

MapInfo enables the users to display non-spatial data from various sources (internal table, external table or remote). Subsequently, the attribute data that originally does not have spatial dimension can be mapped in particular coordinate system in map window of MapInfo with the help from a process called geocoding.

Visual Basic

Visual Basic is one of development tools served to create application in Windows. Visual Basic uses visual approach to design user interface in the configuration of form, as for the coding, it uses Basic language dialect which is pretty much easy to learn. In visual programming, application development is initiated with the formation of user interface, afterward arranging properties from the objects used in the user interface, and eventually program coding composition is done in order to deal with events. Such application development stage is known as Bottom up approach in the application development term. Visual Basic is the easiest and the fastest means in creating applications running in Micrsoft Windows operating system. Visual Basic provides a set of equipments to ease and simplify difficult application development. The following are some other advantages of Visual Basic:

- The shorter learning and development curve compared to other programming languages, such as C/C++, Delphi or even PowerBuilder.
- Removing Windows API retrieving complexity functions, as many of those functios are embedded into Visual Basic Syntax.
- Suitable to use in developing application or program with "Rapid Application Development" in nature.
- Also very suitable for making business application or program.
- It is used by almost all Microsoft Office family as its Macro language, which soon will be followed by others.

Bandung Local Ordinance number 02/2009 [2]

Market Classification

According to Bandung Local Ordinance number 02/2009, Modern Store ia a store with independent serving system selling various goods in retail in the forms of minimarket, supermarket, departement store, hypermarket or wholesale store that buys goods for resale. Small modern store, such as minimarket is a market place to sell daily needs goods in retail, directly to end customers with its site which is less than 400 square meters. Small retailer is individual or corporation that runs in the field of commerce or trade, that has maximum assets of 200 million and/or maximum turnover volume of 1 billion per year directly and/or indirectly to the end buyer. Traditional market is a market that is built and run by the Governemnt, Local Government, Private agency, State-Owned Enterprises (BUMN) and Local-Owned Enterprises (BUMD), including cooperation with private agency for the market place namely store, kiosk, stall and tent owned and run by small, middle traders, community self-reliance or Cooperative with small-scale business, small capital and with bidding trading process.

Peraturan Daerah Kota Bandung No 02 Tahun 2009 (Bandung Local Ordinance number 02 /2009).

Article 19

1) Wholesale can only be situated on arterial or primary collector or secondary arterial road network system.
2) Hypermarket and Shopping Center :
   a. can only be situated on arterial or collector road network system; and
   b. it is prohibited to be on local public service area or environment in urban area.
3) Supermarket and Department Store :
   a. is prohibited to be situated on enviroment road network system; and
   b. is prohibited to be on local environment service area.
4) Minimarket can be situated on road network system, including environment road network system in local environment service area.
5) Minimarket size on environment road network system in service area is 200 square meters maximum; and
6) Traditional market can be situated on any road network system.

Article 20

In establishing shopping center and modern store, the following conditions need to be met :

1) minimarket has minimun distance of 0,5 Km from the traditional market and 0,5 Km from similar small business which is situated on the collector or arterial;
2) supermarket and department store have minimum distance of 1,5 Km from the traditional market situated at the side of collector or arterial;
3) hypermarket and wholesale have minimun distance of 2,5 Km from traditional market situated at the side of collector/arterial;
4) minimarket situated at the side of local road with the size up to 20 square meters, has minimum distance of 0,5 Km from traditional market and similar small business;
5) the deployment of traditional market with distance with the purpose of partnership is prohibited to use the road space;

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6) the disposition of distance as stated on articles 1, 2, 3 and 4 does not prevail for primary center area.

Retail Classification

Retail focusing on selling daily goods is mainly divided into two kinds, namely traditional retail and modern retail. Traditional retail is an average retail, not too spacious, the sold goods are not varied, has simple management system, not offering shopping convenience and there is still bidding process with the trader. On the contrary, modern retail offers spacious place, various goods, good management system, shopping convenience, fixed price and self-service system.

III. CONCEPTUAL MODEL

The conceptual model of GIS for monitoring system in planning and supervising of traditional retail and modern retail can be seen on figure 2. [3], [6]

The sub systems of this GIS consist of:

1. Data input

   In this subsystem, there are the collection and preparation of spatial data and attribute data from various sources. In this subsystem, the conversion of original data template into the GIS template is conducted.
2. Data management

   This susbsystem organizes spatial data and attribute data into a database so that retrieving, updating and editing processes can be performed. The digitization process of map spatial data and the management of quantitative attribute demography, geographic data and retail competition condition and also the existence of traditional market and retail in one database.
3. Data Manipulation and Analysis

   This subsystem determines the information generated by GIS.

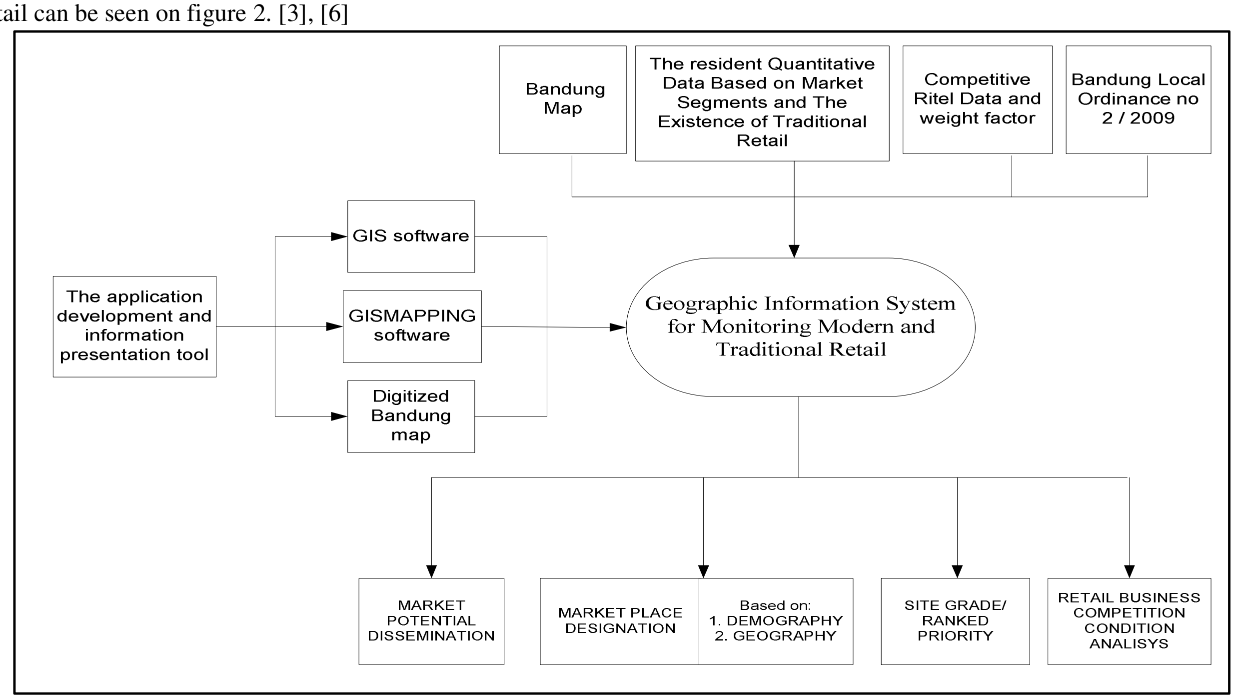

Fig 2. Conceptual Model

4. Data output

   This sub system generates and presents the output in part or the whole database in the forms of table, charts, map, etc. The end result can be used for further analysis or for the supporting of decision making process.
   - Site identification and grouping that become the market target based on the parameters of demography, geography and other factors such as transportation access, the access ease in entering retail site, the short distance to the supplier and also the existing competitive business condition, particularly the existence of traditional market and retail.
   - The market potential dissemination map based on the parameters of demography and geography.
   - The designation of retail location based on the consideration of ensuring the continuity of both the modern retail and traditional retail.
   - The analysis and evaluation medium of modern marketplace/retail in relation to the existence of traditional market /retail.

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IV. RESEARCH METHODOLOGY

In Figure 3, it shows that there are six stages in designing monitoring traditional retail and modern retail in Bandung using geographic information system. The brief review of every stage is elaborated as follows:

The first stage is preparation comprising problem identification and determining the objective of application design. The second stage is system analysis covering identification, output identification, hardware and software identification, and user identification. User identification for this application involves several parties namely: the city government and local government, Indonesia Retail Trader Association (Asosiasi Pengusaha Ritel Indonesia-Aprindo), The Business competition supervision commission (Komisi Pengawas Persaingan Usaha-KPPU), dan Indonesia Market Trader Association (Asosiasi Pedagang Pasar Seluruh Indonesia -APPSI).

The third stage is conducting data collection. In this stage, the data collected covers spatial data and attribute data. The design of Geographic Information System covers the composing components namely input, process and output. Input component represents attribute data and spatial data which are the information required. spatial data constitutes data representing spatial aspects of geographical phenomenon. Spatial data consists of existing tradisional retail, existing layered modern retail, housing layer, and other layers that accomodate all Bandung local ordinance. Meanwhile, Attribute data consists of relevant data and information on retail business establishment site, in this case relating to the marketing components (demography, geography and competition) and the existence of traditional retail.

The fourth stage is data processing and application design. The software utilized are MapInfo and development tools to build application by using Visual Basic. The application design stage covers system design and database design.

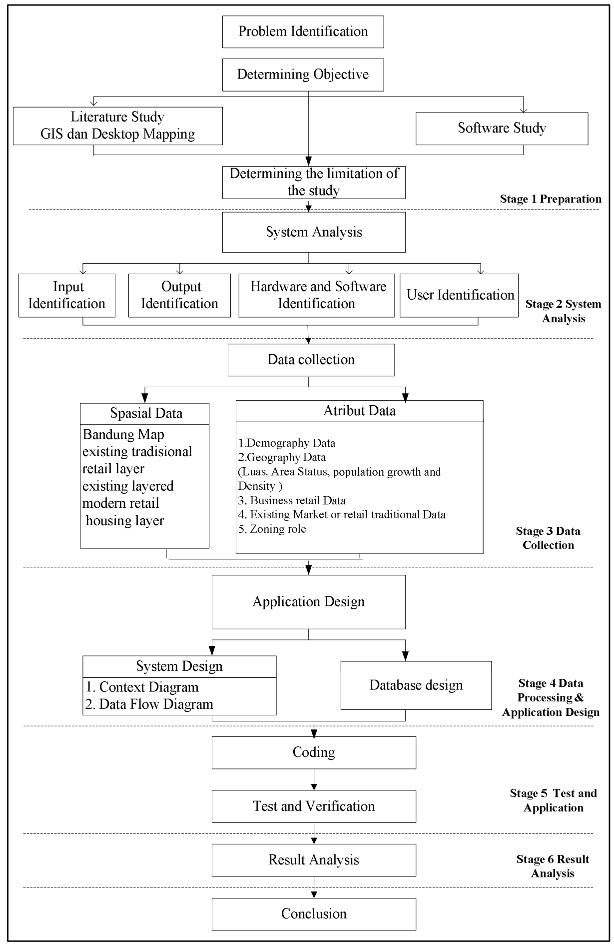

Fig 3. Design GIS Monitoring Stages

The system design is elaborated in context diagram it can be seen on figure 4 and data flow diagram level 1 can be seen on figure 5.

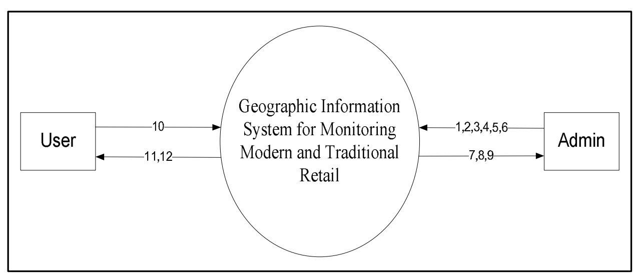

Fig 4. Context Diagram [5]

The entity that hold importance in the designed geographic information system are admin and user with the following data flow:

1. Bandung map
2. Demographic and geographic map

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3. Demography and geography data
4. Competitive retail business data
5. Modern retail zoning radius limit data
6. Historical data of traditional market
7. Spatial database
8. Attribute database
9. Classification table
10. Location, classification, modern retail potential
11. The limited zone area location of modern retail
12. Area potential information

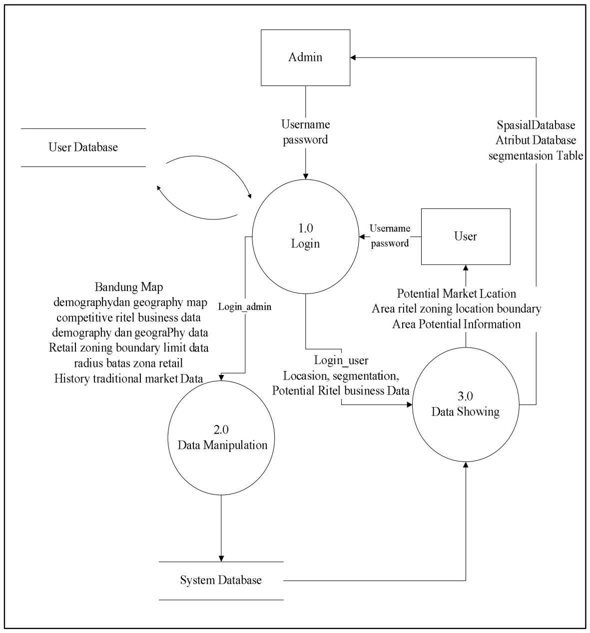

Fig 5. Data Flow Diagram level 1. [5]

Testing and Verification

In fifth stage, testing and verfication are performed for every user depending upon the need of information support for decision making. In this stage, the compatibility needed by every user can be seen, so that when there is incompatibility, verfication process can be done immediately.

The last stage is the analysis of design result. In this stage, it is expected that :

1. The system is capable of conducting location or area search and display it based on demographic and geographic classification.
2. The system is capable of conducting location/area search and display it based on retail zone area that has determined.
3. The system is capable of visualizing gegraphical object in the form of website based vector, so that the system display can be set to be dragged, make it smaller or bigger.
4. The system is capable of displaying the rank of location priority based on the highest quantitative level.
5. The system ability that enables the user to set the layer.
6. This information system can serve as analysis and evaluation tools of the location of modern retail and traditional retail.
7. Entity identification:
   - *The system User* inovolves the whole retail business actor both in micro and macro scale that require the data on market classification and area potential in Bandung that is integrated.
   - *Admin* is the party who holds interest concerning the continuity of retail business.
8. The main reference in regulating retail area zone is Bandung local ordinance number 02/2009 on the arrangements of traditional market, shopping center and modern store.

V. Conclusion

1. The development stage of this application is on application design level. Further stages are required to reach application building so that the objective of the application can be experienced by every user.
2. The application of this geographical information system can serve as assisting tool to support decision making in determining potential market location, modern retail business expansion location by remain ensuring the continuity of traditional retail business and market.

Suggestion

1. The update process of demographic and geographic data has to be done regularly with maximum of once year to ensure that the system database is as accurate as possible so that the result of location designation meets the reality.
2. Classified variable used in determining market location is only in terms of demography and geography, therefore, further development can add extensive variables.
3. The scope of the system is currently limited to Bandung city, therefore, further development of the scope of the system can use other cities in Indonesia.

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ISBN : 978-602-97809-0-1

Development Of Knowledge Management Web Portal For Data And Information On Coastal Areas Using Semantic Approach

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***Abstract*— There are many ways to represent data and information in a coastal area in the region, one of which is to create a portal to access data and information. With the variety of information will require a lot of applications to access it without the underlying knowledge base. Within the framework of a knowledge is very important to integrate giving rise to a paradigm that is more efficient in an information system not only for sequential data access always without the knowledge base. Derived from the data is processed into information and generate knowledge. With this method the quality of information can be improved by identifying, creating and to update the information needed both for governments and for public consumption. Technology for web portal is used to facilitate access to information, because in addition to the role of the machine / computer as a tool not only as a static tool but is more readable or understandable by the assumption that computers understand is meant by the user by applying the method of Intelligent search. In this paper will discuss how the development of knowlwedge management using web portal using semantic approach. Derived from the metadata and then making taxonomic categories to a document containing structured and unstructured information retrieval layer and the metadata group of interconnected.**

***Keywords*— Knowledge Management, semantic web, coastal areas, metadata, RDF, ontology.**

I. Introduction

With the increasing number of population and intensity of development and the fact that natural resources on land (such as forests, farmland) and minerals continue to attenuate or difficult to be developed, then the coastal and marine resources will be the cornerstone of hope for the sustainability of national economic development in the future . However, when compared to its potential, coastal and marine resources are still untapped optimally because of national development policy has been more oriented to the area of land. In addition to the potential of abundant natural wealth, most of the coastal zone is a place of exchange of the flow of goods and services that are an important means to support national economic development. Similarly, the existence of the outermost islands bordering the neighboring countries, is the front page that has a very strategic position in maintaining the territorial integrity of the Unitary Republic of Indonesia. Generally found problems often occur at border areas generally include:

1) Yet he emphasized administrative boundary line between states border the border in several locations;
2) Still the prominence of security issues, especially the passer-limits and illegal trade,
3) Still weak field of counseling and information on social, economic, defense, border security to the public;
4) Handling of border areas has not synergistic, both inter as well as between governments, civil society and business world;
5) Still the weak control of space utilization in the border region;
6) still weak institutional capacity of spatial planning in border areas;
7) Still lack the understanding of spatial planning authorities in the administration;
8) Basic social services is still low;
9) It is not optimum utilization of local economic potential due to limited infrastructure, facilities, and information;
10) Problem of poverty;
11) The limited infrastructure in the border area;
12) definition problems (governance);
13) Social disparity between local community with neighboring communities, as well as
14) Limited access to technology for border communities can utilize local natural resources sustainability.

Of the many problems that were found in Indonesia, the coastal region, a comprehensive information management is the need to sort through the information into knowledge base and forwarded to the grouping information using ontology and implemented in the semantic web.

Aim of this application is: As a medium that provides the facilities and infrastructure based on the knowledge base to deliver one of the utilization of communication and information technologies for coastal areas, helping to make the economic potential as well as the more advanced areas to enhance the quality of the information.

II. Knowledge Management Technology For Coastal Areas

Despite its explosive growth over the last decade, the Web remains essentially a tool to allow humans to access information. The Semantic Web will extend the web's capability through the increased availability of machine-processable information. Currently, Web-based information is based primarily on documents written in HTML, a language useful for describing the visual presentation of Web pages through a browser. HTML and today's Web, however, offer only very limited ways of describing the content itself. So, for example, you can specify that a given string should be displayed in a large bold font but you cannot specify that the string represents a product code or a product price. Semantic Web Technology aims to address this shortcoming using the descriptive languages RDF and OWL, and the data-centric, customizable markup language XML. These technologies, which are standards of the W3C1 (WorldWideWeb Consortium), allow rich descriptions of the content of Web documents. These machine-processable descriptions in turn allow more intelligent software systems to be written, automating the analysis and exploitation of Web-based information.

In fact, the coastal areas in Indonesia has a very abundant natural resources, many applications in use to exploit those natural resources, such as how to cultivate the rare fish, the way of mining tin ore with waste minimization, application of crab fishing, the empowerment of society through the application of biotechnology and more others. but in making such applications if the stored information will be collected a vast knowledge base. therefore to manage these separate knowledge base, made an application that can integrate them through a knowledge management portal.

A. *Knowledge Management Concept*

In most people exchanging meaning between "information" and "knowledge". Whereas in this knowledge has very different meanings, in many ways the expert distinguish between data and information, the image can be viewed as following:

Data is a collection of facts and quantitative measures that lie outside a context, where people can represent a conclusion. Data represents the smallest unit of value.

Information is data that has been translated and has complied with terms of a relationship between context and interpretation of data such as reports, documents, strategic plans, and others.

Knowledge is the people who understand and react to the use of information, both individually and organizations.

- **Tacit Knowledge** is a subconscious reaction is understood about the information on the adoption based on experience, usually delivered through an informal conversation and share experiences Knowledge
- **Explicit** more formal form of delivery of information developed from the original context.

In the formation of the knowledge base for coastal areas, fish breeding techniques of matter, how tin mining can be assumed as tacit Knowledge and presented in special form so that becomes something successor for making future decisions. In this case the people / teachers are data processing centers are converted into information. So to manage the knowledge required to process the human role is not submitted to the system, to obtain knowledge that represents information in these though. data, information, knowledge is some form of separate, but linked using the concept. At the smallest level of data is a representation of simple shapes that do not yet have meaning then collected and grouped. While the information is data that has been summarized and analysed and synthesis. At the peak of the pyramid is concluded that Knowledge is a container for decision making.

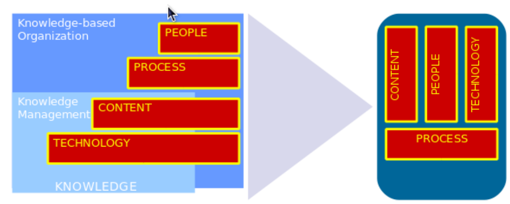

Fig. 1 Framework of KM operation

Based on the empirical knowledge, such following Knowledge Management Operational Framework will fit to the coastal areas and related communities needs, especially in their initial stage of Knowledge Management implementation. When the Knowledge Management practices in the communities reach their maturity, such framework will be a solid foundation to scale up the Knowledge Management operation to the next level.

B. *Knowlegbase Metadata*

The main focus of Knowledge base for coastal areas was on providing the necessary infrastructure for scalable automatic extraction of named entity (NE) references and descriptions, including attributes and relations, from text in structure and unstructure documents . We call both the process and the result semantic annotation. Ontologies and factual background knowledge (held in a semantic repository) are used for analysis of text, implemented as information extraction (IE) application. The outcome is twofold:

- Extension of the semantic repository with structured data, extracted from the text;
- Generation of annotations (metadata) that link the text with the repository.

ISBN : 978-602-97809-0-1

Figure 1 presents the interlinking between the text and the data; each annotation contains an identifier of entity, described in the semantic repository. SWKM (Semantic Web Knowledge Management) recognizes both known and unknown NE, instances of predetermined classes, as well as attributes and relationships between them. In addition to the NE, SWKM (Semantic Web for Knowledge Management) is also extracting and annotating key-phrases, found to be statistically characteristic for the document. Application is designed to be able to take advantage of pre-existing structured data and inference – the text-mining algorithms are initialized from a semantic repository, which can handle large amounts of instance data. A major task in the process of semantic annotation is called identity resolution: to find whether a particular NE reference denotes an already known NE in the repository and which one. In case the reference has no match in the repository, a new entity description is created and stored in the ontology. As a result of the text analysis, and can also extend the descriptions of known entities by means of finding new attribute values and relationships

III. Methodology

A. *Model Knowledge Management Framework for Coastal Area*

In this paper, paper models or paper taken with regard to coastal areas. First is the integration model based on the topic, this model adopts elements of the phenomenon that occurs in community activities in the associate with a variety of disciplines such as examples of 'community participation in managing marine' which connect with the various phenomena that occur in society such as local communities, civil society institutions and organization of fishermen, fish Entrepreneur, conflicts among stakeholders and managers. Given the links that integrate the information then can be scaled back form of ontology matching with this model. Community participation in managing the marine is a class (category), local community, civil society institutions and organizations of fishermen, fish Entrepreneur, conflicts among stakeholders and managers is a subclass (sub categories), while the Doc (document) is a value or instant. Other classes may be defined in accordance with the topic issues that will become the knowledge base.

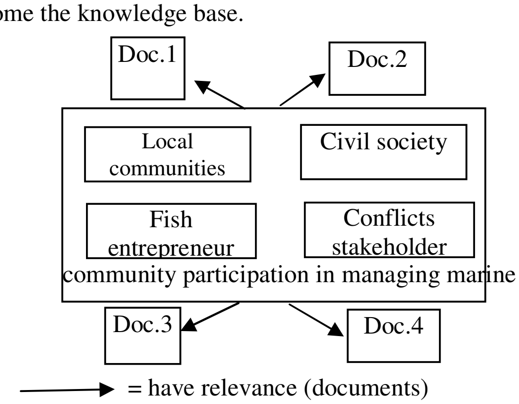

Fig. 2 Integration Model Base on Topic

Second is the integration model based on the main potential, this model is analyzed based on the major potential of a problem as an example of 'potential areas of Bangka Belitung Nature', in a concept of knowledge being developed within the potential area of Bangka Belitung is examined and evaluated from natural factors, historical chronology and causality, as well as public behavior towards nature. With this potential, the local community in addition to understanding the area of Bangka Belitung is also well understand the potential areas that can be viewed from various disciplines. In this model for defining ontologies with an emphasis on power-related elements, namely classes, subclasses and properties[2].

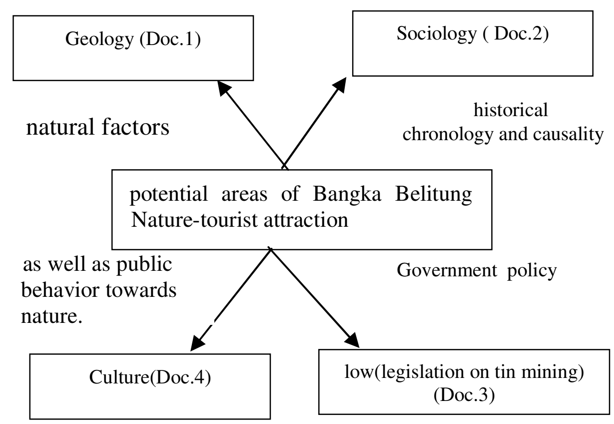

Fig. 3 Integration ontology model base on main potential

In the concept of plain text can be defined by having the class model of integration based on the main potential, while a subclass is a branch of the science group or category is associated with the document in question from every discipline-related knowledge in this instance has the properties of natural factors (the potential tourist attraction) with values, in the model, the division of class (category) and sub class (sub categories) can be seen as below:

class-of defined
    potential areas of Bangka Belitung Nature-tourist attraction
subclass-of Culture
value-type Doc.4 (chapter1_bangka _belitung_culture_history)
OR (**subclass-of** *is-part-of* **has-value** Doc.4 (chapter1_bangka _belitung_culture_history))

subclass-of Geology
value-type Doc.1(chapter3_volcanic _formation)
OR (**subclass-of** *is-part-of* **has-value** Doc.1(chapter3_volcanic _formation))

subclass-of Sociology
value-type Doc.2(chapter6_Indonesian_cultural_diversity)
OR (**subclass-of** *is-part-of* **has-value** Doc.2(chapter6_Indonesian_cultural_diversity)

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subclass-of Low
value-type
Doc.3(chapter3_;egislation on tin mining)
OR (**subclass-of** *is-part-of* **has-value**
Doc.3(chapter3_;egislation on tin mining)

B. Web Portal Language for Coastal Areas Using Semantic

Today, web portal language often be developed using the integrated, graphical, PHP Script, Java, Ontology, and AJAX Technology. All devices used to create / design a new structure that can be updated. In this case the ontology makers better known as the author makes a design concept. The language in the select is OWL (Web Ontology Language) and then into RDF / RDFS that can be accessed using HTML or Plain Text. The ontology is structure of concept :

```
<?xml version="1.0"?>
<rdf:RDF
   xmlns:xsp="http://www.owl-
ontologies.com/2005/08/07/xsp.owl#"
   xmlns:swrlb="http://www.w3.org/2003/11/swrlb#"
   xmlns:swrl="http://www.w3.org/2003/11/swrl#"

xmlns:protege="http://protege.stanford.edu/plugins/owl/prote
ge#"
   xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
   xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
   xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
   xmlns="http://www.owl-
ontologies.com/Ontology1246275230.owl#"
   xmlns:owl="http://www.w3.org/2002/07/owl#"
  xml:base="http://www.owl-
ontologies.com/Ontology1246275230.owl">
  <owl:Ontology rdf:about=""/>
  <owl:Class rdf:ID="Potential_Areas_of_Bangka_Belitung"/>
  <owl:Class rdf:ID="Geology">
    <rdfs:subClassOf
rdf:ID="Potential_Areas_of_Bangka_Belitung"/>
  </owl:Class>
  <owl:Class rdf:ID="Culture">
    <rdfs:subClassOf
rdf:ID="Potential_Areas_of_Bangka_Belitung"/>
  </owl:Class>
  <owl:Class rdf:ID="Sociology">
    <rdfs:subClassOf
rdf:ID="Potential_Areas_of_Bangka_Belitung"/>
  </owl:Class>
  <owl:Class rdf:ID="Low">
    <rdfs:subClassOf
rdf:ID="Potential_Areas_of_Bangka_Belitung"/>
  </owl:Class>
  <owl:ObjectProperty rdf:ID="NaturalFactors">
    <rdfs:domain rdf:resource="#Geology"/>
  </owl:ObjectProperty>
  <owl:ObjectProperty
rdf:ID="AsWellAsPublicBehaviorTowardsNature">
    <rdfs:domain rdf:resource="#Culture"/>
  </owl:ObjectProperty>
  <owl:ObjectProperty
rdf:ID="HistoricalChronologyAndCausality">
    <rdfs:domain rdf:resource="#Sociology"/>
  </owl:ObjectProperty>
  <owl:ObjectProperty rdf:ID="GovernmentPolicy">
    <rdfs:domain rdf:resource="#Low"/>
  </owl:ObjectProperty>
</rdf:RDF>

        <!-- Created with Protege (with OWL Plugin 3.4, Build
533)  http://protege.stanford.edu -->
```

The sample script above is defined that the class ontology refers to a URI which addresses the declared using the ID. Resource here as its placement within the ontology that consists of class - class that represents. A knowledge representation in the output into a framework that will serve as the reference metadata / RDF on creating semantic web portals. One of the specific methods which need to be considered at the high level of semantic web services are in need of an ontology. Machine-readable is a service that can translate the logical point of view of ontology representation. Services are performed has the capability, the ability of the interface that can be done automatically.

IV. IMPLEMENTATION

In the knowledge base for coastal areas as well as scientific publications related to its representation of coastal areas must contain metadata publish attach data, such as the URI identifying the writer / author and license information. This should be recorded as a description of information resources and RDF can describe the non-information resource, that is the subject of RDF triples URI. For resource information allows users to use the data we publish with the provisions that have been clearly defined, each RDF document must contain the license in which content can be used. This is done to enhance and enable users publishing assess the quality of data, to determine whether the user wants to trust the data in publishing, data should be accompanied by meta-information about both the author (author), date created and methods of the author. At first the meta-information can be given by using the Dublin Core or the term Semantic Web Publishing with other vocabularies. Open Provenance Model gives the term to describe the data transformation workflow. In order to support users in selecting the most efficient way to access data on the web, to be followed by the addition of a specific method to do that is a useful addition interlink can provide additional technical data as metadata and relationships interlinkage with other data sets: The Semantic Web Crawling sitemap extension.

ISBN : 978-602-97809-0-1

```
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
        xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
        xmlns:foaf="http://xmlns.com/foaf/0.1/">
  <rdf:Description
rdf:about="urn:lsid:www.sw.informatika.lipi.go.id:concept:substance">
      <rdfs:label>Substance</rdfs:label>
      <rdfs:comment>Scientific Publications for the coastal areas</rdfs:comment>
      <rdfs:comment>This is a knowledge base for Scientific Publications of the coastal area ..!</rdfs:comment>
      <rdf:type

rdf:resource="http://sw.informatika.lipi.go.id/ROOT/CoastalAreas#Potensial_Area_for_Bangka_Belitung"/>
     <rdfs:seeAlso

rdf:resource="http://ckc.informatika.lip.go.id/HP3/HP3.rdf "/>
      <foaf:page

rdf:resource="http://online.informatika.lipi.go.id/analyzer/potentialarea"/>
       </rdf:Description>
```

On the part of the code above, we use foaf vocabulary, which reflects that the document is published to become a knowledge has author, title, year published, and the number of pages from papers published.

Script excerpt above is part of the design of Semantic Knowledge Management application designed data. ***xmlns: rdf = "http://www.w3.org/1999/02/22-rdf-syntax- #" xmlns: rdfs = "http://www.w3.org/2000/01/rdf-schema # "*** represents syntax in the writing of tags that use the rdf and rdf schema. While *xmlns: foaf = "http://xmlns.com/foaf/0.1/* is the vocabulary used, in this case is foaf (friend of friend). ***<Rdf: Description rdf: about =" urn: lsid: www. sw.informatika.lipi.go.id: concept: substance ">*** is a description that uses the description protocol urn with naming. ***<rdf: resource =" # http://sw.informatika.lipi.go.id/ROOT/CoatalAreas#Potensial_Areas_for_Bangka_Belitung" />*** is a URI-based data linked references which describe the resource and has the reference ***#Potensial_Areas_for_Bangka_Belitung***. While the rdf: resource = ***"http://ckc.informatika.lip.go.id/HP3/HP3.rdf" />*** <foaf: page rdf : resource = "http://online. informatics. lipi.go.id / analyzer / potentialarea "/> is an absolute URI that leads directly to the metadata

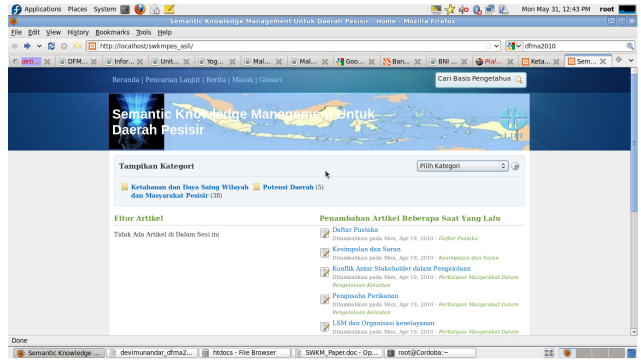

Fig. 4 Application Interface Knowledge Management for Coastal Areas

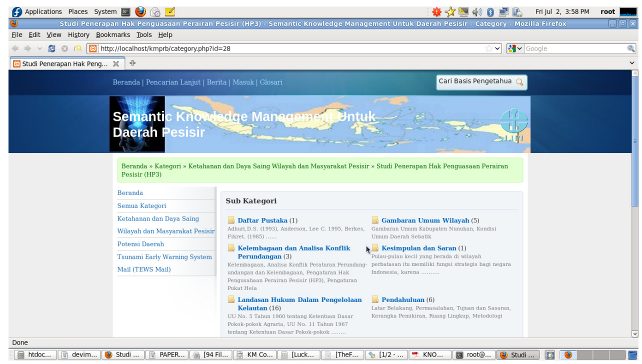

Fig. 4 Categories and Sub Categories for Knowledgebase

V. CONCLUSIONS

In the representation of data and information more intelligently to the coastal areas in a structured knowledge base needed by dividing the knowledge base into categories that more was known by the Class. Class has a subclass and property that was assembled into an Ontology

Ontology is the basic structure for creating semantic web applications. After defining ontologies, metadata created by converting the data in the form of the value of structured documents and unstructured documents to produce RDF format (Resource Description Framework). Through the search interface is made search engine to search for coastal areas Knowledgebase. Semantic Knowledge management for coastal areas is a breakthrough that is needed for regional development and local coastal areas on the Indonesian border to enhance the potential of these areas by adopting a Knowledge Management using semantic web technologies. on future developments, we will attempt deeper semantic technology to integrate them using a data link.

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ISBN : 978-602-97809-0-1

Review on cross cultural studies in cognitive ability: implication for Indonesian context

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Abstract **– Culture play an important role on human cognitive ability. This paper aims to review literature on differences in cognitive ability between cultures. Numbers of example of those differences were described. Later on, the implication of the literature review in Indonesia research context will be discussed.**

Keywords **— cognitive, ability, culture**

I. Introduction

There are various definitions about culture. Hofstede [8] defined culture as collective mental programming that affect how people behave in their daily life. Triandis [14] defined culture as "a set of human made objective and subjective elements that in the past have increased the probability of survival, resulted in satisfaction for the participants in a ecological niche, and thus become shared among those who communicate with each other because they had a common language and lived the same time-place" (p.219).

There is an absence of agreement about definition of culture and the best approach to investigate culture effects on behaviors. However, previous research has investigated work attitudes, leadership styles, and managerial behaviors related to culture [3], [9].

Discussing culture, a lot of researchers make a dichotomy of eastern and western culture in various different views. Eastern culture refers to Asian countries (Singapore is an exceptional) and some of developing countries in other region. Furthermore, the latest culture, western culture, refers to mostly English speaking countries and or developed countries (i.e. European countries, USA).

Eastern culture is characterized by those following value: live in time, value rest, passive, contemplative, accept what is, live in nature, want to know meaning, freedom of silence, lapse into meditation, marry first then love, love is mute, focus on self-abnegation, learn to do with less, ideal – love of life, honor austerity, wealth & poverty – results of fortune, cherish wisdom of years, retire to enjoy the gift of your family.

On the other hand, western culture is characterized by: live in space, value activity, assertive, diligent, seek change, live with nature, want to know how it works, freedom of speech, strive for articulation, love first then marry, love is vocal, focus on self-assuredness, attempt to get some more, ideal – being successful, honor achievement, wealth/poverty is a results of enterprise, cherish vitality of youth, retire to enjoy the rewards of your work (www.lcsedu.net).

Hall [7] differentiated eastern and western culture as fllows : western culture tend to do one thing at a time, concentrate on the job, take time commitments (deadlines, schedules) seriously, adhere to plans, are concerned about not disturbing others; follow rules of privacy and consideration, show great respect for private property; seldom borrow or lend, emphasize promptness, are accustomed to short-term relationships. Members of eastern cultures tend to do many things at once, are highly distractible and subject to attending to interruptions before the issue at hand, focus on an objective to be achieved, but may not be concerned about creating plans to achieve it, are committed to people and human relationships, change plans often and easily, are more concerned with those who are closely related (family, friends, close business associates) than with privacy, borrow and lend things often and easily base promptness on the relationship, have a strong tendency to build lifetime relationships.

Different culture (and also religion) has been already considered in human factors research area, such as in product design. To refresh our memory, several years ago, one of shoes manufacturer made a controversial issue by unintentionally put a picture design on the shoes, which was similar with the name of god in one religion.

Figure 1. Controversial design without considering culture and /or religion.

Another example of cultural consideration in design product is the development of web design [17]. Different web design was applied for east culture which is famous of high context culture (communication to be indirect, ambiguous, maintaining of harmony, reserved and understated) and west

ISBN : 978-602-97809-0-1

culture with low context characteristic (communication was identified as direct, precise, dramatic, open, and based on feelings or true intentions) [6].

Figure 2. Collection of scandinavian sites (upper panel) and asian sites (lower pannel)
(Source : http://jcmc.indiana.edu)

The above mentioned facts raising questions, what is a role of culture on cognitive ability? There are many reasons that culture plays an important role of cognitive ability of human.

Cognition/cognitive is often understood as the act of knowing, and cognitive psychology is the study of all human activities related to knowledge. Those activities include attention, creativity, memory, perception, problem solving, thinking, and the use of language.

Until about 1970 the cognitive approach had little impact outside the experimental laboratory. In the years since then, however, various cognitive theories of personality have been developed, as well as information-processing analyses of intelligence tests and a number of cognitively oriented therapies.

II. Differences in Cognitive Ability

Cultural differences effects on cognitive ability and behaviors have been studied with almost the same common terms: between east and west culture.

As an example, there are cultural differences in adaptation of communication style between American and Chinese [15]. In Wang's study, the influences of individual cultural backgrounds (American versus Chinese), the composition of groups (same- versus mixed-culture groups) on group brainstorming conversations were investigated. Wang reported cultural differences and adaptation in conversational talkativeness and responsiveness. Working in a mixed-culture group also led to cultural adaptation, for example, the communication style of Chinese.

There were also cultural differences in perceptual judgment and memory. Western people are giving more attention to objects that is large, colorful, and fast moving object than to background of object. Western people also analyze object's attributes and assign them to the categories. On the other hand, East Asians people attend more to contextual information and make judgment based on relationship and similarities [11]. In Masuda's study, Japanese reported 60% more information about the background (e.g., rocks, color of water, small non-moving objects) than American participants. In that study, the participants also viewed picture containing an animal with natural background. When instructed to detect the animal in its original background, both American and Japanese group equally accurate in. However, when the background is change and new as well, Japanese is less accurate than American is. Possible explanation is that the Japanese binding information about the animals with the background, so that unfamiliar background affected the retrieval of animal.

Another study, conducted by Boduroglu, et al [2] reveal cultural differences in attention allocation. This study demonstrate that East Asian (Japanese, Taiwan, China, South Korea) are better than American at detecting color changes when a layout of a set of color blocks is expanded to wider region, and on the other way around, worse when it is reduced in size.

There is an also cultural difference in facial emotion perception between Americans and Japanese [11]. Japanese tend to incorporate information from the social context more than American do. When instructed to judge other facial emotions, Japanese' judgment is influenced by the surrounding people's emotions. This result supported by eye tracker study, Japanese look at the surrounding more than Americans do. Concerning social context, western people see emotion as individual feelings, while Japanese see individual feelings as indivisible from the group' feelings.

In the analytic vs. holistic thought, western people tend to explain events in terms that refer primarily or entirely to salient objects or people. In contrast, East Asians people are more inclined to explain events in terms of contextual factors or holistic term [5].

Recent review by Ambady & Jamshed [1] examined how culture affects neural activation. In their review, Ambady explain several studies support their premise about relation between culture and neural activation. Differences in how Americans and Indians perceive music and the mapping result in the brain were discussed [4]. Study by Tang et al. [13] examined different brain activity of native English and native Chinese speakers while performing three numerical tasks and a non-numerical task was discussed as well. Native English speakers showed more activation in the area of brain associated with language processing. In contrast, Native

Chinese speakers showed more activation in visual-spatial processing and functions closely tied to cognitive functioning during the numerical tasks.

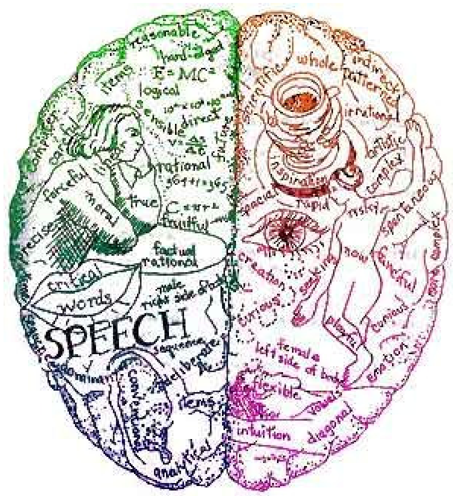

Figure 3. Different area of brain with different function (Source: www.google.nl/imgres)

In the context of individualism and collectivism, researcher from MIT studied cultural differences in judgment between American (as representatives of western culture which is high in individualism) and East Asian (as representatives of eastern culture which is high in collectivism). Although performance between the two groups was not differing, Americans were more accurate on absolute judgment, and East Asians on relative judgments. FMRI data support the result, as can be seen in figure 4.

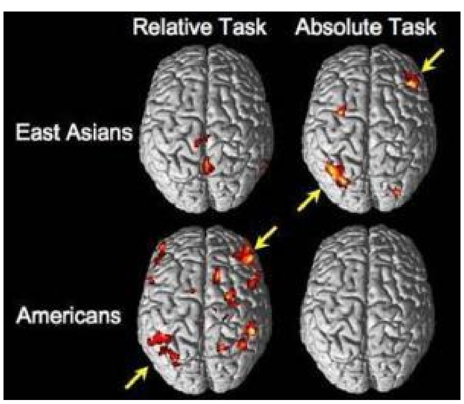

Figure 4. Brain activity in East Asians and Americans as they make relative and absolute judgments (Source : http://www.sciencedaily.com)

The knowledge about different cognitive ability on different culture strengthen the issue of human centered design and customized design based on human characteristic which is unique upon culture. On health care area, this knowledge also gives obvious evidence to implement different cure for same illness on different culture. In business area, the knowledge about different cognitive ability will fostering mutual understanding between culture, as well as anticipation strategies when dealing with cultural differences.

III. What about Indonesia?

All researches mentioned above mostly mentioned East Asian (in this case: China and Japan), as one party that involve in cross cultural studies of cognitive ability.

Those mentioned facts above raising new questions, what about Indonesia? Research in cognitive area is very limited in Indonesia, or we can say scarce in this matter. This scarcity might be caused by little interest among academics, limitation of equipments and tools available in Indonesia, and the list goes on.

Lack of cooperation with international colleague and international institution is other substantial problem in Indonesia. There are many reasons to say Indonesian might be differing with other cultures in cognitive ability. With more than 200 millions Indonesian citizen, who holds 5th position of greatest populations in the world, international cooperation must be started as soon as possible. One preliminary study by Widyanti et al. [16] comparing cognitive ability between Indonesian and Dutch participants reveal differences between two groups on single and dual task. This preliminary result support the idea of importance of joint research in cognitive ability between Indonesian and other western countries, to see underlying facts about the possible difference(s).

IV. Conclusions

Differences in cognitive ability exist between cultures. Knowledge about this fact may lead to further research about possible cognitive ability difference between Indonesia and other countries and or other ethnicity.

Differences on cognitive ability influenced many aspects of daily life, including product design and job activities. Basic principle of product and services design, "human centered design", will be fulfilled by considering different cognitive ability relates to cultural context.

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ISBN : 978-602-97809-0-1

Application of Data Mining to Determine the Most Influenced Item to Design Discount Price Strategy

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***Abstract*-The growth of economic in one territory is often recognized by increasing of retailers quantity both in big or small scale, which will definitely cause fiercer competitive among them. One of the powerful strategies in winning competition is price strategy. The aim of this research is to design of pricing strategy that will help to strengthen company's competitiveness. To solve problem attached, data mining approach using market basket analysis will be employed, this method will classify selling transaction in specific data base then with association rules the trend of business pattern could be notified. The result of this research will generate a decision support system that could advise the information about which superior product that has immense influence towards the purchasing of other products, so it could be considered to be labeled for right price strategy.**

I. Introduction

Background

Data is a fact that haven't proceed and have no added value (Santoso, 2007).Whereas information is a data or a fact that have been proceed by means of certain process that have added value and give an understandable knowledge (Djunaidy and Soelaiman, 2001). Information technology development in 1990 have allow data in an accumulated quantity (Koh and Low, 2004).

But the rapid growth of data accumulation creates a condition of having rich data but less information. Because that data collected are unuseable for some applications (Pramudiono, 2003).

In Enterprises area especially for retail, the owner company or mini market that sales database from customers purchasing activity is only used as sales report. In fact, sales database could give a lot of information. That information describes a group of item that preferable of being purchased by customers in a retail within a single purchasing transaction.

For example, customers prefere to buy item B if purchase item A or the other way. This knowledge is called as basic event. Whereas customers behavior for certain action such doing purchasement of some item is called as target event (Annisa et. al., 2007).

Data mining is an data processing approach that produce useable information for certain case. One of data mining method is MBA. The MBA data mining is new method that arose from customers purchasing behaviour when purchase more than one item (Boztuˇg and Hildebarant, 2005). The aim of this method is to determinethe association relationship between item that being purchased in the same time.

Djunaidy and Soelaiman (2001) have been conduct a research of MBA that investigate the association pattern in based data by using graf association, however the weakness of this method is in data processing with huge memory. Memory restrictiveness influences the proceed data of item so it need a long computation.

Santoso (2003) used apriori method to find the association pattern in his research. This apriori method uses candidate generation and test paradigm. In this research, apriori method is fixed the previous method that is graf association. Computation for getting the association theorem could be reduced, but the apriori method have a tendency of being focused in the relationship between item in all transaction without observating the relationship each item in each transaction. The research by Budhi et.al (2005),

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mentioned that Fuzzy c-Covering based on perception of greater item that being purchased in a transaction could deboilitate the relationship between item in that transaction. the association level between item could be known by using the output of association rule to support the manager in deciding the marketing policy. Smaller support minimum and confidence that being determined, contributes to greater number of rules that being produced and it needs greater time processing. Besides that, the greater number of combination that being analyze, contributes to smaller time processing.

Whereas the weakness of the research that being conducted by Budhi et.al. (2005) is the association rules pattern is not developed to be pricing strategy. According to Sucahyo (2003), data mining could be applied to determine the right pricing strategy by using association rules.

The aim of this research is to determine the item that influences the design of pricing strategy by using MBA method based on ordinary customers purchasing pattern with Fuzzy c-Covering as new method.

II. Literatur Review

1. Knowledge Discovery in Database

   Knowledge Discovery in Database (KDD) is a systematic process to find and to identify a pattern in data that have the characteristics of legal, new, useable and understandable.

   According to Fayyad et.al, 1996, there are some phases in KDD process, that are:
   1. Choosing the data
   2. Preprocessing
   3. Data transformation
   4. Data mining
   5. Pattern evaluation

2. Data Mining

   According to Han and Kamber (2001), Data mining is a process to find method for data mining so the previous information that not known could be presented in this method. It can be concluded that data mining is the analysis of data to find the relationship of data and making undestanable conclussion from that data. Some methods in data mining are Clustering, MBA, classification and prediction.

3. Market Basket Analysis

   MBA is one of data mining method to find some products that often being purchased in the same transaction (Boztu˘g and Hildebrant, 2005). Association rule mining is a procedure to find the association rules between an item combination. The importance rating of association rules could be known with the basis methodology of association analysis, that are:

   Support is percent of item combination in database that could be calculated with this formula:

$$Support = P(A \cap B) = \frac{\text{The number of transactions That contain A and B}}{\text{The total number of transactions}}$$

   Confidence is the size that describes the relationship between two items conditionally (for example, item B is being purchased if the customers buy item A).

$$\text{Confidence} = P(B/A) = \frac{\text{Support}\,(A \cap B)}{P\,(A)}$$

4. Fuzzy c-Covering

   Fuzzy c-covering is one method that uses to find the correlation between items. The assumption is the more items bought, the weaker the correlation between those items. (Budhi et.al, 2005).

III. Research Method

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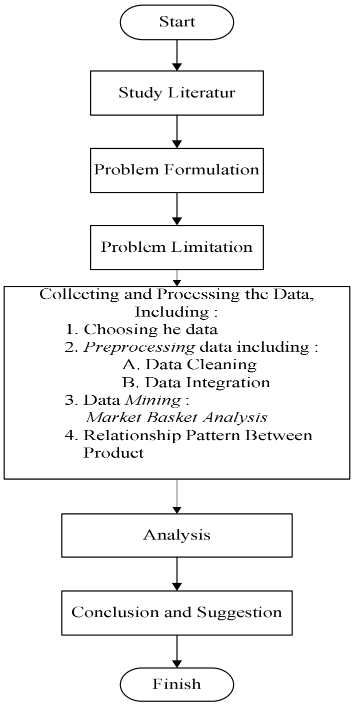

IV. Discussion and Analysis

The data used is a database of sales transactions in Larisma Swalayan Yogyakarta on its supermarket. An example of stage in KDD is presented in appendix 1.

The next stage is the application of Fuzzy c-Covering method in data mining.

Table 4 Transaction

Transaction Code	Item
1	I1, I2, I5
2	I2, I4
3	I2, I3
4	I1, I2, I4
5	I1, I3
6	I2, I3
7	I1, I3
8	I1, I2, I3, I5
9	I1, I2, I3
10	I1, I2, I4, I6, I7

Suppose max_item_threshold = 4; set k = 1. From Table 4, the transactions which meet max_item_threshold only transactions that have code 1 to 9. So from Table 4, QT = {(I1,I2,I5), (I2,I4), (I2,I3), (I1,I2,I4), (I1,I3), (I2,I3), (I1,I3), (I1,I2,I3,I5), (I1,I2,I3)} and T = {1, 2, 3, 4, 5, 6, 7, 8, 9}.

Then specify the first min_support. Suppose min_support_1 = 0.1 = 10%. Based on the QT, we can see the items that sought their support, namely I1, I2, I3, I4 and I5. Here is how to count support for each item:

$$I1 = \frac{\frac{1}{3}+0+0+\frac{1}{3}+\frac{1}{2}+0+\frac{1}{2}+\frac{1}{4}+\frac{1}{3}}{9} = \frac{1}{4} = 0.25$$

:

:

$$I5 = \frac{\frac{1}{3}+0+0+0+0+0+0+\frac{1}{4}+0}{9} = \frac{7}{108} = 0.065$$

(it does not meet).

From the calculation above, results which meet min_support_1 are I1, I2 and I3. Afterwards, k is set to k=2. Suppose min_support_2 = 9% then is sought the combination of two-item and support from the remaining items:

$$\{I1, I2\} = \frac{\frac{1}{3}+0+0+\frac{1}{3}+0+0+0+\frac{1}{6}+\frac{1}{3}}{9} = \frac{7}{54} = 0.13$$

$$\{I1, I3\} = \frac{0+0+0+0+1+0+1+\frac{1}{6}+\frac{1}{3}}{9} = \frac{5}{18} = 0.28$$

$$\{I2, I3\} = \frac{0+0+1+0+0+1+0+\frac{1}{6}+\frac{1}{3}}{9} = \frac{5}{18} = 0.28$$

As can be seen, all itemset candidates above meet the support (u) ≥ min_support_2, then those all itemset are combined into a combination of 3-itemset. Set k=3 and suppose min_support_3 = 11%, support is then sought as follows:

$$\{I1, I2, I3\} = \frac{0+0+0+0+0+0+0+\frac{1}{4}+1}{9} = \frac{5}{36}$$

$$= 0.139$$

Because of no combination that allows more to meet specified min_ support, then the counting is completed. Afterwards, each item that has been obtained from the steps above, namely I1, I2 and I3, is defined as a fuzzy set to T. For more details, it will be given how to define item I1 as a fuzzy set to T=1 and T=4 as follows:

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$$\mu_{I1}(1) = \frac{\mu_{100}(I1)}{\mu_{100}(I1) + \mu_{100}(I2) + \mu_{100}(I5)} = \frac{\frac{1}{3}}{\frac{1}{3} + \frac{1}{3} + \frac{1}{3}} = \frac{1}{3}$$

$$\mu_{I1}(4) = \frac{\mu_{400}(I1)}{\mu_{400}(I1) + \mu_{400}(I2) + \mu_{400}(I4)} = \frac{\frac{1}{3}}{\frac{1}{3} + \frac{1}{3} + \frac{1}{3}} = \frac{1}{3}$$

Based on calculations above, then item I1, I2 and I3 can be defined as follows:

μ_{I1}={(1/3)/1, (1/3)/4, (1/2)/5, (1/2)/7, (1/4)/8, (1/3)/9}

μ_{I2}={(1/3)/1, (1/2)/2, (1/2)/3, (1/3)/4, (1/2)/6, (1/4)/8, (1/3)/9}

μ_{I3}={(1/2)/3, (1/2)/5, (1/2)/6, (1/2)/7, (1/4)/8, (1/3)/9}

From those items then sought confidence of each k-item combinations that are possible, starting from k = 2.

Two-items combination:

$$confidence(I1 \rightarrow I2) = \frac{\frac{1}{3} + \frac{1}{3} + \frac{1}{4} + \frac{1}{3}}{\frac{9}{4}} = \frac{\frac{5}{4}}{\frac{9}{4}} = \frac{5}{9} = 0.56$$

$= 56\%$

(read: confidence of the rule **if I1 then I2** is amounted to 56%).

$$confidence(I2 \rightarrow I1) = \frac{\frac{1}{3} + \frac{1}{3} + \frac{1}{4} + \frac{1}{3}}{\frac{11}{4}} = \frac{\frac{5}{4}}{\frac{11}{4}} = \frac{5}{11} = 0.455$$

$= 45.5\%$

Based on the above calculation, then the confidence value can be defined as follows:

- *confidence* (I1 → I3) = 70.4%
- *confidence* (I3 → I1) = 61.3%
- *confidence* (I2 → I3) = 57.6%
- *confidence* (I3 → I2) = 61.3%

Three-items combination:

$$confidence(I1 \wedge I2 \rightarrow I3) = \frac{\frac{1}{4} + \frac{1}{3}}{\frac{1}{3} + \frac{1}{3} + \frac{1}{4} + \frac{1}{3}} = \frac{\frac{7}{12}}{\frac{5}{4}} = \frac{7}{15}$$

$= 0.47 = 47\%$

(read: confidence of the rule **if I1 and I2 then I3** is amounted to 47%).

$$confidence(I1 \wedge I3 \rightarrow I2) = \frac{\frac{1}{4} + \frac{1}{3}}{\frac{1}{2} + \frac{1}{2} + \frac{1}{4} + \frac{1}{3}} = \frac{\frac{7}{12}}{\frac{19}{12}} = \frac{7}{19}$$

$= 0.368 = 36.8\%$

Based on the above calculation, then the confidence value can be defined as follows:

- *confidence* (I2^ I3 → I1) = 36.8%
- *confidence* (I1 → I2^ I3) = 25.9%
- *confidence* (I2 → I1^ I3) = 21%
- *confidence* (I3 → I1^ I2) = 22.6%

Confidence value is used to determine which rule is the interesting rule. Suppose the user determines min_confidence = 60%, so-called interesting rule is only the rule that the confidence value ≥ 60%, namely:

if I1 then I3 [support = 28%, confidence = 70.4%],
if I3 then I1 [support = 28%, confidence = 61.3%],
if I3 then I2 [support = 28%, confidence = 61.3%],

The Fuzzy c-Covering method intended to obtain association rules from transaction databases. There are three rules obtained. One example of association rules is as follows:

if I1 then I3

Parameter values of market basket analysis is amounted to 28% support and 70.4% confidence value.

Value of support indicates a combination of items in the database. Confidence value shows the strength of the relationship when a customer buys item A, then will purchase item B in the assosiative rules.

From the rule above, it can be concluded that the items that affect the transaction are item 1, item 2 and item 3. Then the price strategy designed for those three items. The pricing strategy used is skimming method by providing a premium price on three influential items to the point of a specific demand.

V. Conclusion

1. Conclusion
   Based on the results of association rules obtained by the MBA technique using the Fuzzy c-Covering method note number of items that have a tendency to be purchased by customers simultaneously. The pricing strategy will be designed for the items that affect. Items that affect the transaction are item 1, item 2 and item 3. Then the price strategy will be designed for those three items.

2. Suggestion
   By knowing the outcome of this final study, it is expected that Larisma Swalayan could design a pricing strategy based on the found items that affect the transaction.
   For further study, it is also expected to be able to design a pricing strategy by doing expectation calculation and validation test.

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ISBN : 978-602-97809-0-1

Apendix 1

Date	Invoice No.	Goods Code	Goods Name	Quantity	Price	Discount	Net
4/8/2009	JL/2.20090804-01	1	AQUA 600ML	5	1.750	0	8.750
		2	CHOKI CHOKI CHOCOBERRY 12G	1	500	0	500
		5	SEDAAP MIE GORENG 75 G	5	1.250	0	6.250
4/8/2009	JL/2.20090804-02	2	CHOKI CHOKI CHOCOBERRY 12G	1	500	0	500
		4	NABATI RICHS PASTA KEJU	1	500	0	500
4/8/2009	JL/2.20090804-03	2	CHOKI CHOKI CHOCOBERRY 12G	1	500	0	500
		3	INDOMIE GORENG	2	1.300	0	2.600
4/8/2009	JL/2.20090804-04	1	AQUA 600ML	1	1.750	0	1.750
		2	CHOKI CHOKI CHOCOBERRY 12G	1	500	0	500
		4	NABATI RICHS PASTA KEJU	1	500	0	500
4/8/2009	JL/2.20090804-05	1	AQUA 600ML	1	1.750	0	1.750
		3	INDOMIE GORENG	1	1.300	0	1.300
4/8/2009	JL/2.20090804-06	2	CHOKI CHOKI CHOCOBERRY 12G	1	500	0	500
		3	INDOMIE GORENG	1	1.300	0	1.300
4/8/2009	JL/2.20090804-07	1	AQUA 600ML	1	1.750	0	1.750
		3	INDOMIE GORENG	1	1.300	0	1.300
4/8/2009	JL/2.20090804-08	1	AQUA 600ML	1	1.750	0	1.750
		2	CHOKI CHOKI CHOCOBERRY 12G	1	500	0	500
		3	INDOMIE GORENG	1	1.300	0	1.300
		5	SEDAAP MIE GORENG 75 G	1	1.250	0	1.250
4/8/2009	JL/2.20090804-09	1	AQUA 600ML	1	1.750	0	1.750
		2	CHOKI CHOKI CHOCOBERRY 12G	1	500	0	500
		3	INDOMIE GORENG	1	1.300	0	1.300
4/8/2009	JL/2.20090804-10	1	AQUA 600ML	1	1.750	0	1.750
		2	CHOKI CHOKI CHOCOBERRY 12G	1	500	0	500
		4	NABATI RICHS PASTA KEJU	1	500	0	500
		6	POCARI SWEAT PET 500 ML	1	5.500	0	5.500
		7	GULAKU PREM.1 KG	3	8.800	0	26.400

ISBN : 978-602-97809-0-1

A Real-Time Knowledge Collaboration Using Web Flexible Editing System

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Abstract **- Most e-learning systems do not allow the modification of its content. In this research, we propose an online method WFES (Web Flexible Editing System), that provides real-time services for user interaction in web flexible editing, document tracking and marking function on an e-learning site for assist in improving the learning process. The main strength of WFES is the method that can provide users with a way to edit material of e-learning regardless of its original author. WFES allows the user in the community to simply select any portion of text on the page and then directly edit the underlying HTML even if the selected text appears in many different places in the document. In WFES, certain confidential information in the community is not publicly shared.**

Keywords **– Knowledge Collaboration, WFES, Student Centred**

I. INTRODUCTION

Developing of technology is makes possible to developing cultural, especially in education. Previously, learning is focused on lecturer or educator, which called "Lecturer centred", now by developed technology facility already effloresce, such as internet, it makes possible create "Student centred" learning or learning which focused on student. Where student is only not depends on their lecturer as one of information centre, but it also can utilize other source to obtain widely information.

Student must active to perform activities which can build knowledge for them. Therefore, lecturer must supports the learning process by create method, atmosphere, and communication that can impassion, motivation, intention, interest, trick and energetic, so they can active in build and finds knowledge for themselves. Lecturer must to manage learning process by the following activities:

- As creator which can create method and atmosphere in learning process;
- As motivator which motivates students to diligent in learning process;
- As facilitator and moderator which facilitate and become moderator for students in learning process;
- Become resources for students in learning process.

One of problems which identified during learning and lecturing process which felt by lecturers in Universitas Indo Global Mandiri is lack of receiving level of students. One of causes of this problem, because media which using by lecturer is inadequate, so lecturer not become as the good creator, motivator, facilitator, moderator, leader, and resources in learning process. Thereby, here must created the most attracted and comfortable learning process, so students has highly intention to learn conceptual or abstract materials and contain "difficult to understand concepts", and finally it can increase student's acceptance to such material. Giving material effectively to difficult concepts category to student is not enough by describe algorithm and formula of standard mathematical relevant ones, but it need an interactive knowledge collaboration like using Web Flexible Editing System (WFES) in learning process.

Knowledge collaboration is defined as the ability of the organization to move the right information, to the right people, at the right time. The "right" information for our purposes is built, maintained, and made available when and where it is needed. This, in turn, leads to:

- Improve student's independence in the effort to get its own knowledge,
- Increase interest, motivation, and student understanding to conceptual/abstract material,
- Gives facilitate for students to exploration and understand core concepts from each material, so learning effectiveness can be enhanced,
- Improve speed of collaboration,
- Positive user perception,
- Ownership and increased enthusiasm on the part of experts.

Develops an interactive knowledge collaboration in learning process using WFES is targeted to efforts elaboration of technology into learning in effort creates one learning environment that supportive, contextual, and wherewith, so it can enhance student's understanding to learned material, especially to conceptual material.

Kanev [10] noted that e-learning has a restricted ability for taking account of the differences between class size, teaching styles and objectives, learner preferences, cultural practices and administrative constraints. This demonstrates the need for a more flexible knowledge sharing or collaborative system that could be easy modified by lecturers to suit their lecturing constraint and objectives, the types of activities and the groups of students learning with the system. The activities offered should also be multi-dimensional to incorporate individuals, groups and whole classes of students within the activity design.

Most e-learning system created by experts without participation of learners who passively download preset materials to retrieve and browse resources. This situation is now changed due to the concept of Web 2.0. By using the tool such as blog, e-learning systems become a platform of knowledge sharing. Dynamic configuration of learning materials is more encouraged to be embedded into the e-learning system [29].

This research will propose a Dynamic Knowledge Collaboration using Web Flexible Editing System (WFES) that is expected to effort elaboration of technology into existing e-learning system to create 'Student Centred" environment. A dynamic group environment for knowledge collaboration or sharing that uses digitally-enhanced paper materials [11] to provide a flexible organizational structure, additional learning content, multi-dimensional learning activities and a reason for students to discuss the content with each other will be developed. WFES will enable students to edit materials or HTML text on an existing web browser directly. WFES does not require any particular plug-ins or software components like similar systems. Since WFES is developed with conventional technologies, students quickly learn how to use it. WFES will enable students to share real-time knowledge through web pages. WFES will allow the student to simply select any portion of text on the page and then directly edit the underlying HTML even if the selected text appears in many different places in the document. WFES will identify the specific instance of the selected text to be found. WFES will maintain student's editing data and autonomously sends it to other student in the same community.

In WFES, the certain confidential information in the community is not publicly. WFES also enables to modify dynamically generated web pages or web pages that get updated continuously. WFES can save the modified page (an HTML text) to a web server to publicize the modified page through internet.

II. KNOWLEDGE COLLABORATION

The term knowledge collaboration refers to an instruction method in which students at various performance levels work together in small groups together towards a common goal. Students are responsible for one another's learning as well as their own. Therefore, the success of one student helps the other students succeed [7].

Students learn best when they are actively involved in the process. Researchers report that, regardless of the subject matter, students working in small groups tend to learn more of what is taught and retain it longer than when the same content is presented in other instructional formats. Students who work in collaborative groups also appear more satisfied with their classes [5].

Roberts [25] defined collaborative as "an adjective that implies working in a group of two or more to achieve a common goal, while respecting each individual's contribution to the whole. Dillenbourg [6] stated that "knowledge collaboration describes a situation, in which particular forms of interaction among people are expected to occur, that would trigger learning mechanisms, but there is no guarantee that the expected interactions will actually occur. Hence, a general concern is to develop ways to increase the probability that some types of interaction occur.''

Boxtel [3] mentioned that "In educational practice, the interest in knowledge collaboration coincides with the shift to more student-centred learning environments in which the students can take more responsibility for their learning." In educational research, how, and under which conditions student interaction facilitates learning, was considered as an important topic for research. Paniz [22] believed that knowledge collaboration is based upon the following principles: working together, resulting in a greater understanding than working individually; spoken and written interactions; opportunity to become aware of relationships between social interactions and increased understanding, some elements of this increased understanding are unpredictable: participation is voluntary and free.

In a knowledge collaboration environment, the learner can learn through interaction, discussion, and explanation of a problem to others [16], [25]. As Van der Linden et al. [18] stated, learning is more productive when learning tasks or problem assignments are solved together with fellow students rather than in individual or lecturer-pupil lecturing/learning situations and knowledge collaboration also seems to have positive effects on motivational factors and areas related to social skills. In their Meta-analysis study Qin, Johnson and Johnson reported that in 87% of studies the cooperative and collaborative condition resulted in a better learning effect and, as summarized [18], other meta-analyses of research in this field revealed that the cognitive achievements of students working in this field are usually more than students who are involved in traditional, individual or competitive learning situations.

In this research, knowledge collaboration is established in small groups that mean groups act relatively independent of a lecturer with the goal of acquiring knowledge or skills [4]. One major goal of knowledge collaboration is to support social interaction and to encourage the learners' cognitive processes. In this context, learners work to co-construct knowledge collaboratively [8]. In addition, learners externalize and elaborate on learning material by taking notes.

In knowledge collaboration environments, learners often create these written representations collaboratively [26].

This, in turn, leads to:

- Improve student's independence in the effort to get its own knowledge,
- Increase interest, motivation, and student understanding to conceptual/abstract material,
- Gives facilitate for students to exploration and understand core concepts from each material, so learning effectiveness can be enhanced,
- Improve speed of collaboration,
- Positive user perception,
- Ownership and increased enthusiasm on the part of experts.

III. RELATED RESEARCH

A wiki is a web-based tool for collaborative idea exchange and writing in the web, and is informal, quick and accessible [17]. Wikis are freely expandable collections of interlinked pages which are easily editable by any user with a forms-capable web browser. Although users of Wiki can edit HTML text and generate web pages using a web browser, they must know its original scripts and tags to do so effectively. Indeed, wikis are not carefully crafted sites for casual visitors; instead they seek to involve the visitor in an ongoing process of creation and collaboration that constantly changes the landscape of the site. Wiki invites *all* users to edit *any* page or to create new pages on the site, and do so in a democratic basis - every user has exactly the same capabilities as any other user, and accounts and passwords are not required.

Whitehead Jr [28] described WebDAV (Web Distributed Authoring and Versioning), is a set of extensions to the HTTP protocol to allow distributed, collaborative sharing and creation of resources. It is a technical underpinning for web authoring tools, but is not user-oriented. It is supported by the Apple's Macintosh and Microsoft's Windows operating systems, allowing any WebDAV-enabled website to be treated as a network file system. Unlike wiki it provides no methods for creating linked pages, only the ability to store and retrieve them.

Appelt [2] presented BSCW (Basic Support for Cooperative Work), is a Web-based groupware tool for online collaboration using the metaphor of shared workspaces, particularly suited for supporting cooperation in locally dispersed, cross-organizational groups. Shared workspaces allow collaborating users to collect and structure any kind of information (including, but not limited to, documents, images, spreadsheets, software, and URL links to other Web pages or FTP sites) in order to achieve their goals of collaboration. The content of shared workspaces is usually arranged in a folder hierarchy based on structuring principles agreed upon by members of a workspace.

Berners-Lee described a key milestone in building the Semantic Web, is the association of high-quality metadata with content. Automating this task is difficult due to the unstructured nature of content on the Web, and so manually annotating Web documents is an important technique for creating the metadata [9]. The World Wide Web Consortium's Annotea project aims to provide such a mechanism to allow users to add shared annotations to Web documents [12], based on an infrastructure which combines existing open W3C RDF, XPointer, and HTTP standards as part of a more general-purpose Semantic Web initiative.

Annotation can also be very useful in document tracking and user analysis. AMIEDoT (Annotation Model for Information Exchange and Document Tracking) is an annotation model that can assist in document tracking and recommendation service [1].

Tashiro [27] presented web based information sharing system called the Proxy Agent-based Information Sharing (PAIS) that a mechanism that enables flexible HTML text modification for a writable web. Users effectively can edit HTML text on an existing Web browser. The proxy agent maintains user's editing data. The agent autonomously sends the user data that has been modified to other agents in the same community. In PAIS, certain confidential information in the community is not publicly shared by using the proxy agent. PAIS just enables users to replace, cut and add plain text and HTML tags in a dialogue window (editor window) using proxy agent.

Ozono [21] proposed an online method Web Flexible Editing (WFE) for editing any web page by realizing a proxy agent. Users can edit and delete existing texts and add new texts and images on a web page by using proxy agent. In WFE a user can simply edit an HTML text cached by a proxy agent. WFE does not directly edit an HTML text for a page on a Web server. But the proxy agent can save the modified page (an HTML text) to a Web server to publicize the modified page through the Internet. The users can also mark words and phrases on web pages by using their browsers without any extra plug-ins like similar systems.

IV. WEB FLEXIBLE EDITING SYSTEM (WFES)

A WFES is an application that allows several users to co-operate and share documents in a structured way, flexible and real-time. WFES provides a standard infrastructure for asynchronous collaborative authoring across the internet in order to turn the web into a collaboration environment. When using WFES, the web is becoming a rich infrastructure for collaborative application.

In this research, will be proposed an online method where users do not require such format and original syntax like Wiki [17], because Wiki just has the ability to store and retrieve information. This application (WFES) enables users to edit and add text on a web page like PAIS [27] and WFE [21] but users do not need using proxy agent and users can create linked pages like WebDAV [28] with tracking documentary evidence [9].

The users can mark words and phrases on web pages by using their browsers [15] [1] without any extra plug-ins like similar systems. The text will be marking on the web page like marking on the papers [14].

The application is also a Web-based groupware tool for online collaboration in the same community [2]. So, certain

ISBN : 978-602-97809-0-1

confidential information in the community is not publicly shared to public or other community.

It has several technical advantages as follows:

- Users simply indicate the editing action (e.g., insert text, add comments) for the e-learning site. Unlike other technologies, WFES does not need particular web page forms to input data or texts on web pages. When a user is browsing web pages and wants to post information, user simply select the text by mouse dragging or double clicking the place where the text is to be placed on browser, and then edit the text in a dialogue window. It is almost like putting a Post-it (sticky note) on paper. [21],
- This pseudo-editing is done by using WFES. Users browse and edit web pages. When a user edits a web page, the edited data is stored into another database managed by WFES. WFES can merge the original web page and the edited data, and generates a new page reflecting the user's edited data. Accordingly, although the original web page is not modified, users of community can browse edited it via WFES. Public or users of outside community will simply view the original one.

V. Design and Implementation

A. System Architecture of KC-WFES

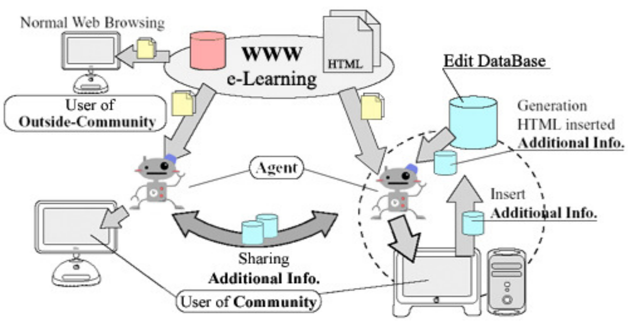

Fig. 1 System architecture of WFES

In the right side of Fig. 1, the outline of this function is shown. A user can use the application of knowledge collaboration and browse web pages using it. When a user wants to add additional information to a web page, they can add the information using the WFES mechanism. The additional information will be added to the web page is stored in the Edit Database which is maintained by the knowledge collaboration application. The WFES has the ability to mark, manipulate and comment on information that is identified, including tracking documentary evidence. Therefore, in KC-WFES, the original HTML text is not modified by WFES. When a user in the community to access a web page contained in the Database Edit, then the application will go straight to the modified web page. Then, a user can browse the modified web page for knowledge collaboration without any specialized operations.

In the left side of Fig. 1, the outline of this function is shown. When a user of community modifies a web page, the modified data will be stored to the Edit Database. The data store it in each Edit Database just able to be accessed by member of community. As mentioned above, the original HTML text is not modified. Thus, even if the web page is modified within a community, non members of the community or users of outside-community cannot browse the modified web page. In KC-WFES, the student's communities do not have access to the lecturer's community, so as do not disrupt privacy the lecturer's community.

B. Physical Design

Meanwhile, physical design deals with the process of converting the logical design into a more technical specification of the system development. In designing the physical part of the system, all diagrams that were produced in the logical design were turned into a structured systems design. During physical design, the researcher which programming language and database system will be used as well as the determination of which hardware platform, operating system and network environment the system will run under. The specifications are as follows:

TABLE I
H/W and S/W Specifications

Purpose	**H/W and S/W Requirements**
Programming Language	Active Server Pages (ASP), VBScript, JavaScript, SQL and Snitz Forums 2000, MaxWebPortal.
Operating System	Microsoft Windows XP Professional or more.
Hardware	Monitor, Processor Dual Core 1.6 GHz, DDRAM (1 GB).

The programming part of the study was dependent on the result from the designing process which include the system's functions, entities involve, hardware and operating system determined. After everything was designed, the physical system specifications were ready to be turned over to programmers for the next phase which is the implementation phase.

C. User Interface of KC-WFES

In Fig. 2, a user selects text for editing by using the mouse-dragging on web browser. Then, the Editor Window that is used to edit the selected text is opened in small new window in Fig. 3. The user edits the text and saves the edited text (in this example, the text "di jadikan" will be the text "dijadikan"). Finally, as shown in Fig. 4, the new web page, which reflects the edited text, is presented.

KC-WFES enables members of the same community to share information flexibly via the WWW. All users in the same community can browse the same web pages including some additional information which is added or edited by one of the community members. For example, in a certain group, if a member edits the string "di jadikan" in a web page like in

Fig. 2, other members can browse the text that has been edited with the information about editor and when the text is edited (Fig. 3).

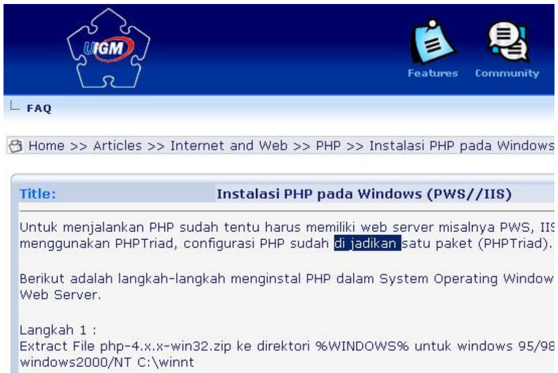

Fig. 2 Interface - the user selects text for editing

Fig. 3 Interface text editing process by WFES

Fig. 4 Interface from other members who browse the text that has been edited with information about the edited text editor and time

The evaluation of the prototype was conducted on 20 undergraduate students from faculty of computer science, which divided become two groups based on GPA score. This study covered a sample size of twenty respondents and that comes in the line of Nielsen [20] which shows that twenty respondents indicated a reasonable confidence interval.

The second evaluation was gained from questionnaire consists of two sections: General Information and User Evaluation. The General section functions as mechanism to collect user's demographics The User Evaluation section functions as mechanism to collect data on user's opinion regarding to evaluation the ten dimensions (Ease of Use, Navigation, Cognitive Load, Mapping, Screen Design, Knowledge Space Compatibility, Information Presentation, Media Integration, Aesthetics, and Overall Functionality) of the proposed system was adapted from Reeves [23].

VI. Result

The show results in Table II present the average values obtain from the ten dimensions. Ease of Use, Screen Design, Information Presentation and Aesthetics all received high average values, which indicate that the student agreed that, the KC-WFES:

- is easy to use (mean = 7.5)
- follow the design principles (mean = 7.5)
- has clear presentation of information (mean = 7.6)
- is pleasing to look at (mean = 7.3)

Out of the 4 values, the Screen Design standard deviation is the lowest (σ = 1.716), indicating the student were in better agreement to this dimension.

Furthermore, the Overall Functionality of the KC-WFES is seen as functioning well (mean = 8.20). This dimension also has the least standard deviation (σ = 1.476), indicating the least dispersion from the mean.

However, "Mapping" which refers to the KC-WFES ability to track and graphically represent to the user his or her path through the program received the lowest average (mean = 5.8). The students seem to agree that the KC-WFES needs to improve on its mapping functionality.

Other dimensions, such as Navigation, Cognitive Load, Knowledge Space Compatibility and Media Integration received a slightly positive feedback. Navigation is seen as rather easy, Cognitive Load is manageable, Knowledge Space is compatible and Media Integration is slightly coordinated.

TABLE II
DESCRIPTIVE STATISTIC FOR THE STUDENT ON USING KC-WFES

Dimension	N	Min.	Max.	Mean	Std. Deviation
Ease of Use	20	3	10	**7.50**	2.121
Navigation	20	2	10	6.50	2.550
Cognitive Load	20	2	10	6.80	2.860
Mapping	20	1	10	5.80	3.225
Screen Design	20	5	10	**7.50**	1.716
Knowldg Space Compa.	20	2	8	6.30	1.889
Information Presentation	20	5	10	**7.60**	1.838
Media Integration	20	2	8	6.30	1.874
Aesthetics	20	3	10	7.30	2.710
Overall Functionality	20	6	10	**8.20**	1.476
Valid N (list wise)	20				

VII. Conclusions

The swift growth of networks and especially the Internet the last years have provided the Institutions and Universities with high access speeds and advanced telematic services. In this way, the ideal conditions for the development of synchronous/asynchronous e-learning systems have been created. Therefore, it constitutes necessity to undertake actions for their dissemination and spread in Higher Education.

KC-WFES was developed to help students of UIGM to exchange and share knowledge or collaborative knowledge with others and with their lecturers in accordance with UIGM environment. The system has been tested and the result confirms that the proposed system is capable and successful to enhance student motivation effectively and easily. The main problem and limitation of this research is not all students ready and have background to use KC-WFES, especially new students.

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ISBN : 978-602-97809-0-1

INTEGRATIVE MODEL OF INFORMATION TECHNOLOGY ADOPTION IN SMALL BUSINESSES: EMPIRICAL STUDY IN YOGYAKARTA

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ABSTRACT **Based on theories from the technological innovation literature, this study is examined model of information technology (IT) adoption in small businesses. Leader, organizational, information technology and environment characteritic for small businesses have important roles in making decision to adopt information technology (IT). The purpose of this research is examine effects of leader characteristics (leader innovativeness and level of leaders`IT knowledge), IT characteristics (relative advantage, compatibility, complexity, perceived cost), organizational characteristics (business size, level of employees' knowledge IT, information intensity) and environment characteristics to decision to adopt information technology.**

A survey was conducted in Yogyakarta city by purposive sampling technique. The samples that are used to data analysing are 102 small business. Partial Least Squares method was used to examine five research hypotheses. Research instruments validity was measured by convergent validity and discriminant validity. Instrument reliability was measured by cronbach's alpha and composite reliability.

This research shows that leader' IT knowledge, relative advantage, and information intensity have significantly positive effect on the decision of small businesses to adopt IT. On the other hand leader innovativeness, complexity, compatibility, business size, employees' IT knowledge and competitive have no effect to small businesses decision to adopt IT.

Keywords **- information technology, small business, diffusion innovation, technology adoption.**

BACKGROUND

Information technology (IT) provides an opportunity for businesses to improve their efficiency and effectiveness, and even to gain competitive advantage. For a small business, embarking on IT adoption for the first time is non-trivial as there is a lot of uncertainty and risk involved. The introduction of IT is likely to cause changes in work procedures and increase computer anxiety among the employees. The technological innovation literature has identified many variables that are possible determinants of organizational adoption of an innovation. The introduction of IT is likely to cause changes in work procedures and increase computer anxiety among the employees.

The technological innovation literature has identified many variables that are possible determinants of organizational adoption of an innovation. Kimberly and Evanisko (1981) identified three other clusters of predictors of innovation adoption—characteristics of organizational leaders, characteristics of organizations, and characteristics of environmental context. Tomatzky and Fleischer (1990) conceptualized the context of technological innovation as consisting of three elements—organizational context, technological context, and environmental context—that influence the technological innovation decision. In summary, four elements of context can be identified in the technological innovation literature: (1) characteristics ofthe organizational decision makers (small business's leader); (2) characteristics of the technological innovation; (3) characteristics of the organization; and (4) characteristics ofthe environment in which the organization operates.

Leader, technological innovation, organizational and environmental characteristics of small businesses have important roles in information technology (IT) adoption. Most of these studies have investigated the effects of leader, organizational and environment characteristics on adoption of innovations in large businesses, but in small businesses still little, specially in Yogyakarta city. The purpose of this study is examine the effect of leader's characteristics (leader' innovativeness and level of leader' IT knowledge), IT characteristics (relative advantage, compatibility, complexity, perceived cost) organizational characteristics (business size, level of employees' knowledge IT, information intensity) and environmental characteristics (competitiveness) on the decision to adopt IT.

RESEARCH MODEL AND HYPOTHESES

Based on a review of the literature on technological innovation, a research model was developed (see Fig. 1).

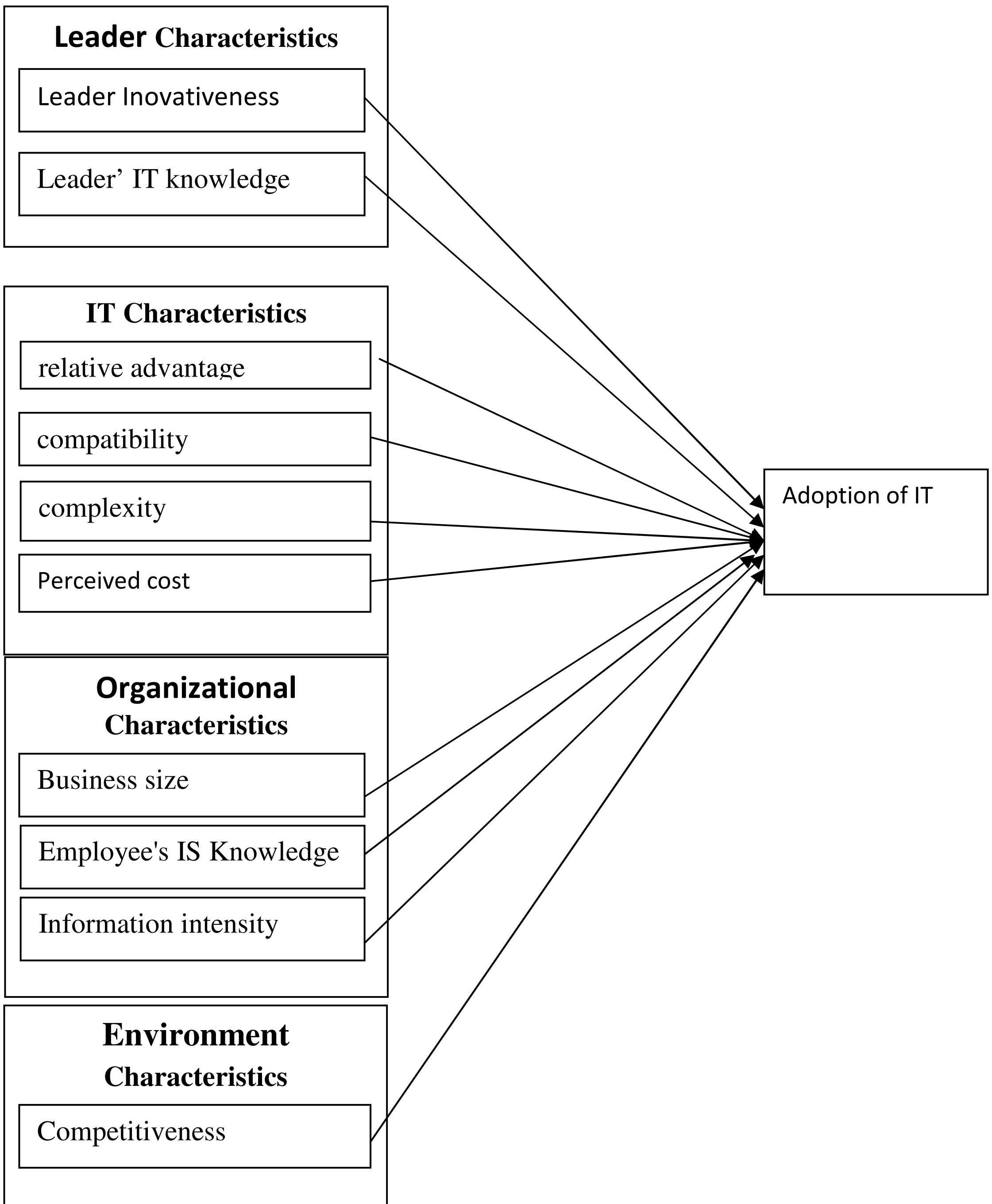

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Figure 1. Research Model

Hypothesis Development

Adoption of IT

The dependent variable is adoption of IT. In this study, adoption of IT is defined as using computer hardware and software applications to support operations, management, and decision making in the business (Davish & Olson, 1985). This implies that IT is used productively and is not a 'white elephant'. The primary purpose is to identify the important factors that lead to adoption of IT.

Leader's Characteristics

Leader's innovativeness.

The leader is an entrepreneur figure who is crucial in determining the innovative attitude of a small business (Rizzoni, 1991). This is because the leader's qualities are the determinants of the overall management style of the business (Rothwell, 1977). In fact, the rate at which a small business changes depends not only on factors like business size or market forces, but also on the abilities and inclinations of the leader and the extent to which he is able or prepared to devolve management (Birley, 1982). It is the role adopted by the leader that determines the innovativeness of the business (Connon, 1985). Kirton (1976) contended that everyone is located on a continuum ranging from an ability to do things better to an ability to do things differently. He called the two extreme ends of the continuum adaptors and innovators respectively. In a business, the adaptor leader would seek solutions that have already been tried and understood. On the other hand, the innovator leader would prefer solutions that change the structure in which the problem is embedded—in other words, solutions that have not been tried out and are therefore risky (Kirton, 1984). Unless the leader has the will to innovate, there is little that other members of the business can do to expedite the adoption of IT.

Hypothesis1: Businesses with more innovative leaders are more likely to adopt IT.

Leader' IT knowledge.

Typically, small businesses are lacking in specialized IT knowledge and technical skills (Gable, 1991). Niedleman (1979) attributed the failure of European small businesses to utilize IT to lack of IT knowledge. In a study of Singapore small businesses, Gable and Raman (1992) found that leaders in such businesses tend to lack basic knowledge and awareness of IT. Many of them rejected the notion that IT could be of any use to their business as they had no idea of the benefits that IT could potentially offer. This would seem to imply that if these leaders could be educated on the benefits of IT, they may be more willing to adopt such technology.

Hypothesis 2: Businesses with leaders who are more knowledgeable about IT are more likely to adopt IT.

IT characteristics

Perception of IT attributes research on innovation has identified characteristics of the innovation as perceived by the adopting business as having influence on the adoption of innovations (Roger, 1983). According to Rogers's innovation theory, an individual forms an attitude toward the innovation, leading to a decision to adopt or reject and, if the decision is to adopt, to implementation of the innovation (Roger, 1983). The perception of the potential adopter toward the IS is the primary determinant of IS adoption. Based on a meta analysis of the technological innovation literature conceming characteristics of innovations, Tornatzky and Klein (1982) identified relative advantage, compatibility, and complexity as innovation characteristics that are salient to the attitude formation. Relative advantage is the degree to which an innovation is perceived as better than its precursor (Roger, 1983). The positive perceptions ofthe benefits of IS should provide an incentive for the small business to adopt the innovation. Compatibility is the degree to which an innovationis perceived as consistent with the existing values, needs, and past experiences ofthe potential adopter (Roger, 1983). If the IS are compatible with existing work practices, the small business will be more likely to adopt them. Complexity refers to the degree to which an innovation is perceived as difficuh to use (Roger, 1983). The perceived complexity ofthe IS is expected to influence the decision to adopt them negatively.

Roger (1983) identify the characteristics of innovation include: relative advantage, triability, complexity, suitability and visibility. In a meta-analysis of the literature related to technological

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innovation characteristics of innovation, Tornatzky and Klein (1982) tested ten innovation characteristic most often used by several studies. Characteristics include 5 (five) characteristics proposed by Roger (1983) plus the cost characteristics, communicability, visibility, profitability and social assessment.

Thong (1999) examine the influence of relative advantage, compatibility and complexity of the SI on the possibility of adopting information system (SI). The findings indicate that three factors are a positive influence on the possibility of adoption of the SI. While studies conducted by Premkumar and Robert (1999) include factors other than relative advantage, compatibility and complexity of IT, Premkumar and Robert (1999) also include cost perceived factors as variables that affect IT adoption decisions in small businesses. Findings indicate that the four variables partially influence the decision to adopt IT.

H3: Relative advantage of IT will be positively related to the likelihood of IT adoption.

H4: Compatibility of IT will be positively related to the likelihood of IT adoption.

H5: Complexity of IT will be negatively related to the likelihood of IT adoption.

H6: Cost of IT will be negatively related to the likelihood of IT adoption

Organizational Characteristics

Business size

Small businesses suffer from a special condition commonly referred to as resource poverty. Resource poverty results from various conditions unique to small businesses, such as operating in a highly competitive environment, financial constraints, lack of professional expertise, and susceptibility to external forces. Because of these unique conditions, small businesses are characterized by severe constraints on financial resources, a lack of in-house IT expertise, and a short-range management perspective (Welsh&White, 1981). Consequently, small businesses face substantially more barriers to adoption of IT and are less likely to adopt IT than large businesses (Ein-Dor & Segev, 1978). Alpar and Reeves (1990) argued that even amongst small businesses, the larger the business, the more able it is to hire people with specialized skills, such as knowledge of IT. In addition, it would appear reasonable to suppose that larger businesses have more potential to use IT than small businesses, simply because of their larger scale of operations (Lind et al, 1989).

Hypothesis 7: Businesses that are larger in size are more likely to adopt IT.

Employees' IS Knowledge

Similarly, Attewell's (1992) technological innovation theory has implications for employees of small businesses. Typically, small businesses are lacking in specialized IS knowledge and technical skills (Gagle, 1991). Neidleman (1979) attributes the failure of European small businesses to utilize IS to lack of IS knowledge. Because of obstacles with developing the necessary skills and technical knowledge, many businesses are tempted to postpone adoption of the innovation until they have sufficient internal expertise. Hence, if employees of small businesses are knowledgeable about IS, the businesses may be more willing to adopt IS and adopt more IS. Further, there is empirical evidence that businesses with employees who have more knowledge of the technological innovation are likely to use more ofthe innovation (Ettlie, 1990).

Hypothesis 8: Businesses with employees who are more knowledgeable about IT are more likely to adopt IT.

Information intensity

The degree to which information is present in the product or service of a business reflects the level of information intensity of that product or service. Businesses in different sectors have different information processing needs and those in more information- intensive sectors are more likely to adopt IT than those in less information-intensive sectors (Yap, 1989). For instance, travel agencies are more information intensive, as their main functions are to process and package tour information. Further, the greater the information intensity, the greater the potential for strategic uses of IT in a business (Porter & Millar, 1985).

Hypothesis 9: Businesses that are in more information-intensive environments are more likely to adopt IT.

Environment Characteristics

Competitiveness of environment

By competitiveness of the business environment, we mean the competition faced by the business in its particular industry. It is tough rivalry that pushes businesses to be innovative (Porter, 1990). Porter and Millar (1985) saw businesses as having to cope with five competitive forces, namely new entrants, the threat of substitute products or services, bargaining power of customers, bargaining power of suppliers, and rivalry amongst current competitors. They suggested that by adopting IT, businesses will be able to change their environment in three ways, IT can change the industry structure and, in so doing, alter the rules of competition. IT can also create competitive advantage by giving businesses new ways to outperform their rivals. Finally, IT spawns new businesses, often from within existing operations of the business. Therefore, a business in an environment that is more competitive would feel a greater need to turn to IT to gain acompetitive advantage. On the other hand, a business in a less competitive environment would not be faced with a push to be innovative. Economists generally believe that competition increases the likelihood of adoption of innovation (Kimberly&Evanisko, 1981) and market power is generally believed to have a positive influence on innovation (Link & Bozeman, 1991).

Hypothesis 10: Businesses that are more competitive environments are more likely to adopt IT.

METHOD

A survey was conducted in Yogyakarta city by purposive sampling technique. This study was conducted in two phases: a pilot study and a questionnaire survey. The pilot study phase aim to determine whether there were any problems with the questionnaire. In the questionnaire survey, a package was directed given to the leader of each of the small businesses in the survey sample. One hundred and twenty small businesses returned the questionnaires. However, 18 questionnaires were returned uncompleted. This resulted in 102 usable questionnaires for data analysis. Partial Least Squares was used to analyze data.

In PLS analysis, the reliability of a variable is evaluated by computing composite reliability while convergent validity is evaluated by the average variance extracted (AVE) (Fomell & Larcker, 1981). Acceptable values for composite reliability and average variance extracted arc 0.7 and 0.5, respectively (Chan et al., 1997). From Table 2, all the variables were reliable and met the condition for convergent validity. Discriminant validity of the variables was evaluated by comparing the average variance extracted for the variable with the squared correlations between it and the other variables. In all cases, the average variance extracted was greater than the squared correlations between variables, indicating that all the variables in the model exhibited discriminant validity.

Table.1 Result of PLS Analysis for IT Adoption

	Composite Reliability	AVE	Squared AVE
IT adoption	1,000000	1,000000	1.000000
Leader'sInnovativeness	0,966150	0,877112	0.887025
Leader's IT knowledge	0,938581	0,792869	0.900042
Relative Advantage of IT	0,974841	0,885828	0.944280
Compatibility of IT	0,946256	0,779794	0.873643
Complexity of IT	0,975975	0,931233	0.858066
Perceived cost	0,921939	0,797689	0.904347
Firm Size	1,000000	1,000000	1.000000
Employees' IT knowledge	0,960703	0,859581	0.912150
Information Intensity	0,966772	0,906539	0.948343
Competitivenes	0,857121	0,668819	0.854520

HYPOTHESES TESTING

The research data were analysed using partial least squares (PLS). The result shown in table 3. The results provide support for three of the hypotheses: H2, H3, and H5. The other hand, H1, H4 and H6 not supported. They suggest that businesses that have leaders who are more knowledgeable about IT and more information-intensive environments are more likely to adopt IT. In addition, businesses that have more employees tend to adopt IT. There is no significant difference between adopters and non-adopters of IT in terms of innovativeness of leader, employees' IT knowledge and competitiveness of environment.

Table 2. Results of structural model

Keterangan	t value	Sig	
Leader's innovativeness-> IT adoption	0,658	0,256	Not supported
Leader's IT knowledge -> IT adoption	2,728	0,003	Supported
Rel Adv of IT -> IT adoption	3,088	0,001	Supported
Compatibility of IT -> IT adoption	0,597	0,276	Not supported
Complexity of IT -> IT adoption	1,429	0,077	Not supported
Perceived cost -> IT adoption	2,773	0,003	Supported
Employees' IT knowledge -> IT adoption	0,752	0,227	Not supported
Firm Size -> IT adoption	1,213	0,113	Not supported
Information Intensity -> IT adoption	2,085	0,019	Supported
Competitivenes -> IT adoption	0,926	0,178	Not supported

*<0,05 **0,1

DISCUSSION

This study has examined potential determinants of IT adoption in small businesses. The main finding is that in addition to leader's IT knowledge, Relative Advantage of IT , Perceived cost and Information intensity are significant determinants of the decision to adopt IT in small businesses. They suggest that businesses that with leader who are more knowledgeable about IT, have more perceive of relative advantage of IT, have perceived cost are more likely to adopt IT. In addition, businesses that have more need information tend to adopt IT.

The main finding of this study is that leader's IT knowledge are important determinants of the decision to adopt IT. Small businesses with leaders who have more knowledge about IT are more likely to adopt IT. The leader must be aware of the ability of the IT innovation and how to use it properly. With greater knowledge, the degree of uncertainty involved in IT adoption will diminish, resulting in a less risky adoption of IT. This is consistent with the findings of other studies which reported that the lack of knowledge of the IT adoption process and insufficient awareness of the potential benefits may be inhibiting businesses from adopting IT (Sen&Gibson, 1981). To the extent a leader can lower the knowledge inadequacies, it will facilitate the path to adoption of IT. This finding is also supported by evidence from the technological innovation literature. For example, Dewar and Dutton (1986) found that extensive knowledge is important for the adoption of technical process innovations.

Perceive of relative advantage is important determinant of the decision to adopt IT. Small businesses will adopt IT if it IT perceived as better than its precursor. IT is perceived as technology which can support its business activities. This finding support diffusion of innovation theory (Rogger, 1983). Perceived of cost as variable of technological innovation effect on decision to adopt IT. The lower cost of IT adoption, small business more interest to adopt IT. Small business still sentitive on IT adoption cost because it have limited allocation fund to pay IT adoption (ie: preparing IT adoption, IT maintenance, IT worker and Consultant cost). Perceived cost of It adoption is important determinant of small business IT adoption (Premkumar and Robert, 1999). Their finding show that cost of IT adoption effect on decision to adopt IT in small businesses.

The third organizational characteristic that affects the extent of IT adoption is information intensity. The greater the information intensity of the product or service that the small business is involved in, the greater the extent of IS adoption. This provides some support for the information-processing theory. Galbraith (Ibrahim&Goodwin, 1989) found that, when businesses take on uncertain tasks, such as scanning and processing complex information about new innovations, they have to manage the increase in information load with various design strategies. Similarly, a small business dealing with a product or service with high information intensity can make more extensive use of IT to meet its information-processing needs.

Contrary to the hypotheses, Leader's innovativeness, compatibility, complexity, employees' IT knowledge, firm size and competition have no significant effect on IT adoption in small businesses. In context of IT compatibility, small businesses view that Information technology not compatible with it's activities. Information technology is not crucial factor to support daily activities. Surprisely, complexity of IT have no significant effect on IT adoption by small businesses. It because IT in small business is perceived as computer only by small businesses. Majority of respondent (89 percent) have used computer more 2 year.This study sugest Attewell's theory of lowering knowledge barriers takes precedence over the decision maker's characteristics and perception of the IT characteristics after the initial decision to adopt IT (Attewell, 1992).

In the case of competition, it appears to have no direct "push" for small businesses to increase the extent of IT adoption. However, competition may have an indirect effect on IT adoption through information intensity. Competition may be positively correlated with information intensity.

CONCLUSION

Using theories from the technological innovation literature, this study developed and tested IT adoption in small businesses. This study has examined the effects of leader's characteristics, IT characteristics, environmental characteristics and organizational charactteritics on the decision of small businesses to adopt IT. It concludes that IT knowledgeable leader, relative advantage of IT, Perceived cost and Information intensity are important determinants of the decision to adopt IT. The implications of this study are, first, the study highlights the importance of having IT knowledgeable leaders. A small business managed by a leaders who understands the benefits of IT adoption will be able to take advantage of the promised benefits of IT adoption, including improved organizational efficiency and effectiveness. Second, among the IT adopters, those small businesses that have greater information-processing needs will tend to adopt more IT. This greater need for information processing will have to be supplemented by IT infrastructure.

LIMITATION AND IMPLICATION

Finally, let us discuss some limitations of this study, First, it is not possible to directly measure the perception of the CEO at the time of IS adoption. This is ameliorated to some extent by asking the CEO for his or her perceptions prior to IS adoption. However, we cannot be completely certain that the respondent can backtrack in his or her mind without being influenced by the experience of IS adoption to the state of thefirm before adoption. Second, because of the cross-sectional nature of the study, direction of causality can only be inferred. Longitudinal studies need to be conducted to determine the causal links more explicitly. Third, operationalization of extent of IS adoption could have been strengthened if the amount of IS investment were measured. Finally, this study has investigated a subset of the variables found to be important in the technological innovation literature, albeit those that are more pertinent to the context of small businesses. Other variables that may be potential determinants of IS adoption in small businesses include other characteristics of the innovation such as peer influence and trialability. Future research can examine these possibilities. Notwithstanding these limitations, this study has proposed and tested an integrated model of IS adoption in small businesses based on the technological innovation literature and identified some important determinants of IS adoption in small businesses.

These findings have implications for IT consultants, vendors, and government agencies responsible for promoting IT adoption. To increase their chances of success, IT consultants and vendors are advised to target their marketing at businesses with innovative leaders. They ought to look out for indicators of innovative behaviours such as adoption of new production technology or processes, imaginative advertisements, and participation in trade organizations and exhibitions.

For those leaders who are less innovative and thus highly adaptive, consultants and vendors should take steps to create IT awareness among these leaders so as to educate them. Adaptive leaders prefer not to adopt IT unless they are sure that adoption of IT is one way of doing things better and not doing things differently. With a better understanding of IT and its potential benefits, these leaders may develop more positive attitudes towards adoption of IT. As their attitudes become more positive, they will be more receptive towards the idea of adopting IT. Government agencies responsible for promoting IT adoption should focus their effort on raising IT literacy. This can be achieved through subsidized IT seminars and training programmes specially designed for leaders and employees of small businesses.

Acknowledgment*:* This study was my master theses research supervised by Jogiyanto Hartono.

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ISBN : 978-602-97809-0-1

Designing A new model of organizational Productivity Based on Continious Change Management theory

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Abstract - Science in the transition from stability and linearity to the focus on non-linearity relations has encountered a vast diversification and change in its contents. Due to the globalization and its speedy and expanding changes, turbulences, particularly with regard to the quick replacement of numerous and dynamic technologies, only creative and innovative organizations can carry on existing and overcome this challenging environment. New type of reenginiring and reorganizing is required to adapt to the current continious changing circumstances. Achieving the secrets of the existence & nature of being has led to the explanation of some theories. This study was designed selected in order to get to a new model of organizational productivity in the changing situations, based on the 'CHAOS THEORY'. In order to measure the dependent variable of productivity, the operationalized model of organizational productivity called 'BALANCED SCORECARD'was used. The criteria of this variable involve the past (financial), present (customer and employee satisfactions), and the future (organizational learning, development and growth).Organizational strategic (long-term) planning, constant learning, common culture, creative and innovative work groups, organizational supervisory and control, structures and communications, evolutionary creating morale of management, and constant conflict and tension in work groups and knowledge workers within the framework of independent variables make up the main body of this research. In order to measure the criteria of the organizational productivity, four questionnaires were designed: JOB SATISFACTION and CUSTOMER SATISFACTION, LEARNING, DEVELOPMENT & GROWTH CRITERIA, and FINANCIAL FACTS & FIGURES. To measure the main effective factors in management development with a new approach to the Chaos Theory, a questionnaire of management schools comparison from the viewpoints of managers was used.

Keywords - Chaos Theory, Balanced Scorecard, Organizational Productivity, Continious Change Management, knowledge Management,Value Management.

Introduction

Dramatic differences in principles and specifications governing the administrative system of Iran and widespread change, and fast content management science principles that have occurred in global networks, and considerable distance more to adapt has created. On the other hand the change from being original cornerstone is a new hope that if there is timely and deserves attention, this retardation compensation quickly, and due to the unity of the possibility of new theories and procedures that popularization with the infrastructure of science and technology culture and human resource characteristics of Iranian organizations be provided. Predetermination dominated world full of turbulence and challenge today so that opportunities and threats continued strengths and weaknesses and become Badrayt management and leaders of organizations can be threats and weaknesses to develop and maintain capabilities for organizational change to survive said.Look above motivation in this research that can be created with the recent finding of reliance and integration in their context and adapt its traditional administrative system governing the country and provide a new model, Starter move in this direction with strategic plan New concepts are. The most important issue or question in the administrative system of Iran, low productivity and organizational collections finding new ways to understand what its true and accurate and followed by question and answer for this is to fill this gap. The next problem is that most Iranian organizations with a mechanism of template management structures stability and sustainability are using , while necessary for the operational model in terms of making repeated changes in the global environment and should be presented. . Hence the next stimulus, the possibility to find employment for this rearrangement or re-engineer the system and change management to change management or stable expression of change management is better management. Military exposure modified not only accept change but to create their enthusiastic and timely management and do change with the presence of its desirable market to the extent that the market researcher to all global markets. Method and therefore the lack of realization of a reliable done in this connection, the problem with combining the two above, subject of review established way to achieve what "productivity" in terms of

Optimal organizational "frequent changes" were selected . This study, literature review and gathering of new change management, in order to understand the theory of chaos theory or the theory of creation, as the experimental order and the survival of any irregularities within the normal pattern of change management researcher makes pays. Theory that in less than thirty years based on the hidden truths are discovered and then entered every branch of science and This time, too broad dimensions of the remaining suspect.Theory of a creature of peaceful coexistence and stability and instability order to reach the pattern of change management within the normal confusion organizations are constantly evolving today.

Statement of Problem Research

Definitely "the biggest recent scientific exploration of human achievement and understanding of concrete reality and the unknown secrets of nature and creation that the efforts of scientists tirelessly with Crown branches of science and the widespread use of computers and advanced software in the form of change management theory or In order words, chaos theory led to many new technologies have been dramatic. . These new technologies, basic data and previous institutionalization of science in order to create a fundamental shift to the following question, and finally as a fundamental new realities based on modern mathematics and empirical relationships, scientific and practical has been accepted. Original exploration mentioned by changes in the root directory of several sciences, especially meteorology, physics, mechanics, astronomy, mathematics, biology, psychology, economics and management has been (Glyk, 1987: 27).

New theory of change management and order in the chaos in different fields of science, right in the same direction that views the system years ago to enter this area while being based on the basis of this theory is based on a system perspective. New theories of change management with natural systems, the topic term management and organizations to create didactic and scientific understanding of learners with communication between systems and real samples and the main organizational behavior (as the attraction of foreign knowledge management) model behavior and order relations among them within the continuous turbulence and instabilities organizational pattern recognition experiment with natural and every condition diagnosed, several control variables, and finally the possibility of consistent and optimal use of scarce vital resources can provide.

Yet in many countries, including the entry of new information about this theory in management science in particular has been published. Remain in these countries most managers, the old attitude of success in establishing stability and sustainability of organizational know, new scientific discoveries invalid if they had shown. Frequent changes in the world that sometimes even the life expectancy of organizations "to much less than the average life expectancy is to serve employees, thinking the stability and continuity, rapid Browse the Organization would be premature Fnay (Astysy, 1382:37).

For the possibility of continued survival of organizations in the global market, organizations today need to change strategy to move from models to models of sustainable change requires preparation of a model based on reengineering, organizational change management theory is that the new results lead will be to productivity and prosperity in new environment. So thoroughly was achieved by relying on findings Pyshynyh new and existing research on the Towards a model of organizational efficiency to perform. Since feasibility study subject provided a model based on organizational productivity, change management is therefore based on background research first review classical models of stability and lack of effective management of its extensive and continuous changes in environmental conditions over the network and global market competition, to Considering the lack of different variables and their different effects on each other under different time and space, we will the need and necessity of the use of change management theory.

Then, based on the findings of the research literature that it should be practical samples the freshness issue, mainly "in the research and studies can be external search, explaining said.

Theories in this article

Theories proposed in the study primarily "on three categories of macro theory is based on the stub.

1- Chaos theory
2- Change management(Knowledge Management)
3- Balanced Scorecard

The first group to explain complex theories in order theory, or chaos theory as a basis for creation of natural, real and actual change any system, including organizational changes and efforts of researchers and the possibility of extracting a model of organizational efficiency will be based on the general theory mentioned in the context of relations and non-linear equations .

Second theories on global change management framework, issues and major issues in global change and management of change, and formed within the theory of knowledge management as a fundamental theory of content and context of the new model of organizational productivity with a transparent relationship between knowledge and learning process, During the development process of organizational knowledge in change management and continuous conversion of data to endless information, information, knowledge and organizational knowledge, wisdom, hidden knowledge of how to become a clear knowledge of production and release of knowledge creation and exploitation and will submit documentation .

In today's world Knowledge management theory as the most important tool acts "Strategic Management" with the focus on human capital management and deployment tools as well as "information management and communications" in new technologies and innovative format is (Drucker ,1999:387-388) .

The third category involves theories of traditional approaches and new approaches to productivity and organizational assessment that it will naturally "selected on the basis of this

ISBN : 978-602-97809-0-1

research, new approaches and the most comprehensive model of the multi balanced performance assessment and measurement of organizational productivity, which is known BSC , currently is used in most the world leading organizations.

Research design and methods of data analysis

Methods descriptive - analytic and analysis of data from multivariate analysis were used. Model desired response to questions for research, diagnostic analysis, through which the user can distinguish two dimensions with high efficiency and low productivity to be removed.

Research design

The subjects stated, the following research process model are provided:

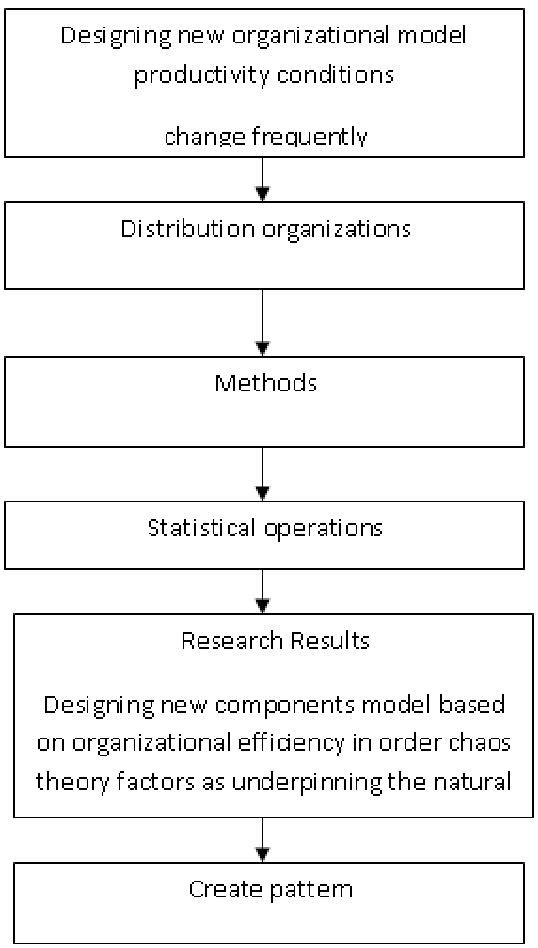

Fig1- Research design

Considering the main purpose of this study design productivity management model based on change management theory, the main themes of this model in accordance with Figure 5 with four dimensions of growth and development, employee satisfaction, customer satisfaction, and indices of financial and managerial levels dependent variable and one after the main independent variable is the efficiency of management. Defined variables section of the instrument are provided.

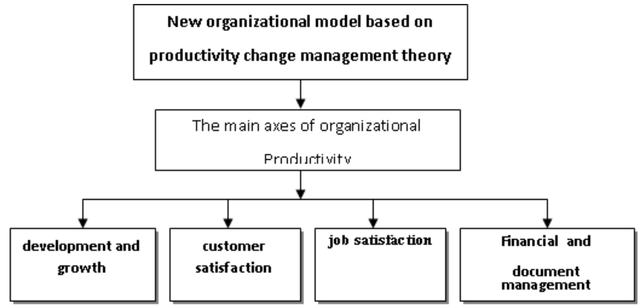

Fig 2-New model based on organizational productivity theory of change management (adapted from Kaplan and Norton 1996)

Dependent variables:

Four dimensions based on the model dependent variable measuring productivity and performance of an organization called the Portfolio Performance Evaluation and Productivity balanced Kaplan and Norton. As noted in this model, financial indices with a retrospective approach, indicators of customer satisfaction and job satisfaction of employees and however prospective approach and the development and growth indices with a prospective approach is placed in the organization studied.

Components in the following tables marked for every dimension :

Components of "job satisfaction" and "Financial balance Increasing income" Dimensions:

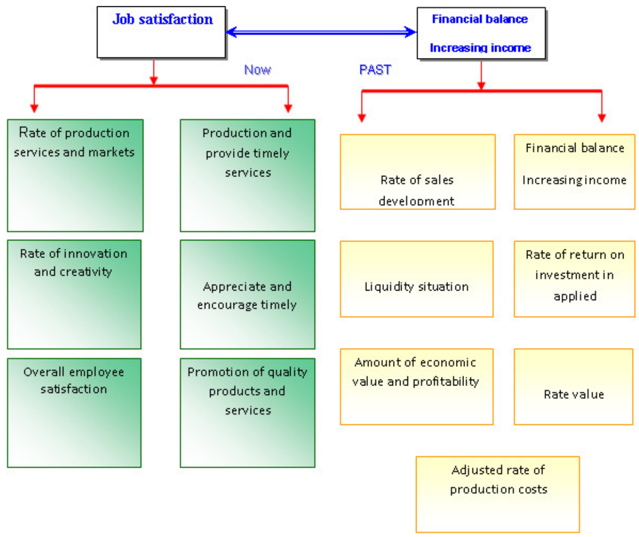

Fig 3- Components of "job satisfaction" and "Financial balance Increasing income" Dimensions

Components of "Customer satisfaction" and "Development and growth" Dimensions:

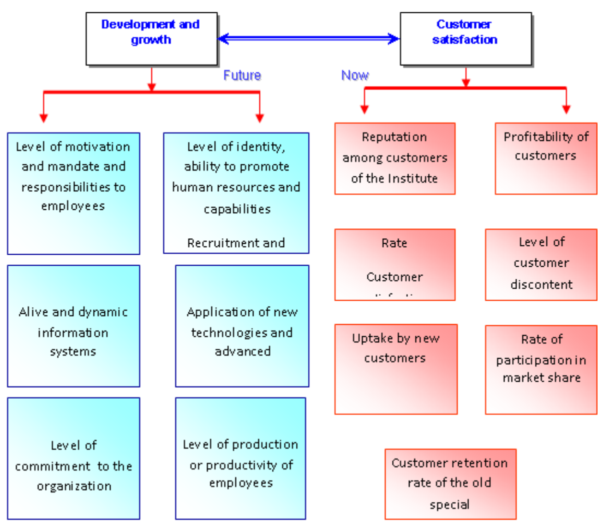

Fig 4- Components of "job satisfaction" and "Financial balance Increasing income" Dimensions

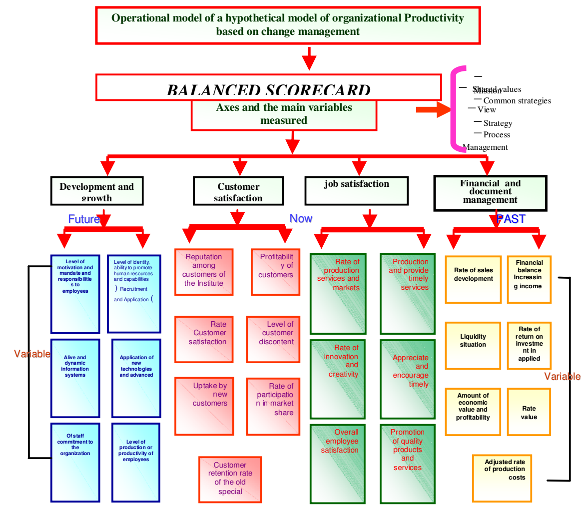

Fig 5-Operational model of a hypothetical model of organizational Productivity based on change management

Independent variables:

Strategic planning process(X1)
Continuous learning (X2)
Common culture (X3)
Specialized working groups (X4)
Process control and monitoring(X5)
Structure and communication (X6)
Spirit transformational managers(X7)
Challenges, conflicts and ongoing tensions (X8)

Thus, the main context questionnaires in order to become operational and the possibility of matching it with characteristics of the administrative system, is localization.

The questionnaires were distributed among six organizations: Dana Insurance Company, Iran Insurance Company, The Airline of the Islamic Republic of Iran, Bank Keshavarzi , Melli Bank, and Iran Khodro.The questionnaires were completed by 171 managers, 568 employees, and 599 customers.

Research Process

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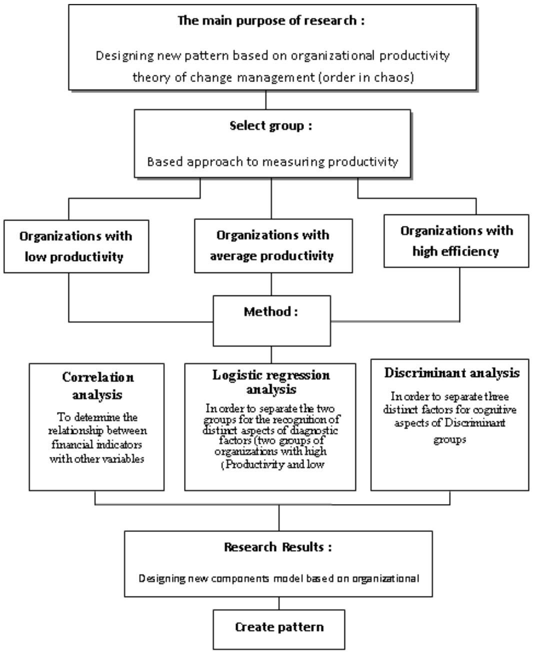
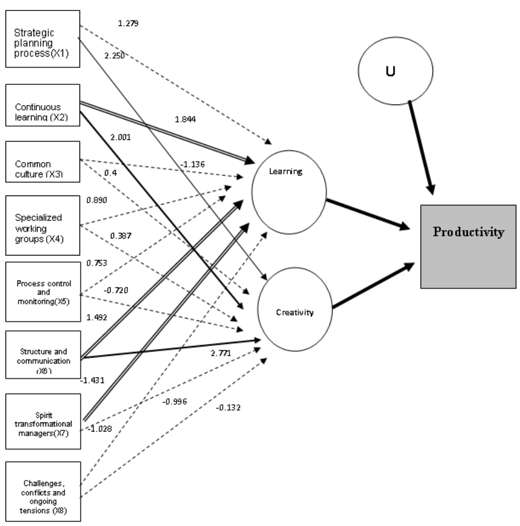


Fig 6- Research Process

Quantitative model



Factor indicating disorder (Disturbance), residual (Residual) or no effort (Unattempted) U
Relationships between dependent variables and The latent
Possible relationships
The second function relationships
The first Function relationships
Dependent variable
Latent variable
Independent variable

Fig3- the relationship between independent variables, dimensions and latent variables

Executive proposals

Considering the findings in order to establish a management system that could be a way to change the higher productivity was achieved organizational issues must be below.

- The strategic proposals for moving the organization from a system based on the stability of a change management system, the most important issue of making operational and institutionalized after two latent learning and creativity in organizations are based on the independent variables.

Recommended considering the lack of long-term planning process to work for change and development organizations, replacing the need to change the pervasive learning (Learning) to remove the organization's future and the unknown system and also the replacement process innovations rather than institutionalize a common culture, Based on the findings and theoretical and research support Bastnad background research, planning, especially after the establishment of two latent resulting from findings of research organizations and similar organizations to establish change management is necessary.

- In order to achieve higher productivity, higher quality services and products in the military should be deployed in organizations with a comprehensive and multifaceted approach as balanced performance evaluation system (BSC) to the three objectives "continuous performance evaluation," "Organizational productivity" and " explaining strategy and new strategy "in the form of organization Platforms and live electronics was achieved that requirement is the presence in the global market.

- Realizing these three goals and good communication between them requires clear definition of organizations associated with the environment and identify and implement elements of axes "work processes" (Productivity in the structure) with the deployment process relying on creativity and innovation as the most important and the first main process "Customers and shareholders" (environmental efficiency), financial indices Economy (financial efficiency) and development and learning (criteria link the future productivity of the current strategy) is the main focus should be on this endless new construction goals for continuous change management and continuous presence in the range of competition.

Past and present management practices based on sustainable management systems in context of linear programming and management of the future will be based on multiple variables within the unstable and non-linear programming.

- Each program of change must be integrated with programs accessible short-term and long-term horizon in the form of a new strategy, well-defined organization so that employees with clients all the achievements of early short-term plan to achieve change in faith to find.

- Start operational management plan to make changes in any organization can be different, usually "the main current problems based organization began making the first axis is operating. The obsolescence and inefficiencies in duty structures in a model of a completely new "to create an organization based on electronic-based change management"

ISBN : 978-602-97809-0-1

process of the work "is the basis for the first begin core is placed.

- deployment of change management model for improving productivity should be the first experiment (Pilot) on one of the smaller organizational units in the highest readiness levels, especially in connection with the change in criteria related to the "people", "processes" and " the organizational systems ", the performed and the results evaluated and reforms needed in all levels of the organization to be generalized.

-Creation of specialized working groups "on the main sealed section defined in the model change management and identity and part of empowering them to make deployment of change management principles to practice informal and temporary structure that integrated with its beautiful formal organizational structure can continuously link between" incidence Creativity and Innovation "and" programs and projects defined by the "organization.

- learning models and models of failure occurred in the most important foundations of successful preparation, sharing and interaction of human capital and transfer led organizational knowledge is to the establishment of change management.

-. Structural computer simulation models that have reconstructed the best software for learning and the new model are extracted.

- Implementation of real system change management and organizational productivity management based on too many "variables", "index" and "criteria" which both independently as well as influencing each other to act only in the form of communications systems and Live electronics and information systems and new technology is possible, therefore suggested that with the establishment of change management systems and organizational productivity (BSC), electronics systems building organizational activities (ERP) and transparent process use for their defining .

A) proposed criteria and indicators for measuring the findings and determined Subjects.

Based on the fact that the findings, the latent "learning" 93% of variance in levels of productivity can therefore justify "the main criteria and indicators" to measure the following to create an efficient organization in the management of change Iran is recommended:

- ✓ Measurement of promoting dignity and human capital capabilities
- ✓ Participation and interaction of staff
- ✓ Powers of motivation and also staff
- ✓ Increasing the number of Knowledge Workers in the form of specialized work groups
- ✓ Staff satisfaction
- ✓ Training of staff
- ✓ The quality and number of meetings and group meetings continuing
- ✓ Usage information systems alive and dynamic (learning inventor)
- ✓ Application of new technologies and advanced (creating learning)

B) The findings after the second latent "creativity" that 7% of variance of different levels of productivity can therefore justify "the main criteria and indicators" to measure the following for proposed be a productivity organization in the change in Iran:

- ✓ Define the process of creativity and innovation (including market and customer type and product innovation)
- ✓ The incidence of creativity (in number of suggestions were found, suggestions accepted as action, reward a job well done and the amount of staff to contribute to decision)
- ✓ Defining criteria for a valuable innovation (percentage of sales of new products and services, percentage of special sales, improve manufacturing capabilities, the time of new products, the efficiency of the production cycle, reduce production time and number of cycles (time series of head) cost reduction, increased income resulting from each work unit, operating profit compared to the costs of research (which can be related to creativity and production show)

c) "Indicators and criteria to determine the" measure customer value, customer satisfaction and dissatisfaction and customer judgments than Organization in the form of customer service management system.

d) "Indicators and criteria to determine a" measured service quality assessment through:

- ✓ Poor service or product failure rate per unit of production
- ✓ Ratio of products to safe products
- ✓ The quality of after sales service
- ✓ Provide timely service and product level (Jit)

To perform the above due to be exquisite and most recently in the first step on the creation and deployment of global systems development centers in the form of Management Development Centers as a form of re-engineering organizations in general agreement has changed. Establishment and strengthening of management studies and development centers in the most basic steps that can achieve proper implementation stage and receive practical demands have followed the above organizations and how exposure to light with new responsibilities and planning to implementation This suggested that in third world countries in terms of human resources capabilities, skills, and professional experts are deficient, the timing could be necessary in the first cause of literature and a shared vision among the elite organization that should change a new system architecture assumed , and then by causing them to generalize and publish it should be at all organizational levels.

Results:

The results showed that 55% of the managers studied have an intention to follow the change management based on the Chaos Theory, 38% preferred the participative management, and only 7% believed in mechanistic (stability) management. In other words, in spite of the domination of stability management in most of the organizations and corporations in Iran including the organizations surveyed, more than half of the managers show their tendencies towards change management according to the chaos theory approaches regardless of the existing range of productivity in their organizations.

The results of discriminant analysis showed at, the three levels of productivity (low, average, high) distinguish two latent dimensions of learning and creativity. Organizations with high productivity have had the highest mean in both dimensions. 93% of the variables among the different levels of productivity can be explained by learning. Therefore, knowledge-based changing organizations have to focus on constant learning in order to increase their productivity with the help of the best practices, experiences and experimentations and evaluation of the new approaches and the continious transfer of knowledge. The second dimension was creativity and innovation which shows clearly that permanent creativity and resistance to compatibility distinguishes today’s successful organizations. According to the logistic regression analysis, 68% of the whole managers studied have been characterized clearly in the classifications of productive and nonproductive levels. These results are in agreement with the findings of the discriminant analysis.In short, the variables of constant learning, knowledge workers, organizational structure and communications,organizational supervisory and control processes,common culture and evolution-creating morale play the most important role in distinguishing the proudactive and nonproudactive organizations in Iran . The coefficients of the two variables of strategic planning, and constant conflict and tension are negative and are not significant from the statistical point of view.

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ISBN : 978-602-97809-0-1

Measuring the Effect of Customization in Influencing the Success of ERP Implementation

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Abstract– **In implementing ERP, customization sometimes can not be avoided due to the need of filling up the gap between organization requirements and ERP package. Even though many studies suggested minimum customization, the amount of allowed customization is still remained unclear. This study proposes a measurement framework to investigate the relationship between ERP customization and ERP implementation success level. The measurement is performed by employing correlation analysis between the degree of customization (DOC) and ERP implementation success level. Beforehand, the measurement of DOC is carried out using the complexity matrix while the implementation success level is assessed through the dimension of satisfaction, individual impact, organizational impact and intended business performance improvement. This measurement framework is expected to be able to explain whether the customization has positive impact, no correlation or negative impact to the ERP success level, but it cannot be used to detect the change of success level when there is the change in degree of customization. However, the measurement result can be utilized to estimate the range of allowed customization level.**

Keywords **— ERP implementation, customization, correlation**

I. INTRODUCTION

Competitive business environment is endlessly forcing business organizations to find the more effective and efficient operation. Organizations are continuously re-adjusting and re-aligning their operation to be more outward looking, market-oriented and knowledge driven [1]. Integration becomes the key factor to support this condition. Integration of all organizational mechanisms will support organization to take quick reaction to competitive pressures and market opportunities [2]. Enterprise Resource Planning (ERP), with the ability to integrate and optimize business processes in corporation has been developed to answer this challenge [3]. Reference [4] explained that ERP works to integrate all corporate information in one central database, so that all information can be easily retrieved from any department. Reference [2] confirmed that implementing ERP is the most effective way toward traceability and enterprise integration.

In almost 20 years, ERP has been implemented and developed widely. Worldwide market of ERP packages was estimated as growing at an annual growth rate of 4.8% and may exceed $21 billion in 2010 [5]. In 2006, ARC Advisory Group was calculating that total ERP market was $18.4 billion and the annual growth of the market was predicted in the level of 6.7 %. Based on that prediction, they estimated that by 2011 the value of the market will reach $24 billion.

Even though ERP sounds promising, its implementation project is not a trivial issue. In information systems development perspective, ERP implementation project is different from a traditional system implementation. References [3,6] noted that ERP implementation is closely linked to the change in business process in organization. According to reference [7], ERP implementation leads the organizations to change the way they perform their tasks. Moreover, ERP project is a risky project for an organization. From the economic point of view, it is high cost and hard to estimate the project. This complexity has attracted academician to do research in this area. It was found that 40% of 313 ERP research articles published from 2000-2006 contain the explanation of ERP implementation [3].

Generally, ERP implementation project consists of many complicated tasks to accomplish. Those complicated tasks, in some cases, leads to failure of ERP implementation. Reference [8] reported that 70 percent of all ERP projects fail to be fully implemented even after three years. According to reference [9] after reviewing 134 articles, there are 26 categories of critical success factors related to ERP implementation. It implies that there is no single reason for ERP success or failure.

Based on that review, it was found that only a few past researches tried to associate the success of ERP to the technical factor, particularly customization. In fact, customization is something crucial to fill the mismatch between enterprise needs and ERP system [10]. Reference [9] clarified that the basic version of ERP with no or minimal customization is a category of ERP critical success factors. While another reference [11] recommended the limit of customization level to guaranty the success of ERP implementation.

Although reference [11] recommended the maximum amount of 30% customization as the limit for ERP implementation, with an inadequate explanation, the level of customization is still a non-representational thing. In other word, it still leaves a question about how the customization of ERP can influence the success of its implementation. This question needs to be answered to get a more complete view of ERP implementation. Further study to investigate the relationship between ERP customization and the success of ERP implementation is considered a necessary action. Moreover it is also necessary to find out how far that ERP can be customized without significant impact to the implementation success.

II. ERP IMPLEMENTATION& ERP CUSTOMIZATION

A. ERP Successes and Failures

Despite ERP implementation has been investigated for long time, definition of ERP success or failures is still vague. Many studies discussed the critical success factors of ERP implementation without sharply defined the condition of ERP success. However, some alternatives can be considered in categorizing the level of the success ERP implementation. For example, reference [8] explained ERP implementation can be categorized as complete success when everything goes off without a hitch; partial success when there are few alignment problems resulting minor inconvenience or minor downtime; partial failure when there are tenuous of adjustment process that creating disruption in daily operation; and complete failure when the project was scuttled before implementation or failed so miserably that the company suffered significant long-term financial damage.

Other reference [2] explained the success of ERP implementation by associating it to the benefits of the ERP system. It explained that when ERP is implemented successfully, it will give some benefits to the company. Those benefits are categorized to 5 groups as follow:

- Operational: cost reduction, cycle time reduction, productivity improvement, quality improvement, customer services improvement
- Managerial: better resource management, improved decision making and planning, and performance improvement
- Strategic: concerning business growth, supporting business alliance, building business innovation, building cost leadership, generating product differentiation and building external linkages
- IT infrastructure: involving building business flexibility, IT cost reduction, increased IT infrastructure capability
- Organizational: supporting organizational changes, facilitating business learning, empowering and building common visions

In different approach, elaborated from previous research, reference [12] proposed a measurement model of successful ERP Implementation which consists of four dimensions as follows:

- User satisfaction: the extent to which users believe that the information system available to them and meets their information requirements
- Individual impact: improved individual productivity, task performance improvement, decision effectiveness and quality, time to make decision.
- Organizational impact: related to organization's operating cost, overall productivity, customer service level, realization of specific ERP implementation objectives.
- Intended business performance improvement: predefine performance objectives of the ERP project including cost reduction, business process integration, time, cost, etc.

Basically, it can be said that ERP is successfully implemented if it can perform well in term of satisfying user, giving positive impact to both individual and organization to perform business activity and improving the particular business performance as planned.

B. ERP Implementation Model

Since the company structure and business process vary from one to another, implementation characteristics also differs. It depends on the characteristic of the organization and the ERP itself. References [13] explain the implementation characteristic by following criteria:

- Physical scope
- BPR scope
- Technical scope
- Module implementation strategy
- Resource allocation scope

All these characteristics are then simplified by reference [14] into the measurable variables as shown in Table 1.

TABLE I. MEASUREMENT VARIABLES OF ERP IMPLEMENTATION CHARACTERISTICS

Variable Name	Measurement Units
Project length	# months
Project efforts	# man-months
Project budget	US$
ERP customization	extent of modification done to ERP to customize the software (1-10)
ERP breadth	single site (1), multiple sites in one state (2), multiple sites in multiple states (3), international multiple sites (4)
ERP depth	# user of ERP
Business process automation increase	(% of processes that are automated after ERP) – (% of processes that were automated before ERP)
BPR magnitude	(% of activities in reengineered processes that were modified) * (extent of modification 1-10)
BPR depth	(# of employees whose activities changed)
BPR breadth	small number of people within a dept. (1); a department (2); more than one department (3); a region (4); more than one region (5)

Considering those scope of implementation, there is no guaranty that the ERP can be implemented using the same method. In order to assure that ERP will work appropriately, scholars tried to design a systematic approach to implement an ERP system. They tend to make a proper integration of all ERP components (software, process flow, customer mindset, and change management) [15]. Because of the different approaches, scholars have proposed varying implementation models. For examples, six-stage model [16], five-stage model [15], three-stage user oriented model [17] and the comprehensive five-stage model [18]. All of these models, principally, consist of three stages: pre-implementation (preparation), implementation (realization) and post-implementation stage.

C. Customization as Part of ERP Implementation

In the marketplace, ERP as a packaged-software was designed by considering best practice process from the specific industry to support typical business process in the entire industrial field [19]. It was designed by an organization but used by others. Since the designer and user are two independent organizations, misalignment between users need and the software design are often happened. Reference [20] reported that the gap between functionality of the package and the organization's requirement is frequently happened. It brings the implication for the organizations to customize their ERP package to make it fit with their specific needs. It is then become an important step in implementing ERP system.

ERP customization refers to the modification of the ERP package or its functionality, it may include modifications to user interfaces, reports, messages or even program codes [19,21]. This activity is usually taken in ERP implementation as an effort to align the system with the specific need. Therefore, this activity has been considered within various implementation models.

References [16,17,18] highlighted the customization as an integral part of implementation although it was named differently. In the six-stage ERP implementation model [16], customization takes place in adaptation stage. It was clearly stated that organization need to customize their ERP package to suit their specific requirement. In this model, customization was finished when the system are available for the end users.

Five-stage implementation model [18] describes customization as the part of realization whereas technical development and conference room pilot project take places. In this stage, they suggested technical development (modification, interfacing and data conversion) to work concurrently with conference room pilot project (prototyping and final adjustment). Similarly, three-stage implementation model [17] set apart the customization in the stage of realization which they called implementation stage. Nevertheless, at the end they found that customization has to be made minimally to ensure the system will work properly in longer time horizon.

D. Degree of Customization

Customization is one of the distinctive parameter to define the ERP implementation characteristics [5,13]. It is because in the real world, organization made various ERP customizations due to different requirement. As the implication, there are various types and amount of customizations have been done. Even though many studies [8,11,13,14,21,22] suggested the minimum customization to implement ERP successfully, the degree of customization is still unclear.

A study [19] tried to formulate the customization matrix that can be used in real world practice. The study collected data from some companies about the objects that have been modified and their development time range. Modified objects were grouped into several types of customization while development time ranges were classified into several classes to represent their complexities. For each class in every types of customization, the range of development time, average and standard deviation were calculated. Finally, the complexity indices were defined using the average of development time. Entire complexity indices are provided in Table II.

TABLE II. CUSTOMIZATION COMPLEXITY MATRIX [19]

Customizati-on types	Complexity			
	Simple	Medium	Complex	Very complex
Reports	$0< dt\leq 56$ $i = 31$	$56< dt\leq 84$ $i = 66$	$84< dt \leq 157$ $i = 121$	$157< dt$ $i = 292$
Interfaces	$0< dt\leq 44$ $i = 33$	$44< dt\leq 166$ $i = 66$	$166< dt$ $i =213$	-
Extensions	$0< dt\leq 44$ $i = 21$	$44< dt\leq 103$ $i = 65$	$103< dt\leq 227$ $i = 179$	$227< dt$ $i = 281$
Conversions	$0< dt\leq 90$ $i = 56$	$90< dt\leq 212$ $i = 124$	$212< dt$ $i = 300$	-
Workflows	$0< dt\leq 57$ $i = 49$	$57< dt\leq 71$ $i = 64$	$71< dt$ $i = 77$	-

dt = development time (hour)
i = complexity index

ISBN : 978-602-97809-0-1

III. Effect of Customization to ERP Implementation Success

A. Effect of Customization to the Daily Operation & Maintainability

In order to serve daily business operation smoothly, ERP customization processes are hardly to avoid. Customization is projected to fill up functionality gaps, satisfy user requirement and cover user's demands in post implementation stage [21]. Reference [23] proved that greater customization implies better business operation in term of coordination improvements. This perspective suggests a large numbers customization processes to ensure users satisfaction in daily business operation.

In contrast, references [8,11,13,14,21,22] recommended the minimum level of customization. It is related to the maintenance issue of the ERP system after customizations have been made. Reference [24] reported that the increased customization complexity will amplify maintenance efforts. Customization can also increase the risks and cost of maintenance while it creates difficulties for further development [21].

ERP customizations have contradictory implications. From the daily operation perspectives customization must be made in maximum level to satisfy users' need. However, it brings negatives implication regarding the cost, risk of implementation and maintainability of the systems. Therefore, customization can be seen as a tradeoff between the ease of use and its maintainability.

B. Measurement Framework

In order to find out the effect of customization to the success of ERP implementation, some measurements are needed. Generally, entire measurement process can be described as the process of measuring degree of customization, assessing the implementation success level and followed by examining the relationship between them. Entire measurement processes are shown in Figure 1.

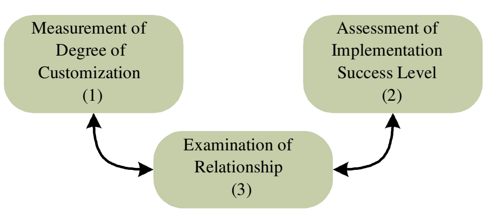

Figure 1. Framework of measurement process

The detail measurement framework is explained in the some steps below:

1) *Measurement of Degree of Customization*: This measurement can be performed by observing all modifications that have been made. All the modified objects then being categorized and converted to their complexity index using customization complexity index as show in Table II. Finally, the total complexity can be calculated.

2) *Assessment of Implementation Success Level:* To perform this measurement, first the dimensions of ERP success level have to be defined. Although the four dimensions measurement model [12] can be employed for this purpose, the implementation success level still cannot be measured. For this purpose, as suggested by reference [25], these four dimensions have to be decomposed into some measurable variables. In this case, accumulation of these variables reflects the complete concept of implementation success level. Hence, this assessment can be performed by measuring the variables.

3) *Examination of Relationship*: When some data about degree of customization and level of success ERP implementation in an adequate sample size are provided, correlation analysis can be employed to examine their relationships.

IV. Measuring Customization Effect

A. Relationship between ERP Customization and Successful ERP Implementation

To measure the effect of ERP customization to successful ERP implementation has the same meaning with the examination of their relationship. Here the ERP customization is represented by the degree of customization value. As the concept of successful implementation is non-representational, it has to be represented by something else. Reference [25] suggested that operational definition of a concept should be described by its dimensions or typical characteristics which are able to be described by some measurable elements. In this case the successful ERP implementation is described by dimensions of user satisfaction, individual impact, organizational impact and intended business performance improvement. Therefore, this relationship can be represented as the relationship between the degree of customization and those four dimensions. As shown in Figure 2, the degree of customization is related directly to the four dimensions, while those four dimensions are related directly to the successful ERP implementation. It can be assumed that degree of customizations is indirectly related to the successful ERP implementation.

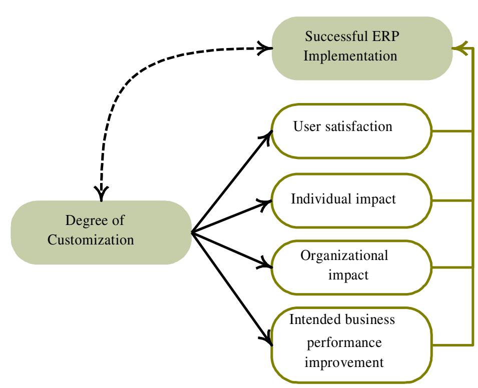

Figure 2. Relationship between ERP customization and the successful ERP implementation

ISBN : 978-602-97809-0-1

B. Measurement Setting

This measurement uses selected ERP user companies as the unit of analysis. Therefore, it needs a set of data collected from some sample companies. To determine the numbers of sample companies, reference [26] can be considered for further analysis. Measurement processes are explained below.

1) Notation

Following notations are used here:

O_i i_{th} customization object
dt_i development time to modify i_{th} object
CI_i complexity index for i_{th} object
DOC degree of customization
v_{ab} b_{th} variable for a_{th} dimension of ERP success level
f_k k_{th} factor for ERP success level

2) Degree of Customization Measurement:

The objective of this measurement is to find out the degree of customizations that have been made in each sample company. Steps in measuring degree of customization for each sample company are explained as below:

- *Step 1*: make a list of modified objects
- *Step 2*: assign O_i to the type of customization; check whether it belongs to reports, interfaces, extensions, conversion or workflows category
- *Step 3*: refer to Table II, find the class of O_i based on dt_i
- *Step 4*: convert O_i to CI_i
- *Step 5*: calculate DOC for every sample using customization complexity formulation [19]:

TABLE III shows the example of DOC measurement in a company. TABLE III consists of 4 columns; modified object (column A), category (column B), development time (column C), and customization index (column D). Column A is filled by the name of objects that have been modified. Column B is filled by the category (reports, interfaces, extensions, conversion or workflows) of the corresponding modified object. Time needed to develop each object is stated in column C. Column D is filled by the customization index for each modified object based on customization complexity matrix [19]. Finally, the DOC of this company can be measured by summing up the customization indices. These steps have to be repeated for all sample companies.

TABLE III. EXAMPLE OF DOC MEASUREMENT

A	B	C	D
Modified Object	**Category**	**Development Time**	**Customization Index**
O_1		dt_1	CI_1
O_2		dt_2	CI_2
O_n		dt_n	CI_3
Total			

3) Assessment of ERP Success

The ERP success is assessed through its dimension; user satisfaction, individual impact, organizational impact and intended business performance improvement. Each dimension is assessed through the assessment of some measurable variables which are reflected that dimensions. For example, the dimension of user satisfaction is measured by assessing the user perception about the availability of the system, the ease of information retrieval from the system, and so on. After all measurable variables are provided, the complete assessment can be proceeded. The assessment steps are explained below:

- *Step 1*: measure the value of v_{ab}
- *Step 2*: set groups of variables using confirmatory factor analysis so the level of success can be measured through the factors (f_k). f_k are representing the dimensions of implementation success level. Further explanation of confirmatory factor analysis can be found in statistic references.
- *Step 3*: calculate f_k for every sample

4) *Correlation*

After the DOC and f_k value of every sample are measured, the new dataset is established as shown in Table IV . Column A consists of the number of sample companies. Column B is filled by the DOC (degree of customization) of each corresponding company. Column C is filled by the value of the first factor (user satisfaction) of each corresponding company. Column D reflects the value of —individual impact□, column E reflects the value of —organizational impact□, and column F reflects the value of —intended business performance improvement□ in each sample company.

TABLE IV. EXAMPLE OF DOC AND ERP SUCCESS DIMENSIONS

A	B	C	D	E	F
Company No.	**DOC**	f_1	f_2	f_3	f_4
1	DOC_1	$f_{1.1}$	$f_{2.1}$	$f_{3.1}$	$f_{4.1}$
2	DOC_2	$f_{1.2}$	$f_{2.2}$	$f_{3.2}$	$f_{4.2}$
3	DOC_3	$f_{1.3}$	$f_{2.2}$	$f_{3.3}$	$f_{4.3}$
n	DOC_n	$f_{1.n}$	$f_{2.n}$	$f_{3.n}$	$f_{4.n}$

From dataset as shown in Table IV, the relationships between DOC and each f_k can be examined by employing correlation analysis. The result of correlation analysis can be utilized to determine how DOC can influence every dimensions of ERP success.

V. CONCLUDING REMARKS

This measurement framework is proposed to examine how customization can influence the success of ERP implementation. Using some companies as samples, the effect of customization can be examined through the analysis of the relationship between customization level and ERP success level. Customization levels are measured in term of degree of customization (DOC) by employing the complexity index. The success of ERP implementation is assessed through its dimensions, which are user satisfaction, individual impact, organizational impact and intended business performance improvement.

To determine the relevant factors to ERP success level, this study will employ the confirmatory factor analysis. In using confirmatory factor analysis, there are some potential miscalculation problems. It could happen when all extracted factors cannot represent the entire ERP implementation level. In this case, there are some unknown factors related to the success level of ERP implementation.

In examining the relationship, correlation analysis can explain whether the customization has positive impact, no correlation or negative impact to the ERP success level. However, in this method, the amount of change in the degree of customization cannot be utilized to detect the change of ERP success level. The range of allowed degree of customization can be estimated by setting up the desired level of ERP success. This method is satisfying when inter-dependency among factors is not existed. When interdependencies among factor are existed, some multivariate statistics method can be used for further analysis.

ACKNOWLEDGMENT

This research has been conducted under UTeM's Fundamental Research Grant Scheme, The Malaysian Ministry of Higher Education.

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The Impact of Knowledge Sharing towards Benefit Realization during Implementation of ERP

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Abstract**—** The success of implementation of ERP during both project or post project phases depend on the organization ability to reduce obstructions in order to facilitate knowledge sharing process. Knowledge sharing in ERP which is cross function of business process, is required to obtain the benefit during implementation of ERP [5].

The objective of this research is to discover influences of knowledge sharing for attaining the benefit of implementation of ERP in post project phase. The research approach is survey with distributing questionnaires to companies which have implementation of ERP during at least one year. Questionnaires which are able to be processed are 41 pieces. Method for testing the model is partial least square (PLS).

The results of this study indicate that knowledge sharing affect to achievement benefit of implementation of ERP. This research is expected to give scientific contribution in implemention of ERP system during post project phase in Indonesia, especially relating knowledge sharing to benefit realization during implementation of ERP. In addition, this research is able to give insight for companies in order to enhance their capability in accomplishing the benefit realization of implementation of ERP.

Keywords: ERP, benefit realization, knowledge sharing, organization culture.

I. INTRODUCTION

The business world that more competitive require firms to implement a business strategy to survive their business even more to be a superior in the competition. Business strategy has several factors, such as effort to reduce costs, improve efficiency and productivity, expand business and organizations, as well as agreement with business organizations as a statute and interconnected systems [1]. An effort of business process improvement is implement an Integrated Information System, namely the Enterprise Resource Planning (ERP).

Implementation of ERP requires big investment [2], but many companies can not percieve the benefit of the investment. According to [3], Standish Group noted that only 10% of companies can implement ERP successfully, 35% abort it and 55% delayed the project. Many companies in Indonesia also experienced the same failure after a massive investment for implementation of ERP. However, such failures are rarely expressed, because they were embarrassed to disclose details of the company's failure. It will degrade company's image and disappoint consumers and shareholders [4].

Many companies assume project during the implementation of ERP system as the final destination, or many ERP systems are only used during three months to one year after they were declared a successful implementation of ERP system project. End of the project is seen as a static ending point, whereas to obtain / realize the benefit of implementation of ERP is required a continuous improvement during post project phase [2]. The ERP system can be used up to 15 years if the company did not experience major changes. Implementation process of Enterprise System requires understanding about the proper software and related business knowledge [5].

The success of implementation of ERP during both project as well as post project phases, require the role of the organization minimize barriers in order to knowledge sharing can work well. Because of ERP is a cross-function of business processes, the knowledge sharing was required to obtain the benefits from implementation of ERP [6].

Research about knowledge sharing during implementation of ERP had been widely applied. But no studies that examine comprehensively about the benefit realization during implementation of ERP and its relation with the management of knowledge sharing during the ERP post project phase, especially for companies in Indonesia. Therefore, this research was conducted to assess the effectiveness of knowledge sharing during post-implementation of ERP.

Sustainability of the success of implementation of ERP systems require a continuous improvement during post-project of implementation of ERP. One critical factor of the successful during post project implementation was a management of knowledge sharing [7].

The success of knowledge sharing can be achieved, if the benefit of implementation of ERP can be perceived by the company. Knowledge sharing and benefit realization of ERP has positive correlation [8].

As already mentioned in the background, the problem that formulated in this study is how knowledge sharing can affect on achievement of benefit realization during implementation of ERP in the post project phase? The purpose of this study was to determine the effect on achievement of knowledge sharing benefits during implementation of ERP in project or post project phase.

II. MODEL DEVELOPMENT

The research model based on model of Cheng and Huang (2009) that examined the relationship between implementation of ERP and the level of knowledge sharing to see if the implementation of ERP facilitate (or inhibit) the employees to share knowledge. The ERP system integrate all data and business operations, so every employee can share information more easily. There is a pair of instruments adopted in this research, namely the benefit realization of ERP and knowledge sharing. The benefit realization of ERP that used are the benefit realization of ERP that is proposed by Shang and Seddon (2002), which is used to evaluate the benefit of implementation of ERP.

Implementation of ERP and knowledge sharing have a positive relation [8]. This study did not reveal any significant conflicts in the relationship between implementation of ERP and knowledge sharing (there is no negative correlation coefficient), although some of them are overlap and showed no significant relationship. But it did not mentioned how knowledge sharing influence towards achieving the benefit realization during implementation of ERP. Hence this paper developed a model to determine how knowledge sharing influence towards achievement the benefit realization of ERP.

Generally, the model will be built is shown in Figure 1.

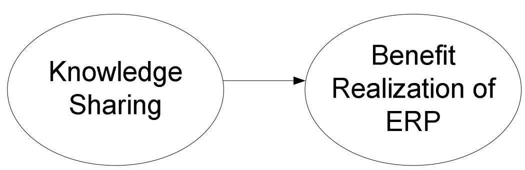

Fig. 1 The initial model of the development model

A. *Research variable*

One critical factor in post-project of implementation of ERP is transfer of knowledge from key users to other users, and sharing of knowledge among users related to the operationalization of the ERP system [7]. Therefore, the independent variable of this research is the knowledge sharing from the user's side (user's knowledge sharing). User's knowledge sharing is sharing of knowledge from key users to other users, or among users related to the operationalization of the ERP system. Many things that must be considered from the user's knowledge sharing were as follows:

a. Level of the user's willingness to share knowledge related to its ERP system [9].
b. Level of user's curiosity related to the operationalization of the ERP system that is used [9].
c. Availability of media to share the knowledge [9].

Meanwhile the dependent variables is the dimension of the benefits of implementation of ERP, focused on benefit realization of implementation of ERP, because not all firms that implement ERP can percieve its benefit.

Categorizes the benefit realization during implementation of ERP in five categories, namely operational, managerial, strategic, IT infrastructure, and organizational [10]. In this study, the dimension of benefit realization during implementation of ERP use three perspective [11], that are business perspective, technology perspective, and organizational perspective. These three categories perspectives had included the five categories of benefit proposed by Shang and Seddon. Therefore, the dependent variables in this study were as follows:

1. Benefit Business, that is benefit during implementation of ERP related to the management of managerial, business processes and company's strategic planning.
2. Benefit Technology, that is benefit during implementation of ERP related to the company's technology infrastructure
3. Benefit Organizational, that is benefit during implementation of ERP related to the human resources and company's working culture.

B. *Research Hypothesis*

One of the characteristics of an ERP system is integration [12], which can coordinate between various discipline of sciences and aligning processes among departments [8]. Functional integration is needed in the implementation of ERP, because ERP systems conserve the environment, where all functional units are working together to achieve the organizational goals [13]. This integration is creating new knowledge that enables companies to gain new insights or knowledge about timely new market, quickly adapting to market changes, and quickly respond to customer needs [13].

The knowledge is gained through information and data network, which provides scope of communications and strengthen of the structural relationship that brings the flow of information and knowledge to different organizational units. Information and data network facilitate an effective communication which binding the organizational units and essential to increase competitiveness (Tu et al., 2005). It shows that knowledge sharing will affect to the benefit realization of organizations and business. According to Black (1999), with appropriate KM mechanism, enabling companies to extend their business processes outside the boundaries of the organization including customers, suppliers, and partners [13]. The ERP system can assist towards achieving a strategic advantage, namely business growth, alliance, differentiation, innovation, cost, and external relations. Organizations placing Infrastructure KM to achieve strategic advantage, such as differentiation and innovation. Building business innovation, creating new products or services, generating the new ideas or reusing the knowledge maybe often occurs within the organization [8].

ISBN : 978-602-97809-0-1

From the description above, then made the following propositions:

H1: Knowledge sharing has a positive influence on the benefit realization of the business (MB)

H2: Knowledge sharing has a positive influence on the benefit realization of the technology (MT)

H3: Knowledge sharing has a positive influence on the benefit realization of the organizations (MO)

C. Research Model

Research model is built based on the explanation and the formation of hypotheses in the previous section. The model for this study is shown in Figure 2.

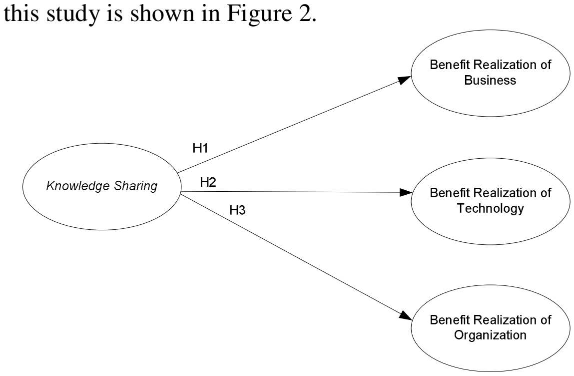

Fig. 2 The research model

III. METODHOLGY

This research use a survey approach to obtain data from the companies that have implemented ERP systems, by distributing a questionnaire. Survey research are explanatory because it explains a causal relationship between the variables in the model of research by testing the hypothesis.

Data collected by the distribution of questionnaires to the respondents. Before collecting data, the research population was determined by identifying many companies in Indonesia that have implemented ERP systems during at least one year. Samples taken from the population and will be a respondent.

Determination of sample size based on general rules of PLS method, that is the number of samples is ten times the largest amount of reflective indicators. The largest number of reflexive indicators in this study is four, so the minimum amount of samples to be taken is 40.

Distribution of the questionnaire was conducted in March-April 2010. The distributed questionnaires was 78, which returned only 56.41% (44 questionnaires). Among the 44 questionnaires returned, 41 questionnaires (93.2%) are valid and can be processed, while 3 questionnaires (6.8%) can not be processed, because some statements are not filled (incomplete questionnaires).

After data collected, the questionnaire was tested, which consists of the validity test and the reliability test. The validity is a test of how well an instrument can measure a particular concept to be measured, while the reliability test is a test of how consistent an instrument can measure a particular concept to be measured [14].

Both validity and reliability test using SPSS version 18. The validity of each statement seen from the value Corrected item-total correlation of the item (r_{count}). Statement will be valid if the value of r_{count} > the r_{table}, while it will be a declared reliable if the Cronbach alpha > 0.6 [15].

The next step is testing the measurement and structural models by evaluation the model of PLS (partial least square). Measurement model was tested by convergence and discriminant the validity of indicators and the composite reliability for the block indicator, while structural model tested by examining the percentage of explained variance. Software used for test is SmartPLS version 2.0.

IV. RESULT

A. Test of questionnaires

Calculations show that majority of the statement declared valid, because value of Corrected item-total of each item statement corellation (r_{count}) greater than r_{table}. There are three statements that are not valid because the value corellation Corrected item-total on the statement (r_{count}) is smaller than r_{table}, so that the statement should be removed, and re-testing the validity of the relevant indicators. Revalidity test indicated that all statements valid and reliable.

B. Evaluation of Measurement Model

Evaluation of the measurement model use both test of validity indicator and construct reliability supported by PLS 2.0 software.

The validity of measurement model can be seen from the correlation between the score of item / indicator with score of construct. Indicator will be valid if correlation value / loading factor greater than 0.50. Calculations show that all indicators have loading factor greater than 0.5, so all indicators are valid. The loading factor value shows in Table 1.

The reliability of measurement model measured by composite reliability, because its estimation to size of internal consistency more accurate [16]. Measurement model will be reliable if the value of composite reliability greater than 0.60. Table 2 shows the composite reliability of all variables, that are greater than 0.60, so the model has high reliability

C. Evaluation of Structural Model or inner model

The structural model is evaluated by percentage of variance that explained by counting R Square (Table 3), a test of goodness of fit model, and also see the path coefficients for testing of hypotheses. Evaluation of the structural model was conducted by PLS 2.0 software.

ISBN : 978-602-97809-0-1

TABLE 1

LOADING FACTOR VALUE

	T hitung	T Statistics (|O/STERR|)
KS1 <- KS	0.6085	2.6957
KS2 <- KS	0.7191	3.1952
KS3 <- KS	0.7672	7.6176
MB1 <- MB	0.8684	24.5392
MB2 <- MB	0.8646	15.7083
MB3 <- MB	0.9409	116.4671
MB4 <- MB	0.9593	95.2484
MO1 <- MO	0.7099	3.0668
MO2 <- MO	0.9467	36.1674
MO3 <- MO	0.8739	22.8037
MO4 <- MO	0.7373	4.1485
MT1 <- MT	0.9386	31.4522
MT2 <- MT	0.9224	4.8153

TABLE 2

COMPOSITE RELIABILITY

	Composite Reliability
KS	0.7422
MB	0.9501
MO	0.892
MT	0.9281

TABLE 3

R SQUARE

	R Square
MB	0.1631
MO	0.1801
MT	0.1222

Interpretation of the value of R^2 for each latent variable is as follows:

- The value of R^2 for MB latent variable is 0.1631. it suggests that MB latent variable which is explained by latent variables may influence 16:31%, while 83.69% is explained by other variables outside of the study.
- The value of R^2 for MT latent variable is 0.1222. It shows that MT latent variable which is explained by latent variables may influence 12:22%, while 87.78% is explained by other variables outside of the study.
- The value of R^2 for MO latent variables is 0.1801. This indicates that MO latent variable which is explained by latent variables may influence 18:01%, while 81.99% is explained by other variables outside of the study.

Testing of hypothesis measured by the value of t from path coefficient. Variables will be influence significantly if t value > t table (t table significant 5% = 1.96). The path coefficient is shown in Table 4.

TABLE 4

PATH COEFFICIENT

Hipotesis	variabel	Original Sample (O)	T Statistics (|O/STERR|)	Kesimpulan
H1	KS -> MB	0.4039	5.4893	Diterima
H2	KS -> MT	0.4243	5.8518	Diterima
H3	KS -> MO	0.3495	3.8224	Diterima

D. Analysis

1) Analysis of hypothesis on variable of Benefit Business (MB)

The KS variable have positive impact to the MB, because of parameter coefficients of KS to MB is 0.4039. The t value of KS to MB is 5.4893, that is greater than 1.96 so it is significant .

It is indicate that knowledge sharing has positive effect significantly to the benefit business. It shows the higher the level of knowledge sharing that occurs in the company, the higher the level of benefit business that can accepted during implementation of ERP. Therefore hypothesis of H1 can be accepted.

2) Analysis of hypothesis on variable of Benefit Technology (MT)

The KS has positive effect to the MT, because of the parameter coefficient of KS to MT is 0.4243. The t value of KS to MT is 5.8518, that is greater than 1.96 so it is significant.

It is indicate that knowledge effect significantly to the benefits technology. It shows the higher the level of knowledge sharing that occurs in the company, the higher the level of benefit technology that can be perceived during implementation of ERP. Furthermore the hypothesis H2 can be accepted.

3) Analysis of hypothesis on Benefit Organization variable (MO)

The KS has positive effect to the MO, because of the parameter coefficient of KS to MO is 0.3495. The t value of KS to MO is 3.8224, that is greater than 1.96 so it is significant.

It is indicate that knowledge effect significantly to the benefits technology. It shows the higher the level of knowledge sharing that occurs in the company, the higher the level of benefit technology that can be perceived during implementation of ERP. Furthermore the hypothesis H3 can be accepted.

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V. CONCLUSION

A. Conclusion

From the data processing and analysis, the conclusions of this study are as follows:

1. In a knowledge-sharing variable, the level of the user's curiosity relating to the operationalization of an ERP system that is used is high enough.
2. The benefit business which most widely percieved by the company during implementation of ERP is the effectiveness of decision making, while the least perceived is the level of cost reduction.
3. The benefit technology which most widely percieved by the company during implementation of ERP is the flexibility of IT infrastructure for today's business conditions and changing in the future.
4. The benefit Organization which most widely percieved by the company during implementation of ERP is a changing in organizational structure of company's business to be better.

B. Research Limitations

This research has limitations in the number of data collected, that is the number of many companies in Indonesia that have implemented ERP systems. Because of limitation about time, effort and cost, in this study the distributed questionnaires was 78, which returned only 56.41% (44 questionnaires). Among the 44 questionnaires returned, which are considered valid and can be processed as many as 41 questionnaires. Therefore the results from this study can not be generalized.

C. Suggestion

This study still has many shortcomings, due to the limited time and cost. Suggestions for further research are as follows:

Knowledge sharing is one of the main critical factors that affect the benefit realization during implementation of ERP. The result showed that knowledge sharing influence 16:31% to the realization of benefit business, 12:22% to the realization of benefit technology, and 18:01% to the realization of benefit organization. The value shows that in addition to knowledge sharing are still many factors that affect the benefit realization during implementation of ERP. Therefore, futher research is needed to explores the factors that affect to the benefit realization during implementation of ERP, apart from knowledge sharing.

Based on this research, to enhance the benefit of ERP, companies need to improve knowledge sharing. Suggestions for improvement are as follows:

Knowledge-sharing affect benefit realization during implementation of ERP. Therefore, to enhance the benefit realization during implementation ERP, companies must improve the knowledge sharing. Based on survey results, the level of user's willingness to share knowledge related to its ERP system, and the level of user's curiosity associated with the operationalization of ERP system that is used is quite high. But to enhance the benefit realization, it should be further enhanced by making procedures within the process of knowledge sharing that allows users to share knowledge.

Availability of media for sharing knowledge on companies that have implemented ERP during 3 to 6 years, and 10 years are enough available, while companies that have implemented ERP during 1 to 2 years, and 7 till 10 years is still lacking. Therefore, to enhance knowledge sharing, suggestions related to availability of this medium is as follows:

- The company must complete the media in order to facilitate knowledge sharing among users with a user key, and among users.
- Evaluate whether the available media have facilitated the implementation of knowledge sharing.
- Socialization the available media, so that users can use these media.

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ISBN : 978-602-97809-0-1

Developing Evaluation Model for Project Management in Higher Education (A case study)

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***Abstract* – A project is a unique endeavour to produce a set of deliverables within clearly specified time, cost and quality constraints. Project Management is the skills, tools and management processes required to undertake a project successfully.This research has 8 steps in the methodology. First, we have a preliminary activities. And then, we have to engage key people and assess evaluability. The next step is project evaluation framework development. We continue our research with data colletion and develop data collection tools. Our research is ended by data and interpretation results, research verification and sharing result. We conclude that the instrument is reliable and valid, the student aspect change better than before and many advantage is got from the project.**

***Keywords* – evaluation, project management**

I. INTRODUCTION

A project is a unique endeavour to produce a set of deliverables within clearly specified time, cost and quality constraints. Project Management is the skills, tools and management processes required to undertake a project successfully. It incorporates skills, tools, processes. [3]

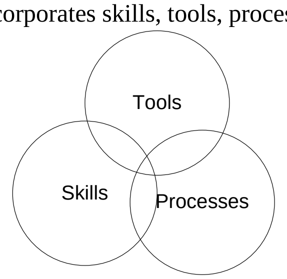

Fig. 1 Project management components

The project *phases/* life cycle consists of four phases. There are : [3]

1. **Project initiation.** The first phase of a project is the initiation phase. During this phase a business problem or opportunity is identified and a business case providing various solution options is defined. Next, a feasibility study is conducted to investigate whether each option addresses the business problem and a final recommended solution is then put forward. Once the recommended solution is approved, a project is initiated to deliver the approved solution. Terms of reference are completed outlining the objectives, scope and structure of the new project, and a project manager is appointed. The project manager begins recruiting a project team and establishes a project office environment. Approval is then sought to move into the detailed planning phase.
2. **Project planning.** Once the scope of the project has been defined in the terms of reference, the project enters the detailed planning phase. At this point the project will have been planned in detail and is ready to be executed.
3. **Project execution.** This phase involves implementing the plans created during the project planning phase.
4. **Project closure.** Project closure involves releasing the final deliverables to the customer, handing over project documentation to the business, terminating supplier contracts, releasing project resources and communicating the closure of the project to all stakeholders.

The evolution and trends of project management research are analyzed by exploring, identifying, and classifying management journal articles on project management in the allied disciplines. The analysis of project management research in the allied disciplines reveals an explosion of popularity and strong interest in project management research. The ranking of occurrences of the eight allied disciplines from most to the least appeared subjects over the last 50 years are [2]

1. Strategy/Portfolio Management
2. Operations Research/Decision Sciences
3. Organizational Behavior/Human Resources Management
4. Information Technology/Information Systems
5. Technology Applications/Innovation
6. Performance Management/Earned Value Management
7. Engineering and Construction;
8. Quality Management/Six Sigma.

According to [2], many research in project management is conducted within the project management cycle. In this research, we propose a model for evaluating a project. This

ISBN : 978-602-97809-0-1

model will focus on the impact of the project for the stakeholders. This research is done after the cycle of project management is finished.

II. Research Methodology

A. This research methodology consists of 8 step, there are : [1]

1. **Preliminary activities**. In this step, we looks for similar research.
2. **Engage key people**. In evaluation research, it is important to get input from all the stakeholder. We define that the scope of this research will focus for student perspective evaluation.
3. **Assess evaluability.** This step assess whether the project have enough data to be evalated.
4. **Project evaluation framework development.** We define the source of data dan data gathering method.
5. **Data colletion and develop data collection tools.**
6. **Data and interpretation results.**
7. **Joint research verification.** In this step, we verify the research results with the stakeholders.
8. **Sharing result.** After verifying, we disseminate to the society.

B. Research Question

What are the impacts of the project for student activities after the project closure?

C. Hypothesis

The hypothesis of this research is :

" there are many advantages after the project closure"

D. Research Model

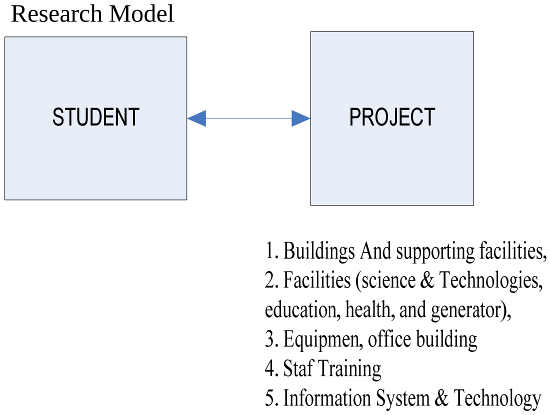

Fig. 2 Research Model

III.

IV. Design dan Result

A. Project Profile

This project consist of several package, there are :

1. One package for construction and supporting facilties.
2. Four package for A (science and tehnology), B (Education Facilities), C (Health facilities), and D (generator).
3. One package for equipment and building.
4. One package for training.
5. One package for academic prgram.
6. One package for information system and IT.

B. Research Questionnaire

In this research, we develop a questionnaire for gathering data from stakeholder. The variables in the questionnaire are shown below.

TABLE I
Variable

Number	Variabel / Sub variable
1	Quality of student activities
2	Intensity of student activities
3	Level of cooperation between student organization
4	Familiarity feelling
5	Optimalize academc quality
6	Improving positive image for student
7	Learning process facilities

C. Respondent

The respondents for the questionnaire are students, lecture, and administration staff. The number of each group is shown below.

TABLE III
Respondent

Group	M	D	K	
Tarbiyah	24	6	4	
Syariah	26	6	5	
Ushuludin	23	6	5	
Sosial Humaniora	27	5	2	
Dakwah	26	6	5	
Adab	26	7	6	
Science & Tech	31	9	6	
Post Graduate/University Office	12	0	9	
	195	45	42	282

Where :

M : Student
D : Lecture
K : Administration Staff

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D. Data analysis

Data analysis is conducted for quantitative analysis.
Before the analysis done, we have to do several preprocessing analysis. There are item analysis, validity analysis, and reliability analysis [5].

1. Item analysis

The steps for item analysis are : [6]

a. Choose 20% the highest score respondent (X_1) and 20% the lowest respondent (X_2)
b. Choose the average of every group ($\overline{X}$) and Standard deviation (S)

The standar deviation formula is shown below:

$$S_1 = \sqrt{\frac{X_{1i} - \overline{X_1}}{n-1}}$$

$$S_2 = \sqrt{\frac{X_{2i} - \overline{X_2}}{n-1}}$$

c. Count S combination (Sc)

The S combination is shown below:

$$Sc = \sqrt{\frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{(n_1 + n_2) - 2}}$$

d. Count tc

tc formula is shown below:

$$Tc = \frac{\overline{X_1} - \overline{X_2}}{Sc\sqrt{1/n_1 + 1/n_2}}$$

e. Compare t count with significant level 5 %

TABLE IIIII
ITEM ANALYSIS

Data Type	No 1	2	3	4	5	6	7	8	9	10
X2	2.16	2.14	2.2	2.16	2.59	2.52	2.84	2.16	2.14	2.2
S_2	0.85	0.77	0.67	0.8	0.73	0.87	1.01	0.85	0.77	0.67
X1	4.14	4.02	4	4.07	4.14	4.45	4.38	4.14	4.02	4
S_1	0.48	0.45	0.6	0.5	0.52	0.5	0.49	0.48	0.45	0.6
X2-X1	1.98	1.88	1.8	1.91	1.55	1.93	1.54	1.98	1.88	1.8
Sc	0.69	0.63	0.64	0.67	0.64	0.71	0.79	0.69	0.63	0.64
t c	15.19	15.72	14.95	15.11	12.94	14.33	10.28	15.19	15.72	14.95
t critical	2.23	2.23	2.23	2.23	2.23	2.23	2.23	2.23	2.23	2.23
Validity	valid	Valid	valid	valid	valid	valid	valid	valid	valid	valid

Based on item analysis, we conclude that all item are valid.

2. Validity test

The steps for validity test are : [6] and [4]

a. Correlate factor score and total score

b. If the correlation value is positive and more than 0.3, the validity of instrument is good

The validity calculation is shown below:

TABLE IVV
CORRELATION

Number	Correlation (r count)	Minimum r	Status
1	0.776	0.3	Valid
2	0.805	0.3	Valid
3	0.727	0.3	Valid
4	0.748	0.3	Valid
5	0.756	0.3	Valid
6	0.792	0.3	Valid
7	0.726	0.3	Valid

After testing the validity, we calculate pearson product momen correlation. The formula is:

$$t_{count} = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$$

From the calculation, we get the validity value.

TABLE V
COEFFICIENT

Number	Correlation coeffisien r count	t count	t 0.05,281(~)	Status
1	0.78	20.59	1.96	Valid
2	0.81	22.71	1.96	Valid
3	0.73	17.70	1.96	Valid
4	0.75	18.87	1.96	Valid
5	0.76	19.35	1.96	Valid
6	0.79	21.69	1.96	Valid
7	0.73	17.67	1.96	Valid

Based on validity test, we conclude that all items are valid.

3. Reliability test

We use alpha cronbach formula. The formula is shown below. [4]

$$r_{11} = \left(\frac{k}{(k-1)}\right)\left(1 - \frac{\sum \sigma_b^2}{\sigma_t^2}\right)$$

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Where :

r_{11} = instrumen reliability
k = number of question
$\sum \sigma_b^2$ = sum of varians
σ_t^2 = total varians

Based on reliability test, we conclude that the instrument is reliabel.

After item analysis, validity analysis, and reliability analysis, we can count the total score of the data. The interpretation table is shown below.

TABLE VV
INTERPRETATION

Total score	Status
0-1974	Get much worse
1975-3948	get worse
3949-5922	No change
5923-7896	Change better
7897-9870	Change much better

E. Results

The questionnaire results are shown below :

TABLE VIVI
QUESTIONNAIRE RESULT

Item	Answer					
	1 (STS)	2 (TS)	3 (R)	4 (S)	5 (SS)	
1	11	45	99	112	15	282
2	8	46	108	113	7	282
3	9	38	130	94	11	282
4	12	40	122	96	12	282
5	3	29	81	151	18	282
6	7	24	66	149	36	282
7	6	14	59	165	38	282
Total	56	236	665	880	137	

The total score is 6728.

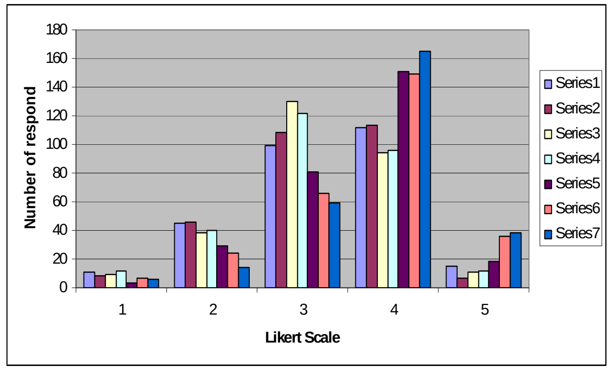

Fig. 3 Total Score

V. CONCLUSIONS

We conclude that the instrument is reliable and valid, the student aspect change better than before and many advantage is got from the project.

ACKNOWLEDGMENT

The author thanks to IDB Indonesia for financing this research. And the author thanks to "Sunan Kalijaga" State Islamic University of Yogyakarta for supporting this research.

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CHAPTER 8 : Supply Chain Management (SCM)

editor :
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ISBN : 978-602-97809-0-1

Leagile Supply Chain Strategy of Indonesian Corrugated Box Manufacturer

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Abstract - **Leagile supply chain is the combination of the lean and agile paradigms within a total supply chain strategy, for example by positioning the decoupling point to enable a level scheduling and opening up an opportunity to drive down costs upstream while simultaneously still ensuring that there is an agile response capable of delivering to an unpredictable marketplace. The purpose of this paper is to support this hybrid leagile supply chain understanding through case study in an Indonesian corrugated box manufacturer. The unpredictable customer demand of highly customized corrugated box in make to order production system is the characteristic of its demand, meanwhile difficulties in its relationship with paper suppliers that resulting long lead time and unreliable supply become its supply characteristic. In this situation, the corrugated box manufacturer can implement the combination of lean and agile supply chain or leagile supply chain using decoupling point approach.**

Keywords - **leagile supply chain, corrugated box**

I. INTRODUCTION

The term “leagile supply chain” was first being introduced by Naylor, Naim and Berry (1999). This idea has been discussed by many researchers such as Mason-Jones, Naylor, and Towill (2000) , Stratton and Warburton (2001), Van der Vorst, Van Dijk, and Beulens (2001), Christopher and Towill (2002), Christopher, Peck, and Towill (2006), and Goldsby, Griffis, and Roath (2006).

Leagile supply chain is a kind of combination, hybrid, integration or fuse between lean supply chain and agile supply chain. According to Goldsby, Griffis, and Roath (2006), lean and agile must not necessarily compete and can be employed simultaneously. In some cases, the two idea of lean and agile can be brought together as a hybrid “leagile” solution (Naylor, Naim, and Berry, 1999).

While this hybrid idea still become debated topics by academics or practitioners, some case studies of leagile supply chain has been introduced such as by Naylor, Naim and Berry (1999), Mason-Jones, Naylor, and Towill (2000), Oser (2004) and Goldsby, Griffis, and Roath (2006), and Christopher, Peck, and Towill (2006). All the case studies illustrate the parallel implementation of lean and agile supply chain in many industries such as electronics products manufacturer, car manufacturer, and apparel industry. The purpose of this paper is to support the hybrid “leagile” supply chain understanding through a case study in an Indonesian corrugated box manufacturer.

Corrugated box is a type of box made of corrugated sheets (fiberboard) for packaging and shipping container purpose. The corrugated box manufacturer in this case study is located in Banten Province, Indonesia. Located nearby the Indonesian capital, Jakarta, it supplies corrugated box and fiberboard to other manufacturers in Indonesia and sometimes to companies abroad. It is an independent corrugated box manufacturer with around 300 employees and it continuously builds their business including the supply chain.

This paper provide the result of several analysis concerning the corrugated box industry business environment including the marketplace, production system, its supply chain structure and current relationship between the company with their suppliers, customers and other business partners, and the measurement of its supply chain performance. It identifies the situation and reason for the company to implement a combination of lean and agile supply chain as their strategy.

II. LEAGILE SUPPLY CHAIN STRATEGY

Leagile supply chain is the combination of the lean and agile paradigms within a total supply chain strategy by positioning the decoupling point so as to best suit the need for responding to a volatile demand downstream yet providing level scheduling upstream from the marketplace (Naylor, Naim and Berry, 1999). Though lean and agile strategies are often pitted as opposing paradigms, they share a common objective: meeting customer demands at the least total cost. Researchers in recent years have suggested that the two approaches need not necessarily represent opposing points of view. Rather, they may be merged in a variety of ways to create so-called leagile approaches (Goldsby, Griffis, and Roath, 2006). Leagile supply chain is a hybrid of lean and agile supply chain.

ISBN : 978-602-97809-0-1

Christopher and Towill (2002) conceived three distinct hybrids (Goldsby, Griffis, and Roath, 2006). The first hybrid approaches embraces the Pareto (80/20) rule, recognizing that 80% of a company's revenue is generated from 20% of products. Fast moving products that make up the dominant 20% of the product line can be produced in a lean, make to stock manner given that demand is relatively stable for these items and that efficient replenishment is the appropriate objective. Meanwhile, the remaining 80% should be produced in an agile, less anticipatory manner, perhaps even employing make to order production to generate supply for only those items ordered when they are ordered.

The second lean-agile hybrid involves having temporary capacity to meet the needs of peak demand. Most companies experience a base level of demand over the course of the year. This base level of demand can be accommodated in a lean manner, using the company's own resources to employ heijunka (smooth production) principles to maintain highly efficient operations. However, when demand spikes over the course of peak seasons or heavy production periods, outside capacity is procured to meet the heightened demand of these distinct time windows. The procurement of outside capacity for coverage in these situations is viewed as the agile component of this hybrid approach. Many companies engage in leagile supply, manufacturing, and logistics to support seasonal demands.

The third hybrid, calls for form postponement using decoupling point. Supply chain can adopt a lean manufacturing approach upstream, enabling a level schedule and opening up an opportunity to drive down costs upstream while simultaneously still ensuring that downstream of the de-coupling point there is an agile response capable of delivering to an unpredictable marketplace (Figure 1). This approach works best when goods can be developed from common materials into a near-finished state with final touches to the product providing for a diverse assortment that accommodates distinct customer needs.

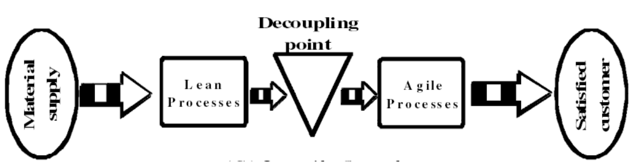

Figure 1: Block diagram representing leagile supply chain (Mason-Jones, Naylor, and Towill, 2000)

Christopher, Peck, and Towill (2006), develop taxonomy for selecting global supply chain strategies (Figure 2). In situations where demand is predictable and replenishment lead-times are short then a "lean continuous replenishment" strategy may be appropriate. If lead times are long but demand is predictable, then there is opportunity for the pursuit of lean type strategies, e.g. make or source ahead of demand in the most efficient way. When demand is unpredictable but lead times are short, then agile solutions will be required based upon rapid response. Finally, at the other extreme (unpredictable demand and long lead times) the ideal solution is to carry strategic inventory in some generic form and assemble/configure/distribute as required when actual demand is encountered, in classic postponement concept.

Within each cell of the matrix, the tactics adopted may also be influenced by whether the product is standard or special. For example, in the postponement cell of Figure 1, for a special product we may postpone manufacturer, but for a standard product it may be better to postpone distribution (Pagh and Cooper, 1998).

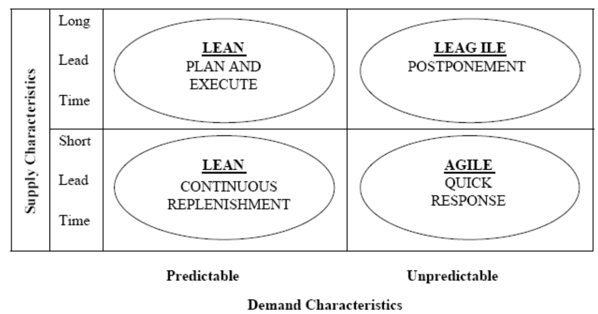

Figure 2: How demand /supply characteristics determine supply chain strategy (Christopher, Peck, and Towill, 2006)

III. BUSINESS ENVIRONMENT AND SUPPLY CHAIN OF THE CORRUGATED BOX MANUFACTURER

Corrugated box is an industrial good. It tends to have a few raw materials, i.e. paper rolls, adhesive material, and ink, but produce many different designs of boxes and varied by many factors such as paper type and structure. Corrugated box is a customized product; one design is only useful for one customer, moreover for one customer's product or item. Make to order is then the common system in corrugated box manufacturing.

As corrugated manufacturer works in a make to order system, the production processes are starting after customer order arrives. This actually needs speed and flexibility to react, adjusts, and executes different customer order. In fulfilling customer order, there is preliminary step called pre-order to prove the ability of manufacturer to produce the ordered product in the specified specification and design and to negotiate the price and other term and condition. This pre-order negotiation actually support company's agility to react, adjusts, and executes different customer order.

The production process of corrugated box is actually a mixture of continuous and discrete manufacturing. The routing of the production is relatively fixed except in finishing processes. This fixed sequence of main production processes with short manufacturing time enable the company to have flexibility to different customer order.

For the forthcoming five years, corrugated output is expected to grow at an annual average rate of 4.0 percent (International Corrugated Case Association (ICCA), 2007). According to Ming et al (2004), corrugated box manufacturers are facing tough challenges ahead, characterized by increasingly stronger competition due to overcapacity, increasingly higher customers' expectation and increasingly higher production cost

According to the Indonesian association of corrugated cardboard industry (PICCI) the production of corrugated box in Indonesia increase in average 4% per year, but there are over capacity compared to the overall demand from consumer good manufacturers, therefore competition in this industry is tough and customer can easily move to other corrugated box manufacturer.

In general, we can say that in corrugated box industry in which this company works characterized by strong competition due to over capacity compare to the customer demand, increasingly higher customers' expectation such as higher quality, customization, and just in time delivery, and where corrugated box manufacturing is no longer simply producing of corrugated boxes but combining production and services, with services being increasingly important.

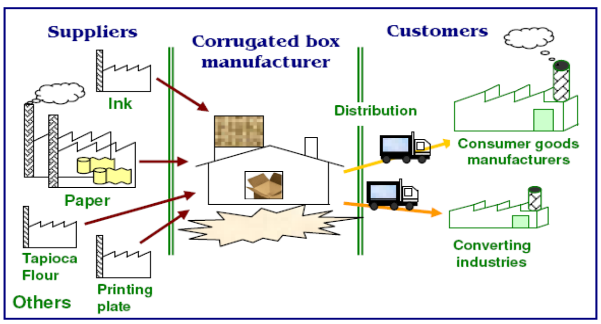

Figure 3: The corrugated box manufacturer's supply chain

The supply chain structure of the corrugated box manufacturer in this discussion is limited in 1-tier upstream (suppliers) and 1-tier downstream (customers) as shown in Figure 3. The corrugated box manufacturer has several suppliers such as paper manufacturer, ink, printing plate, and tapioca flour suppliers. Around 80% of the customers are consumer goods manufacturers and 20% are converting industries that buy corrugated sheet and then convert them into others products. There are also some transportation partners that distribute their products to the customers.

Around 75 – 90% of corrugated box production cost is for the paper; therefore strategic partnership with paper supplier is very important. Unfortunately, it is found that collaboration and coordination with paper supplier is very weak. Figure 4 shows the collaboration and coordination profile between the corrugated box manufacturer and its paper suppliers. It's a result of qualitative judgment of the company through an interview with the company's directors, adopted from Hieber, 2002.

Collaboration-related feature

Orientation of business relations	Cooperation oriented		Competition oriented
Mutual trust and openness	High		Low
Balance of power	High dependancy		Equal

Coordination-related feature

Intensity of information sharing	Low		High
Degree of communication	Single contact		Multiple contacts
Variability of consumption	Low/stable		High
Use of information technology (IT)	IT use only for supporting internal business process		IT use to support planning and execution in network

Figure 4: Collaboration and coordination profile with paper suppliers

Collaboration-related feature

Orientation of business relations	Cooperation oriented		Competition oriented
Mutual trust and openness	High		Low
Balance of power	High dependancy		Equal

Coordination-related feature

Intensity of information sharing	Low		High
Degree of communication	Single contact		Multiple contacts
Variability of consumption	Low/stable		High
Use of information technology (IT)	IT use only for supporting internal business process		IT use to support planning and execution in network

Figure 5: Collaboration and coordination profile with customers

There are limited corrugated box paper suppliers in Indonesia with varied quality level. Paper supplier is usually bigger in size and economic scale; meanwhile they prefer to sell their product to global market that has higher price than local market. Corrugated box manufacturer is too dependent to paper supplier. For all their purchase order, company can not determine the delivery date, frequency of delivery, and the number of paper roll in each delivery.

Giving the best service and relationship to the customer is the strategy of the company. One of the implementation is by selecting and maintaining only the highly beneficial customer. Figure 5 shows the collaboration and coordination profile between the corrugated box manufacturer and its customers. Pre-order process and negotiation indicate better coordination with customers, but they still have low collaboration indicate by low information sharing and limited communication contacts. In general all parties try to build mutual relationship with balance of power.

The corrugated box manufacturer outsources the ink inventory and warehousing, printing plate production, and product distribution. These practices ensure the availability of ink in economic level, fast and economic design and production of printing plate, and also flexible and quick delivery of customer order. Telephone, fax, and email are the information and communication technology used for information sharing and communication with their suppliers, customers, and other partners. Internally the company implements Corrugated Packaging System (CPS), a special Enterprise Resource Planning (ERP) system for corrugated box industry that integrates the information sharing throughout the system in the company.

According to Industry Canada (2007), the main key performance indicator for evaluating supply chain agility is inventory turns. The inventory turns of the corrugated box manufacturer have been measured and then being compared to the performance of Canadian corrugated box manufacturer. The result is shown in Table 1.

TABLE 1
COMPARISON OF INVENTORY TURNS WITH INDUSTRY CANADA STANDARD

Performance Indicator	Subject of Case Study	Canadian Corrugated Box Manufacturer
Inbound inventory turns	9.56	25.7
Outbound inventory turns	79.6	32.1

TABLE 2
CORRUGATED BOX MANUFACTURER SUPPLY CHAIN PERFORMANCE

Performance Indicator	Performance
Responsive planning time	1 day
Order promising time	1 day
Procurement lead time	14 days
Supplier flexibility	1 day
Upside procurement flexibility	29.18 days
New design time to order	4 days
Upside production flexibility	1 day
Order fulfillment lead time	5 days
Upside delivery flexibility	1 day
Return order lead time	3 days

It is clear that problem occurs in inbound inventory turns. The corrugated box manufacturer has lower inbound inventory turns compared to Canadian corrugated box manufacturers. Lower inbound inventory turns means raw material (paper) is stocked in longer time or they stock more raw materials in their warehouse in comparison with their production quantity. Availability of raw material and the lead time and also level of collaboration and integration with supplier may cause this difference. Table 2 provides other performance of the corrugated box manufacturer supply chain.

IV. LEAGILE SUPPLY CHAIN OF CORRUGATED BOX MANUFACTURER

According to Wadhawa and Rao (2003), company that works in make to order production system has a higher need for agility, because they need speed and flexibility to react, adjusts, and executes different customer order. As they work in make to order system and customized products, corrugated box manufacturer surely need an agile supply chain. But, can they implement an agile strategy in their entire supply chain span? From the inventory turns performance, it can be seen that their outbound inventory turns indicating an agile supply in satisfying customer demand, but it does not supported by the inbound inventory turns. It also can be seen from the other supply chain performance.

Further analysis was done based on Christopher and Towill (2002) taxonomy. From the analyses of its demand characteristics, corrugated box manufacturer has an unpredictable demand indicating by a highly customized product with many variety and modification on its design and short term and low relationship with customer related to strong competition due to many player and overcapacity. About the supply characteristics, it can be conclude that the corrugated box manufacturer has long lead time with 14 days of average procurement lead time and 29.18 days of upside procurement flexibility. From the analysis of the relationship with paper supplier it can be seen that corrugated box manufacturer has an unequal balance power. Corrugated box manufacturer is too dependent to paper supplier. For all their purchase order, company can not determine the delivery date, frequency of delivery, and the number of paper roll in each delivery.

This unpredictable demand and long lead time is fit with the characteristic of leagile supply chain form Christopher and Towill (2002). Therefore the corrugated box manufacturer can implement a hybrid leagile supply chain. They can implement a leagile supply chain with decoupling point or postponement approach (Figure 6). As they produce special and customized product, they can postpone their manufacturing operations (Pagh and Cooper, 1998).

In supply side, the corrugated box manufacturer needs a lean supply chain. Increasing their inbound inventory turn can be the improvement measure. Better inventory management

ISBN : 978-602-97809-0-1

can be an internal solution in order to increase inbound inventory turns. This company need to understand inventory characteristic from historical data such as using ABC and XYZ analysis and than define appropriate policy for optimizing their inventory such as safety stock policy and inventory controlling system.

The ABC classification is based on percent of consumption and XYZ classification is based on variation coefficient. For A-class items, higher attention by daily review is need to be given. The company also must find and keep alternative supplier for these items. For B-class items, alternative suppliers also important to be found but inventory review can be performed in weakly interval. Therefore A and B class items need to be considered in finding new supplier. In managing C-class items, efficient effort by monthly planning is required as they have less value. Based on XYZ classification, the company can set different safety stock policy for different inventory class. Because Z-class item is more difficult to forecast, it needs a higher safety stock. For CZ-class items, because they have low value but require higher attention since they more fluctuate, it would be better to accumulate and/or substitute the CZ-items by the same paper type with bigger dimension and belongs to A or B class.

In their production and distribution side, the corrugated box manufacturer needs an agile supply chain to rapidly respond any changes in customer demand. This is currently not a big problem for the company; they just have to maintain their current production and distribution capacity and flexibility supported by their ERP information system.

V. CONCLUSION

The unpredictable customer demand of highly customized corrugated box in make to order production system is the characteristic of corrugated box manufacturer's demand, meanwhile difficulties in its relationship with paper suppliers that resulting long lead time and unreliable supply become its supply characteristic. In this situation, the company can implement the combination of lean and agile supply chain or leagile supply chain using decoupling point approach. In the supply side they need a lean supply chain and better inventory management can be their internal improvement. Their current production and distribution capacity and flexibility, supported by their ERP information system support their agility in production and distribution side.

From the case study it can be concluded that combining lean and agile supply chain in one company is possible and is necessary in this company. Other corrugated box manufacturer facing the same situation can also implement the same leagile supply chain strategy.

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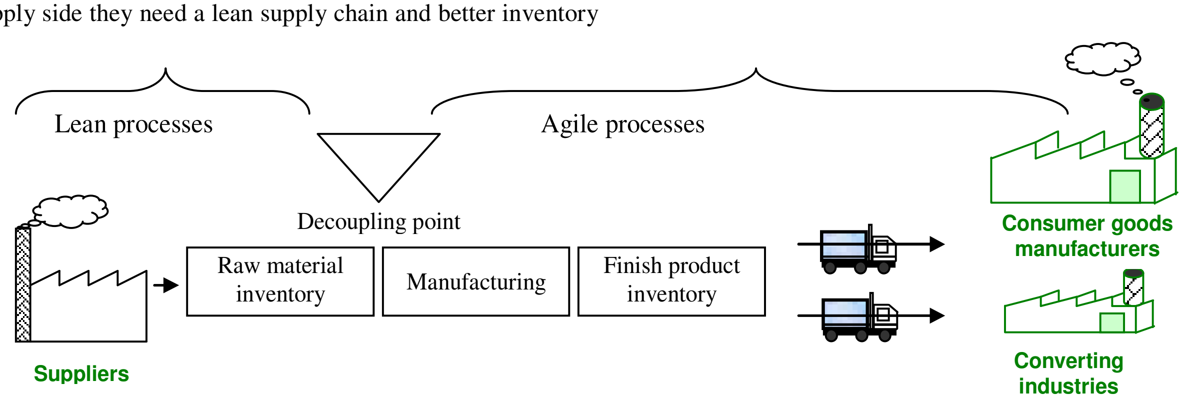

Figure 6: Leagile supply chain of corrugated box manufacturer

ISBN : 978-602-97809-0-1

A Hybrid Model using AHP and Neural Network for Vendor Selection

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Abstract— **As the most important responsibility of purchasing management, the problem of vendor evaluation and selection has always received a great deal of attention from practitioners and researchers. This management decision is a challenge due to the complexity and various criteria involved. This work attempts to develop a rule based model, to evaluate the performance of vendors, supplying components and raw materials to a multinational organization engaged in designing, manufacturing and delivering a range of products covering various stages of electric power transmission and distribution system. To select the vendors, there is a need to rank all the potential vendors according to their performance because in this industry almost all components are outsourced from vendors and 80% cost of product is used for purchasing raw material and components. For this reason any organization is required to select suitable vendors who can supply a host of materials and components to the organization as per the need.**

This paper presents a hybrid model using analytic hierarchy process (AHP) and neural networks (NNs) theory to assess vendor performance. The model consists of two modules: Module 1 applies AHP and pair wise comparison of criteria and vendors with respect to each criterion to obtain the weight of each criteria and vendors. Module 2 utilizes the results of AHP into NNs model for vendor selection. Our results yield the best vendor and appropriate score to know the performance of each vendor.

Keywords— **Supply chain, optimization, vendor selection, networking, method of AHP, neural network theory.**

I. INTRODUCTION

Supply chain vendor evaluation is a very important operational decision, involving not only selection of vendors, but other decisions with respect to quantities to order from each vendor. Globalization has led to the opportunities for many to utilize sources from around the world. This, of course, introduces additional decision-making considerations. Vendor selection decisions are complicated by the fact that various possible criteria must be considered in the decision-making process.

Proper identification of vendors is important for increasing the efficiency of service and manufacturing organizations. For this reason any organization is required to select suitable vendors who can supply a host of materials and components to the organisation as per the need. The purchased department focuses more on "A" types of items for administrative purposes. Most of the time the purchasing department uses some tools for decision making to evaluate vendors. The variable market condition also requires that in any organization specific SC models must be developed and applied.

This paper considers the case of a manufacturing organisation which provides comprehensive electrical solutions for utilities and electro-intensive industries engaged in (a) transmission, distribution and power generation, (b) railways, (c) industrial buildings and mining and metal industries. The manufacturing organisation, under consideration has multi-plants and is located in several countries. Vendors are distributed evenly in those countries and the organisation attempts to purchase raw materials and components from local suppliers.

Some customers of this organisation also require certain components (or raw materials) to be purchased directly from their selected vendor. Price may not be the criteria for these purchases. For these cases the manufacturer does not have the freedom to select the vendors themselves on the basis on cost or time parameters. No systematic procedure or mathematical model is applicable for such situations. The manufactured items are power transformers of various sizes and specifications. It may be noted that a customer may opt for any type of transformers as per their need.

II. LITERATURE SURVEY.

Many research methodologies of vendor analysis have been reported and published in literatures. An extensive review can be referred in [1]. Also the research works as given in [2] [3] and [4] are very informative and contain reviews of previous researches. A new grey-based approach to deal with the supplier selection problem is presented in [5].

The first published work [6] in the direction of vendor selection is meaningful for research purposes. In this article the terms vendor and supplier are often mean same and used interchangeably. A dogmatic framework of supplier selection situations that not necessarily coincides with supplier selection processes found in practice in [7] and [8] which offer a purchaser a manageable number of typical, different supplier selection situations with associated ways of carrying out and organizing the supplier selection process.

Traditional methods of vendors' evaluation in the early 80s are mainly based on buyer's experience. The qualitative methodology have utilised in [9] and [10] for performance evaluation of vendors. Qualitative methods

ISBN : 978-602-97809-0-1

may include tools for visualizing and analysing the decision-maker's perception of a problem situation and tools for brainstorming about possible (alternative) solutions.

In the domain of quantitative techniques, a series of research papers [11-13] had addressed to solve cost based optimization problems. Research work as presented in [14] is improvised over the previous paper as in [15] and developed as a multi objective programming model to fix number of suppliers/vendors in SC. Though the list of such researches is wide and the techniques range from linear programming to highly complex mathematical modelling which are often found to be NP hard. Thus practical and realistic models are more preferred for vendor selection by industrial organisations. The quantitative techniques cause significant problems in considering qualitative factors. The models which can combine subjective and quantitative criteria are more useful for practical application. Hybrid systems had been implemented to solve vendor selection method [16] which had also attempted to quantify the attributes like quality, cost and delivery parameters so as to make the selection of vendors more justified. Previous work as in [2] is the original concept which has culminated in [16].

For dealing with multi-level criteria for vendor selection, analytic hierarchy process (AHP) had widely been in use for solving such problems. A web-based AHP system had been developed in [17] and is based on AHP, as utilised in [18] to evaluate the suppliers of casting with respect to 18 different criteria. A five-step AHP – based model [19] had been proposed to aid decision makers in rating and selecting suppliers with respect to nine evaluating criteria. An AHP methodology [20] based on a combined AHP and a genetic algorithm (GA) also developed as cited in [21]. However the GA in vendor selection is not much utilised in realistic problems.

Artificial neural network (ANN), an evolutionary optimisation based algorithm had been developed in [22], [23], and [24]. ANN based algorithms are claimed to be helpful for practical industrial applications especially for dynamic situations. A neural network has one or more input nodes and one or more neurons. Some neuron's outputs are the output of the network. The network is defined by the neurons and their connections and weights. All neurons are organized into layers; the sequence of layers defines the order in which the activations are computed

In many realistic applications, organizations have utilized their own methods as illustrated in [25] and [26]. The experience of the management staff is often seen to generate acceptable results in decision making process by using rules of thumb and is not reported in literature. Dependencies on use of theoretical models are avoided mostly by such industrial organizations. An intelligent supplier relationship management system (ISRMS) using hybrid case based reasoning (CBR) and artificial neural networks (ANNs) techniques to select and benchmark potential suppliers is discussed in [27]. A hybrid model is presented in [28] using data envelopment analysis (DEA), decision trees (DT) and neural networks (NNs) to assess supplier performance which yield a favorable classification and prediction accuracy rate.

This paper presents a hybrid model using analytic hierarchy process (AHP) and neural networks (NNs) to assess vendor performance. The model consists of two modules: Module 1 applies AHP and pair wise comparison of criteria and vendors with respect to each criterion to obtain the weight of each criteria and vendors. Module 2 utilizes the results (weights) of AHP into NNs model for vendor selection. Our results yield the best vendor and appropriate score to know the performance of each vendor. Moreover, to our knowledge, there is no work to analyse the vendor selection problem by jointly using AHP and NNs approaches. It is very attractive to use DEA and NNs approaches to develop an integrated model, which involves the advantages of both AHP and NNs.

III. MODELS AND METHODOLOGY

The model is consists of two modules, module 1 applies AHP to calculate the weight of each criteria and vendor. and module 2 utilizes the weight of each criteria and vendor for neural network model to select the best vendor and know the performance (score) of each vendor.

A. *AHP vendor selection model*

A method of analytic hierarchy process (AHP) for the fixation of vendors is described hereunder.

Step 1: Structure of the decision problem in a hierarchy of goal (best vendor), criteria and alternatives (vendors). The criteria here are taken as an illustrative example as quality of the product expressed in percentage of rejected parts, delay time, unit cost of the input and quality of service of the vendors. The relative importance given for these criteria may be considered as w1, w2, w3 and w4. These values of relative importance "w_is" are not known by the manufacturers and the decision criteria of the customers may react in different ways. Fig. 1 shows the diagrammatic representation of the AHP model.

Step 2: Compare the alternatives based on the criteria which is adapted from a common scale [14].

Step 3: Synthesize the comparisons to get the priorities of the alternatives with respect to each criterion and the weights of each criterion with respect to the goal. Local priorities are then multiplied by the weight of the respective criterion and the results are summed up to produce the overall priority of each alternative (vendor).

B. *Neural network model*

The concept of neural networks started in the late-1800s and traditionally, the term neural network had been used to refer to a network or circuit of biological neurons. The modern usage of the term often refers to artificial neural networks, which are composed of artificial neurons or nodes.

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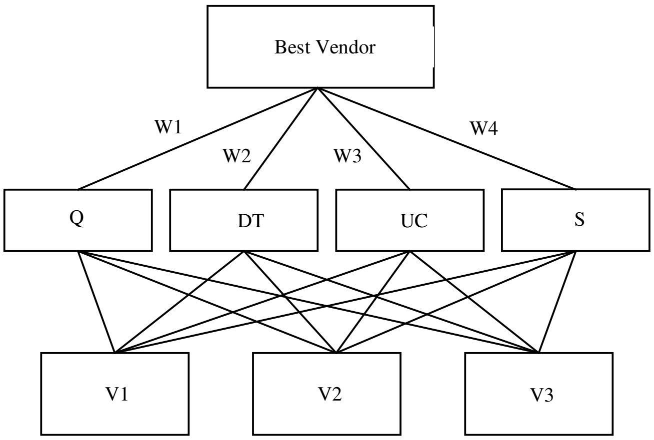

Fig. 1. A AHP model for vendor section of a transformer industry

C. Neural network model

Neural networks provide a new way for feature extraction (using hidden layers) and classification (e.g. multilayer perception). The perceptron is essentially a linear classifier for classifying data specified by parameters and an output function. Its parameters are adapted with an ad-hoc rule similar to stochastic steepest gradient descent. Because the inner product is a linear operator in the input space, the perceptron can only perfectly classify a set of data for which different classes are linearly separable in the input space, while it often fails completely for non-separable data.

The cognitron (1975) was an early multilayered neural network with a training algorithm. Networks can propagate information in one direction only, or they can bounce back and forth until self-activation at a node occurs and the network settles on a final state. The ability for bi-directional flow of inputs between neurons/nodes was produced with the Hopfield's network (1982), and specialization of these node layers for specific purposes was introduced through the first hybrid network.

The rediscovery of the back propagation algorithm was probably the main reason behind the repopularisation of neural networks after the publication of "Learning Internal Representations by Error Propagation" in 1986 (Though back propagation itself dates from 1974). The original network utilized multiple layers of weight-sum units with a sigmoid function or logistic function such as used in logistic regression. There are three major learning paradigms, each corresponding to a particular abstract learning task. These are supervised learning, unsupervised learning and reinforcement learning. Usually any given type of network architecture can be employed in any of those tasks.

1) *Supervised learning*

In supervised learning, we are given a set of example pairs (x, y), x ε X, y ε Y, and the aim is to find a function f in the allowed class of functions that matches the examples. In other words, we wish to *infer* how the mapping implied by the data and the cost function is related to the mismatch between our mapping and the data.

2) *Unsupervised learning*

In unsupervised learning we are given some input data x, and a sigmoid function $[1 / (1 + e^{-\alpha(\Sigma xiwi)})]$ which is to be minimized which can be any function of x and the network's output, y=f (w, x), where w is the matrix of all weight vectors. This method of learning is adopted in this study.

3) *Reinforcement learning*

In reinforcement learning, data x is usually not given, but generated by an agent's interactions with the environment. At each point in time t, the agent performs an action y_t and the environment generates an observation x_t and an instantaneous cost c_t, according to some (usually unknown) dynamics.

D. Hybrid conceptual model

Fig. 2 depicts the conceptual model for vendor selection using AHP and, NNs concept. As mentioned before, the hybrid model using analytic hierarchy process (AHP) and neural networks (NNs) theory to assess vendor performance. It generally consists of two modules. Module 1 applies AHP and pair wise comparison of criteria and vendors with respect to each criterion to obtain the weight of each criteria and vendors. Module 2 utilizes the results (weights) of AHP into NNs model for vendor selection. Our results yield the best vendor and appropriate weight to know the performance of each vendor. The algorithm developed in the above case contains two modules. The main algorithm is shown below. Module 1 applies AHP and pair wise comparison of criteria and vendors with respect to each criterion to obtain the weight of each criteria and vendors. Module 2 utilizes the results (weight) of AHP into NNs model for vendor selection.

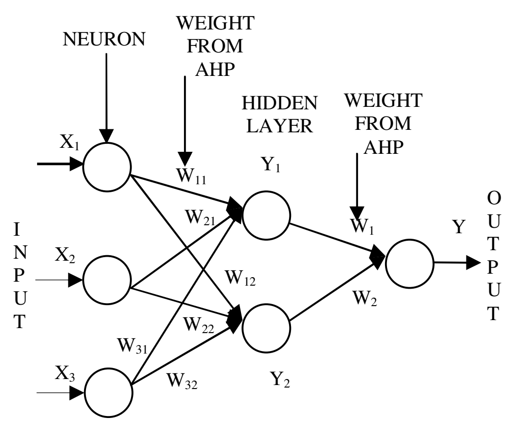

Fig. 2. The hybrid model for vendor selection

Algorithm

Input the no. of criteria decided.
Input the no. vendors.

Define the scale for criteria using Saaty's common scale.
Enter the data of each vendor.
Generate a matrix for comparison of each criteria of goal.
Create a matrix for the calculation of weights on objective by using the following formula:

Weight of given criteria = Value of given criteria / Sum of column value

Generate the comparison matrix for vendor with respect to given criteria.
Create next matrix for the calculation of weight of vendor with respect to criteria by using the following formula:

Weight of given vendor wrt criteria = Value of given vendor / Sum of column value

Repeat the steps for vendors until the criteria i = 0
Create a matrix for hidden layer by using the following formula:

Output value for hidden layer $Yc_i = 1 / (1 + e^{-\alpha(\Sigma XiWci)})$

Create a matrix for output layer by using following formula:

Value for output layer $Yv_i = 1 / (1 + e^{-\alpha(\Sigma YciWvi)})$

Yv_i = Total score of vendor

Select the vendor of max. score from the above matrix for the best vendor.
STOP

IV. NUMERICAL ILLUSTRATION

A. Data

The data is derived from a large, multinational, transformer company, which is a global leader in design, production, and marketing of power and distribution transformers systems. Table-1 shows the data of of the quality (Q), delay times (DT), unit cost (UC) and services(S) of seven vendors.

TABLE I

VENDOR DATA

V	Q (% R.P.)	DT (Days)	UC (Rs.)	S
V1	1	5	1.85 LAC/T	AV
V2	1	4	2.68 LAC/T	G
V3	2	10	2.31 LAC/T	O
V4	5	12	2.55 LAC/T	G
V5	3	11	2.01 LAC/T	VG
V6	2	18	2.71 LAC/T	O
V7	0	15	2.85 LAC/T	AV

O-Outstanding, VG-Very good, G-Good,, AV-Average, P-Poor

B. Implementation and calculation

the above steps can be illustrated with the data shown in Table-1.

Scaling the criteria with respect to important criteria (i.e. quality).
Quality is somewhat more important than delay time–3
Quality is much more important than unit cost–5
Quality is very much more important than service–7
Delay time is somewhat more important than unit cost –3
Delay time is much more important than service–5
Unit cost is somewhat more important than service-3

Consider a data sheet of seven vendors of a component. Table-1 shows the quality, delay times unit cost and services of vendors. The method as shown on the left hand side of the page is used. The tables 2 and 3 are showing the pair wise comparison of criteria and weight on objective with respect to goal (preference on quality).The table 4 and 5 are showing pair wise comparison of vendors with respect to quality and its weight from vendor data.

In this industry for quality maximum rejection parts is 8% and total scale is divided from 1% to 8% (i.e. for difference of 0%-1, 1%-2, 3%-4, 4%-5, 5%-6, 6%-7, 7%-8, 8%-9). For delay times maximum days is 15 and these days are divided into scale of 1 to 9 (i.e. for difference of 0=1, 1-2=2, 3=3, 4-5=4, 6=5, 7-8=6, 9=7, 10-11=8, 12-15=9).For unit cost the total difference of cost is 1.00 Lac/T (i.e. 2.85-1.85=1.00) and difference of each component cost has been taken and scale is used for these differences between 1-9 (i.e. for difference of 0=1, up to.125=2, .126-.250=3, .251-.375=4, .376-.500=5, .501-.625=6, .626-..750=7, .751-.875=8, .876-1.00=9). For service scale is divided between P to O (Poor to Outstanding i.e. P=2, A=3, G=5, VG=7, O=9) by 1 to 9 (i.e. for difference of 1-2=2, 3=3, 4-5=5, 6-7=7, 8-9=9).

All value is obtained by pair wise comparison of vendors with respect to delay times, unit cost and service and arranged in table 6. Now we will use all weight for criteria and vendors in hybrid model for vendor selection (figure 2).

TABLE 2

PERFORMANCE ON CRITERIA

CR	Q	DT	UC	S
Q	1	3	5	7
DT	1/3	1	3	5
UC	1/5	1/3	1	3
S	1/7	1/5	1/3	1

TABLE 3

WEIGHT ON OBJECTIVES

CR	Q	DT	UC	S	AV
Q	.598	.662	.536	.438	.559
DT	.197	.221	.322	.313	.262
UC	.119	.073	.107	.188	.122
S	.085	.044	.035	.063	.057

TABLE 4

RELATIVE MATRIX OF VENDORS WITH RESPECT TO QUALITY

	V1	V2	V3	V4	V5	V6	V7
V1	1	1	2	5	3	2	1/2
V2	1	1	2	5	3	2	1/2
V3	1/2	1/2	1	4	2	1	1/3
V4	1/5	1/5	¼	1	1/3	1/4	1/6
V5	1/3	1/3	½	3	1	1/2	1/4
V6	1/2	1/2	1	4	2	1	1/3
V7	2	2	3	6	4	3	1

TABLE 5

WEIGHT ON QUALITY

	V1	V2	V3	V4	V5	V6	V7	AV
V1	.18	.18	.21	.18	.20	.21	.16	.19
V2	.18	.18	.21	.18	.20	.21	.16	.19
V3	.09	.09	.10	.14	.13	.10	.11	.11
V4	.04	.04	.03	.04	.02	.03	.05	.03
V5	.06	.06	.05	.11	.07	.05	.08	.07
V6	.09	.09	.10	.14	.13	.10	.11	.11
V7	.36	.36	.31	.21	.26	.31	.32	.30
								$\sum = 1$

TABLE 6

WEIGHT MATRIX OF VENDORS

V	Q	DT	UC	S
V1	.19	.30	.41	.03
V2	.19	.40	.05	.07
V3	.11	.10	.14	.32
V4	.03	.06	.08	.07
V5	.07	.06	.26	.13
V6	.11	.03	.04	.33
V7	.30	.05	.02	.05

TABLE 7

OUTPUT VALUES FOR HIDDEN LAYER

Criteria	Weight	Input value Xi	ΣXiW_{Ci}	Output value for hidden layer Yci
Q	.559	.143	.760	.681
DT	.262		.463	.614
UC	.122		.322	.580
S	.057		.257	.564

ΣXiW_{C1}=.143x.559+.143x.559+.143x.559+.143x.559+.143x.559+.143x.559+.143x.559+1x .2 =.760

Let input value for all bias neuron = 1

Let weight for all bias neuron = 0.2

Xi = Input value for input layer = 1/7 = .143

W_{Ci} = Weight of criteria

Yc_i= Output value for hidden layer = $1 / (1 + e^{-\alpha(\Sigma XiWci)})$ = Input value for output layer

α=1

Yc_1 = .681

TABLE 8

MATRIX FOR OUTPUT LAYER

V	Yc_1= .681	Yc_2= .614	Yc_3= .580	Yc_4= .564	ΣYc_iW_{Vi}	Yvi
V1	.19	.30	.41	.03	.769	.683
V2	.19	.40	.05	.07	.639	.655
V3	.11	.10	.14	.32	.598	.645
V4	.03	.06	.08	.07	.344	.585
V5	.07	.06	.26	.13	.518	.627
V6	.11	.03	.04	.33	.499	.622
V7	.30	.05	.02	.05	.471	.616

ΣYc_iW_{V1}= .681x.19+.614x.30+.58x.41+.564x.03+1x.2=.769

W_{V1} = Weight of vendor wrt criteria

Yv_i= Value for output layer= $1 / (1 + e^{-\alpha(\Sigma YciWvi)})$= Total score of vendor

Yv_1= 0.683

C. Validation of proposed model & Vendor selection

In our example we have taken data of seven vendors of a component with some important criteria. Here we are trying to take the advantages of AHP and NNs theory. The main role of AHP is to calculate weight of each criteria and vendor for neural network. Input value for all neurons are same and it depends upon no. of vendors. Input value and weight (assumed) for all bias neurons are same. The bias accounts only for the degree of fitting the given data, but not for the level of generalization. A bias term can be treated as a connection weight from a special unit with a constant, nonzero activation value. The term "bias" is usually used with respect to a "bias unit" with a constant value of one. Not all authors follow this distinction. Regardless of the terminology, biases are added or subtracted has no effect on the performance of the network. Output value for hidden layer is calculated in table 7 which is the input values for output layer.

In table 8 total score for all vendors are calculated and we can see that vendor 1 is the best vendor because it has maximum score (.683) in comparison to all other vendors. For validation of this method through vendor data (table 1) that vendor 1 has less rejection parts, less delay time, less unit cost and average service against other vendors, so vendor 1 is the best. In this paper quality has much effect on total score of vendor because quality is main objective for selection of vendor.

V. DISCUSSION

It is important to note that supply chains (SC), can be viewed as a network of vendors, manufacturers, distributors, and retailers. The efficiency of the network is dictated mainly by the characteristics of vendors and also is influenced by mode of transportation, information flow, and financial infrastructure. The ability to represent a complex but realistic supply chain of any organization by using any model is often difficult if the organization supplies customized products to its customers. The preferences of vendors from customers side create further problems. It is very attractive to use AHP and NNs approaches to develop an integrated model, which involves the advantages of both.

VI. CONCLUSIONS

This paper has developed a hybrid vendor selection model using analytic hierarchy process (AHP) and neural networks (NNs). The model enables us to deal with the complexity and criteria embedded in the vendor selection problem. The model consists of two modules: Module 1 applies AHP and pair wise comparison of criteria and vendors with respect to each criterion to obtain the weight of each criteria and vendors. Module 2 utilizes the results of AHP into NNs model for vendor selection. Our results yield the best vendor and appropriate score to know the performance of each vendor. However, the results are meaningful in that this study provides the hybrid to integrate AHP and NNs techniques and demonstrate its application to vendor selection problem. In addition, the results of this study provide on the way for selecting the appropriate prediction method for any type of dataset problem. A promising area of future research would be in applying this approach to compare the performance of other vendor selection methods.

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ISBN : 978-602-97809-0-1

A Linguistic Model to Solve Cellular Manufacturing Problems

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Abstract - **This paper presents a new approach for forming part families and the corresponding machine groups using a linguistic based algorithm. Subsequently a simplified GA model on cell formation technique is applied to ensure that the result is not trapped in a local optimum point. The concept of null machine is introduced in this linguistic model to calculate the dissimilarity among parts. The flexibility of changing number of machine groups is also built-in the model. The model has been found to be useful to solve realistic cell formation problems for partitioning discrete manufacturing systems to GT cells. The processing sequence may be modeled as sequential or random. The concept of bag theory is applied in this model.**

Keywords —**Cellular manufacturing, linguistic model, genetic algorithm, bag theory.**

I. Introduction

Cellular manufacturing (CM), an application of Group Technology [1], is a manufacturing philosophy that attempts to derive the benefits of a flow shop in a job shop situation. The job shop is partitioned in various groups of dissimilar machines known as machine groups. Each machine group completely processes its corresponding family of components or parts. A number of benefits arise from adopting cellular manufacturing such as reduced inventory, increase of shop capacity, reduced labour and overtime costs, shorter manufacturing lead times, faster responsiveness to internal and external changes due to machine and other equipment failures, product mix and demand changes [2]. Many research methodologies of cell formation have been developed and published. For an extensive review of literature please refer [3] ,[4] and also [5].

Most of the cell formation models make simple assumptions and ignore many manufacturing factors. These models consider machining operations of parts, and the manufacturing system is represented by a binary machine-part incidence matrix(MPIM) A, with the following convention:

$$A_{mn} = 1 \quad \text{if part } m \text{ is processed on machine } n$$
$$= 0 \quad \text{otherwise}$$

The aim of the model is to manipulate the incidence matrix shown in Fig. 1 so that machine groups and the corresponding dedicated part families may be formed as shown in Fig. 2. Fig.1 is the input matrix and Fig. 2 is the resultant matrix showing machine groups and dedicated part-families with one exceptional element as shown.

Most of the methods, developed earlier had ignored major practical issues such as the sequence of machine operations for parts and the size of the cells. Earlier models for example as cited in [6] and [7], based on matrix manipulation are having several limitations and cannot be used in practical conditions. These earlier models get attention as these are the useful ones for understanding the evolution of cellular manufacturing techniques. Mathematical models developed for cell formation can incorporate more complicated features of the problems but they often become computationally inefficient to solve large problems. Most of these models are not suitable for practical problems and do not incorporate flexibility of specifying the number of cells. Fixation of cell size are often neglected in these models.

The cell formation problem can be viewed as a combinatorial optimization problem However a combinatorial may be NP-hard and difficult to solve [8]. The optimization algorithms yield a globally optimal solution with prohibitive computational time. Most of the approaches are heuristic-based tailored algorithms for solving specific problems. However none of these methods can guarantee optimal solutions for varied types of situations. Similarity consideration in different data type has been used in informatics also where similarity measurements are utilized in data matching. Distance criteria had earlier been used for matching two types of data (strings) and validation of the developed algorithm have been carried out in [9].. A search approach had been utilized to find an actual string from jumbled data [10]. Meta-heuristic methods, which include evolutionary methods, have emerged subsequently to solve combinatorial optimization problems with global or near-global optimal solution, without being trapped in local optima. Since cell formation problem is a difficult combinatorial optimization problem in general, recent search meta-heuristics have been utilized. A team of researchers[11] have experimented their developed heuristic which generates good quality solutions to initialize a genetic algorithm.

In this paper, a new linguistic based methodology, is utilized to generate a suboptimal or near optimal solution that can be inputted to the GA algorithm. A threshold value of a dissimilarity measure called Levenshtein's distance is utilized here to generate part families first and then the corresponding machine groups are identified. This method can be applied to random processing of parts similar to job shop manufacturing situations or for sequential processing for flow shop. Further, a GA based model is utilized to ensure that the result is not being trapped in local minima by using a suitable value of mutation factor. Thus improvements in the cell formation are being achieved. In this manner the GA approach intends to build "independent" cells, with no part visiting more than one cells. However no exceptional elements and bottleneck machines must exist theoretically. The practical cases when such situation cannot be obtained, the machine groups are generated with the best possible combination. Corresponding part families are thereafter generated.

II. Basics of Manufacturing Cell Formation

Many of the algorithms in cell formation use a machine-part incidence matrix, an example of which is shown in Fig. 1.

Machines

Parts		1	2	3	4
	1	1	0	1	0
	2	0	1	0	1
	3	1	1	1	0
	4	0	1	0	1

Fig. 1 Machine incidence matrix

	1	3	2	4
1	1	1	0	0
3	1	1	1	0
2	0	0	1	1
4	0	0	1	1

Fig. 2 Diagonalised matrix

In the incidence matrices '1' shows the incidence i.e. if the machine processes the component else it will be shown blank or '0'. For example, part 1 is processed by machines 1 and 3, part 4 is processed by machines 2 and 4. The matrix is now block digitalized in Fig. 2. The component 3 cannot be fully processed in one single machining group and the machine 2 is called bottleneck machine. The objective of the cell formation algorithms is minimizing these bottleneck machines since they represent inter-cell movements. In this paper parts and components are used interchangeably.

The clustered matrix in Fig. 2 shows a particular machine-component relationship with a bottleneck machine. It is seen that although two distinct sub-matrices exist or 'nevertheless, part 3 hold relationship with both cells. It needs machines of both machine group for its complete processing. However, if machine 1 is eliminated or duplicated in other cell, the condition for ideal cell formation is satisfied. Machine 1 is, therefore, a bottleneck machine.

III. Basic Assumptions of the Model

The following assumptions are followed in this model:

1. The data solely represents the machine requirements on which operations are performed to produce any component.
2. The time needed for production is not considered.
3. The type of operation is not considered. For example, if a machine is utilised for performing many types of operations, no separate code is provided for each of the operations. However the software can be used for coding each operations separately.
4. Service departments like heat treatment, painting, quality control etc., are not considered for grouping, as they are always shared.
5. Workload for each type of machine has also not been considered initially for the obvious reason that in a dynamic condition the same cannot be correctly predicted. However the modification in the model has been made subsequently.

IV. Levenshtien's Distance Calculation

Levenshtein's Distance (LD) measures the dissimilarity between any two components represented in alphabetical strings. The distance between two strings, *1* and *2*, is defined as the minimum numbers of transformations required in deriving string *2* from string *1*. Three types of transformations are accepted, viz., deletion, insertion, and substitution. As an illustrative example the LD calculation of 4 strings, namely *abcd, ab, abcdef*, and *efgh* are shown in the Table I.

TABLE I
CALCULATION OF LAVENSHTEIN'S DISTANCE

String-1	String -2	Transformation	Levenshtein's Distance
abcd	ab	2 deletions	2
abcd	abc def	2 insertions	2
abcd	efg h	4substitutions	4

Different weightages can also be assigned separately to each type of the transformations for calculation of LD.

V. Model Description

In this paper, a string denotes how a component undergoes its process of manufacturing. The model is divided into two parts, and described hereunder:

In the first part of the model, data preparation and data validation are implemented. In this phase manual data entry and checking are conducted. The database file can be subsequently modified, in case the planner decides to change the sequence of operations. The processing requirements of each component are indicated in terms of a string.

The second part of the model attempts to generate the component families. Here the input file, created previously, is utilized to calculate the distances between all pairs of strings

ISBN : 978-602-97809-0-1

in terms of Levenshtein's Distance. Subsequently, the distance between each pair of strings are presented in a square-matrix form and search procedure is applied to select the initial seeds which form the basis or nucleus for creation of individual component families. The process is repetitive and the primary aim is to reach solution with maximum inter-cluster distance among the component families and the secondary aim is to obtain minimum total intra-cluster (or within cluster) distance of all component families. Here, a trade off, for balancing the number of component families is made by the two conflicting aims; while the primary aim increases the number of component families, the second one tries to minimize the inter cluster movement in terms of existence of bottleneck machines or exceptional components. As the number of seeds can be varied, the model generates practical and optimized set of machine-component groups.

A. Algorithm

The algorithm can be described in six steps as follows:

Step-1: Represent processing of each component in terms of alphabetical strings. Here each alphabet represents a machine/work centre.

The model is capable of considering sequential processing along with random processing. If a component in processed in the order of '*d-c-g-h-a'* where *d, c, g, h*, and *a* represent the machine element, then, the corresponding sequential processing plan will be 'dcgha', while random processing plan will be 'acdgh'. Most of the Matrix formulation methods follow random processing.

Step-2: Sort the strings in ascending number of machines in the strings and create a sorted file.

Step-3: Pick up the last string in the file and calculate the Levenshtein's Distance with other strings sequentially from the top first. The method of calculating Levenshtein's Distance is modified by using the concept of Null Machine. For example when calculating Levenshtein's Distance between 'a b c d m n j' and 'a b m n s t', the second string is changed to 'a b ~~b b~~ m n s t' and thus the Levenshtein's Distance measure changes from 5 to 4. Here '~~b~~' represents null machine i.e. machine, which remains idle for that particular part.

A systematic modification of Step-3 is shown hereunder:

1. Check the number of entries(alphabets) of all strings and arrange in descending order.
2. Move the longer string by one position at a time towards right (or in reverse move smaller strings in left) and check vertical matchings, vertical position of matching and LD
3. Expand the string (any one or both systematically) and check if LD is decreased. This process can be followed for both the string or restricted to one string for all possible positions.
4. Select the one which will have minimum LD

In case one string becomes subset of the other string, LD is counted as zero.

Examples for calculation of LD

Case1

String *abcdmnj* and *jkmnst* can be positioned as

a b c d m n j
j k m n s t

2 deletions (*a* and *b*) 3 substitution (*c, d,* and *j*) and one deletion (*t*) thus LD is 6

Case2

String *abcdmnj* and *abmnst* can be positioned as

a b c d m n j
a b m n s t

2 deletions (*c* and *d*) 1 substitution (j) and one deletion (*t*) thus LD is 4

Step-4: Create a distance matrix showing inter-relationships of all components.

Step-5: Consider the maximum dissimilarities (Levenshtein's Distance) in the matrix. The corresponding (i, j) value (row entity and the column entity) will represent initial seed points of the two prospective component cluster. Fix a threshold value of τ, which lies between 0.5 to 0.8, multiply with most maximum LD value (m) to get threshold LD. Include all those parts having lesser LD value than threshold LD value in the corresponding seeded part family. If a part has LD value more than threshold value for both the clusters, then, that part will act as initial seed for third component cluster.

Step-6: Select next seed points with the next maximum Levenshtein's Distance and repeat Step-5 till the optimal/desired number of clusters is obtained.

This is hierarchical based clustering algorithm as it may give different number of component families depending upon the threshold value of the Levenshtein's Distance. Thus, flexibility for deciding number of cells is built-in in the model.

B. Formation of Machine Groups or Cells:

Once the part families are formed, the following four steps are considered for machine cells:

Step-1: Consider the part families. Create number of bags as equal to number of part families. Use 'Bag Theory' to form machine bags. In each bag the number of counts of each machine will be equal to the number of counts of the same machine in the corresponding part family.

Step-2: Check if any machine is included in more than one bag. Fix an integer as threshold value (1 or 2 in general case). If in any bag it is more than the threshold value, include the machine in the bag else exclude it.

Step-3: Each bag indicates the machine group.

Step-4: Identify the bottleneck machines which are contained in more than one bag.

ISBN : 978-602-97809-0-1

In this article, a multiset (or bag) is a generalization of a set. While each member of a set has only one membership, a member of a multiset can have more than one membership (meaning that there may be multiple instances of a member in a multiset, not that a single member instance may appear simultaneously in several multisets).

C. Genetic Algorithm

Since above proposed Levenshtein's Distance Method is heuristic in nature, so there is every possibility the result of optimisation may be trapped in local optima, instead of reaching global optima. So, a metaheuristic technique like Neural Network, Genetic Algorithm, Simulated Annealing etc, which are although heuristic but based on some natural phenomenon and are scientifically proven, must be used to check the validity of the results obtained from the heuristic method used. The author has proposed Genetic Algorithm (GA) Method which is based on theory of Natural Selection and "survival of the fittest" chromosome. The constraint of maximum number of machines in any cell is considered by the author. Readers may refer [12] and [13] for understanding of application GA in cellular manufacturing.

D. Genetic Algorithm Procedure:

Choose initial population
Evaluate each individual's fitness
Repeat
Select best-ranking individuals to Reproduce
Mate pairs at random
Apply Cross-Over operator
Apply Mutation operator
Evaluate each individual's fitness
Until terminating condition.

The chromosome C_k is represented by a sequence of genes (g_i|=1, 2…..M), where M is the number of machines. Each individual gene g_i contains two bits of information: (a) the machine number 'i' represented by the position of gene g_i in the sequence of chromosome, and (b) the machine cell denoted by the value of g_i . For example, in a problem consisting of 7 machines M1-M7, and 3 cells, the chromosome C_2 = (1 2 3 3 2 2 1) shows that the second chromosome in the population and g_5 = 2 indicates that machine 5 is assigned to cell 2.

Consequently, this chromosome suggests three machine cells with the following cell compositions:

Machine Cell 1: (M1, M7)

Machine Cell 2: (M2, M5, M6)

Machine Cell 3: (M3, M4)

Example

A [5 X 9] matrix size problem is chosen (shown in Fig. 3) in this work to illustrate a simple problem. This is a medium size problem with small number of bottleneck machines.

	a	b	c	d	e	f	g	h	i
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1	1	0	0	0	1	0	1	0	0
2	0	1	1	1	0	0	0	1	0
3	1	0	0	0	1	1	1	0	0
4	0	1	1	1	0	0	0	1	0
5	1	0	0	0	1	0	1	0	1

Rows are components and columns are machines

Fig.3 Machine-part Incidence Matrix

Step-1: The string representation of 5 components/parts (assuming sequential processing) is given below:

(1) *aeg* (2) *bhdc* (3) *aegf* (4) *hdbc* (5) *iaeg*

Step-2, 3, 4: The LD values between all the pairs of strings are calculated and represented in a matrix form. The Levenshtein distance matrix generated for the above data is shown in Fig. 4 below:

	1	2	3	4	5
1	0	4	1	4	1
2	4	0	4	2	4
3	1	4	0	4	2
4	4	2	4	0	4
5	1	4	2	4	0

Fig.4 Levenshtein distance measure of Fig.3

The maximum LD is 5 which have been found at following six pairs:

(1, 2), (1, 4), (2, 3), (2, 5), (3, 4), (4, 5).

E. Formation of Component Families:

Step-5: Consider components 1 and 2 as seed points of two prospective part families:

Part Family-1: 1 Part Family-2: 2

Step-6: Let us consider threshold value of τ = 0.75, hence threshold LD value is τ * max LD i.e. 0.75 * 4 = 3. Assignment of remaining components to the part families is as follows:

First consider component 3 for including it in part family-1. LD between components *1* and *3* is 1 which is less than threshold LD, hence component *3* will be in same part family as is component 1 i.e. part family-1. Now, consider LD between component *1* and *4*. LD between them is 4 which is more than threshold value, hence component *4* will not be in part family-1. Let's investigate whether it will be in part family-2 or not. Consider LD between component *2* (seed of part family-2) and component *4*, it is 2 which is less than threshold LD. Hence, component *4* will come in part family-2. Similarly, when we investigate for component *5*, it comes in part family-2.

If for any component, LD between that and both initial seeds is greater than threshold LD, then that component will become seed for third part family. Similar process as in Step-2 then follows for finding out other members of this third part family.

So, the two part families (i.e. component families) formed are as:

Part Family-1: *1, 3, 5*

Part Family-2: *2, 4*

F. Formation of Machine Groups or Cells:

Step-1: Two Part families are formed. Part Family -1 contains components *1, 3* and *5* and Part Family-2 contains components 2 & 4. As there are two component families (i.e. part families), two machine bags are formed.

In bag 1, machine 'a' is utilized in processing components *1,3* and *5* and as such 'a' will have 3 number of occurrences or *count*. Similarly, machine 'e', 'f', 'g' and 'i' will have *3, 1, 3* and *1* counts respectively. So, the contains of bag 1 is given hereunder:

Bag 1 = {a, a, a, e, e, e, f, g, g, g, i }, or
Bag 1 = { a (3), e (3), f (1), g (3), i (1) }

In a similar manner, the contains of bag 2 is given hereunder:

Bag 2 = {b, b, c, c, d, d, h, h}, or
Bag 2 = {b (2), c (2), d (2), h (2)}

Step-2: It is found that there is no common machine in any of the bags.

Step-3: Machine group 1 contains machines a, e, f, g and j; while machine group 2 contains machines b, c, d and h. So, machine cells are:

Machine Cell-1: a, e, f, g, j or *1, 5, 6, 7, 9.*
Machine Cell-2: b, c, d, h or *2, 3, 4, 8.*

Step-4: No bottleneck machine is identified.

Final diagonalised matrix is shown below:-

	a	e	f	g	j	b	c	d	h
	1	**5**	**6**	**7**	**9**	**2**	**3**	**4**	**8**
1	1	1	0	1	1				
3	1	1	1	1	0				
5	1	1	0	1	1				
2						1	1	1	1
4						1	1	1	1

Fig.5. Final diagonalised matrix using LD Method

VI. RESULTS AND DISCUSSIONS

In this paper a new heuristic using a linguistic model is utilised with the provision of allowing bottleneck machines. The result is generated first by using a linguistic model. This, in most of the cases, will create *"independent cells"* if it exist. However in case bottleneck machines exist and matrix is not sparse the model is seen to generate comparable result with other methods. It is found that most of the cases the result obtained by LD technique does not require further scrutiny.

As the model is flexible and capable to accept defined cluster size and/or number of clusters, it is obvious that the proposed model is capable of generating more than one set of machine-component combinations.

But, for cases where some bottleneck machines exist, "independent cells" are not possible unless duplication of machines is being carried out. For these situations, results obtained may differ as bottleneck machines are duplicated and independent cells are formed. Without duplicating the bottleneck machines, GA method will further improve the result by decreasing the intercellular movement as machine groups will combine to create a single machine group. However, this process will decrease intercellular movement but will result in decreasing number of cells. If large number of bottleneck machines exist for any two cells, then that pair of machine groups will merge into one machine group. This may result in decreasing *grouping efficiency*[14]. But since this action has been taken with the sole objective for decreasing intercellular movement, decreasing grouping efficiency is quite permissible.

The presented method is hierarchical genetic algorithmic approach for obtaining machine cells and product. The model is expected to guarantee global optimal solution. It is found to generate comparable results with other popular methods. This presented method is capable to account operation sequence of parts and also attempts to make independent cells simultaneously. Random processing and Sequential processing both can be dealt with using this method. It works effectively for small and medium size cell formation problems and is useful if the matrix density is sparse moderately.

However, this method was found to generate inconsistent result if the number of bottleneck machines is increased. Future researches may be devoted more on solving sparse matrices, particularly with large number of bottleneck machines.

Further the developed algorithm may implement the concept of sequential processing as advocated in [15]. In fact the concept of cellular manufacturing goes well with the concept of flow process, interpreted as sequential processes.

VII. CONCLUSIONS

The methodology, described here, is a simple linguistic theory based heuristic algorithm to solve machine component cell formation problem. The basic information of input is collected from process sheets and each of the machine is coded. The size of the problem set can be increased by redefining scheme of the machine codes. This heuristic attempts to select a suitable set of machine groups and the components can be assigned to form corresponding component families. Further a GA technique validates the results of LD method. In case the optimality is not achieved in the LD method, the GA model ensures that.

The validity of this model is proved for large size cell formation problems especially with large number of machines. With a machine size of 50 the model has been found to generate consistent and workable result. However this method fails while solving cell formation problems with a large number of bottleneck machines. Though the existence of large number of bottleneck machines always create disturbances with other models equally, in this model the process sheets can suitably be modified and several trial can be carried out to generate diagonalised MPIM structure. It is also observed that the proposed model works very well for machine part incidence matrices with sparse density. It eliminates the basic fault of common clustering algorithms where the number of machine groups cannot be always inputted. This model also ensures global optima of the result using GA.

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ISBN : 978-602-97809-0-1

The Research Gaps and Opportunities in the Logistics Service Provider (LSP) Research Development

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Abstract **- The growth of logistics service provider (LSP) industry has resulted in an increase of LSP research conducted in recent years. However, papers which investigate research gaps and opportunities in LSP are limited. The aim of this paper is to identify research gaps and opportunities in LSP research by evaluating development of mainstream themes in this area. The study finds that the following themes have not been researched intensively: influence of innovative technology adoption, key capability and development of performance measurement in LSP. This paper identifies probable mainstream themes that can be developed for further research in the LSP field.**

Keywords **- Logistics service provider, content analysis**

I. INTRODUCTION

Logistics service has a complex role in the expansion of business market through managing market demand, creating customer satisfaction, sales, market share, and improving business performance [1-3]. The important role of logistics motivates organisations to manage logistics well. Organisations have three alternatives to operate logistics effectively and efficiently [4]. These include arranging the logistics function in house, through subsidiaries or outsourcing it. Outsourcing logistics service means employing an external organisation to perform logistics services such as transportation and warehousing that were formerly performed within the organisation [5]. Generally, organisations decide to outsource if a lot of benefits can be acquired and realised from a provider. Evidently, expected benefits from outsourcing stimulate trend in logistics service provider (LSP) as increasing demand of logistics service outsourcing expands the growth of LSP industry [6-8].

The expansion and growth of LSP industry in recent years have encouraged researchers to develop research that explores knowledge in the LSP industry. The complexities of issues encountered by the LSPs imply various research themes can be identified from this sector. However, a comprehensive research which investigates research gaps and opportunities in the literature is scarce.

The aim of this paper is to identify the research gaps and opportunities in the LSP area. This study contributes to the finding of potential further research needed in the LSP sector. The rest of the paper is organised as follows. Section II describes the research method employed; section III discusses overview of the nature of LSP industry; section IV presents definitions of LSP; section V identifies current states of LSP research; section VI identifies the mainstream themes in LSP research; section VII presents the evaluation of mainstream theme development, and section VIII concludes the paper.

II. METHODOLOGY

In order to identify research gaps and opportunities, this paper evaluates the development of the mainstream themes in LSP research. The mainstream themes in this study are obtained through classifying LSP research based on similarity research purposes and objectives. We employ content analysis method to investigate the content of literature in LSP themes. Content analysis is "a research technique for systematic, qualitative and quantitative description of the manifest content of literature in an area" [9, p. 252]. Content analysis is a useful method to identify certain concept and make inference relating to message within literature [10].

The first step of content analysis is searching pertinent articles that are relevant to the objective of study. The keywords used in searching are "logistics service provider" and the various terms that are similar to LSP terminologies that include "third party logistics" and "logistics service outsourcing". The search was limited to academic journals.

Table 1 shows the list of articles in various journals from 1995 to 2009 in the LSP themes. Because of the procedure in conducting analysis, the articles selected in this paper are only a representative of relevant literature, not an exhaustive collection. The next step defines the content classification scheme. This step will be described in the next part.

TABLE I

DISTRIBUTION OF ARTICLES BY JOURNAL

Journals	Number of articles
International Journal of Physical Distribution & Logistics Management	9
Journal of Business Logistics	7
Transportation Journal	7
The International Journal of Logistics Management	4
Asia Pacific journal of Marketing and Logistics	3
International Journal of Logistics Management	2
International Journal of Operations & Production Management	2
International Journal of Productivity and Performance Management	2
Management Research News	2
Transportation Research Part E: Logistics and Transportation Review	2
Others	9
Total	**49**

III. OVERVIEW OF THE NATURE OF LSP INDUSTRY

Market globalisation and rapid growth of LSP business have created an intensively competitive LSP business environment which leads to the LSPs working extremely hard to offer superior service levels to their customers. The situation is compounded by customers also becoming highly selective and sensitive toward service levels as their needs become increasingly complicated. In order to survive in a highly competition market, the LSPs must pursue the changing needs of their customers. They develop various strategies to retain customers in the existing market and even creating new market through provision of customized services to meet customer requirements as well as identifying relationship pattern within each market segmentation [11-13]. In order to provide customized services, LSPs need to understand what customers value the most.

Without understanding issues that the customers highly value, the relationship between LSPs and their customers will be short-lived. Wilding and Juriado [14] have investigated reasons of why firms do not use LSP services for a longer time period; their results show that as much as 68% is caused by service issues which made customers hesitate to re-engage the same LSP for the next contract. This phenomenon shows that achieving the desired service levels as identified by the customers is an important issue that must be resolved in the LSP business context, especially in the current highly competitive market environment.

Services offered by the LSPs are very diverse, from standard services to integrated services, such as transportation management, warehouse management, logistics information systems, product assembly, product packaging, labelling, quality control, purchasing service and insurance service. This often resulted in variety of terminologies similar to above various services used in the LSP industry. In particular, transportation, warehousing, carrier selection, rate negotiation and freight payments are some of the examples of services requested the most by companies [15, 16].

IV. THE DEFINITION OF LSP

There are a variety of terms and definitions on LSP that have been used in the literature. Table 2 shows a variety of definitions of LSP used. From the table, it appears that each author has its own definitions, however five substances can be identified in the overall definitions, namely “who the LSP is”, “what the LSP offers”, “what kind of relationship between the LSP and customers is”, “what the output of LSP service is”, and “what the result for the LSP is” (see Table 3). In this study, we will use a definition that includes all five substances above which is simple and easy to understand. In this paper, we define LSP as “a company that provides a part or multiple parts of logistics services to create value for customers by developing a longer-term and mutually beneficial relationship to get compensation from customers”.

TABLE II

THE VARIETY OF DEFINITIONS ABOUT PROVIDER OF LOGISTICS SERVICE

Authors	Definition
Reference [17]	“LSP is provider of logistics services operating the logistics functions for clients or an external organisation that performs all or part of a company’s logistics functions.”
Reference [18]	“Third party logistics services are multiple distribution activities provided by an external party, assuming no ownership of inventory, to accomplish related functions that are not desired to be rendered and/not managed by the purchasing organisation.”
Reference [19]	“A third party provider is defined as any firm providing a good or service that is not owned by the purchaser of the good or service.”
Reference [20]	“An external supplier to perform some or all of a firm’s logistics function.”
Reference [21]	“A company that provides multiple logistics services for its customers, whereby the third party logistics provider is external to the customer company and is compensated for its services.”
Reference [22]	“Third party logistics is analogous to outsourcing or contract logistics and is broadly defined as the use of an external company to perform all or part of another company’s operations. Contract logistics encompasses a broad number of functions and is characterized by longer term, more mutually beneficial relationships.”
Reference [12]	“A TPL provider is an independent economic entity that creates value for its client.”

TABLE III

ELEMENT OF THE DEFINITION ABOUT PROVIDER OF LOGISTICS SERVICE

Authors	Elements of Definition				
	Who	What offered	Kind of relation-ship	Output of service	Result for LSP
Reference [17]	√	√			
Reference [18]	√	√			
Reference [19]	√	√			
Reference [20]	√	√			
Reference [21]	√	√			√
Reference [22]	√	√	√		
Reference [12]	√			√	

V. OVERVIEW OF THE CURRENT STATES OF LSP RESEARCH

Current studies show that the importance of LSP research has not been supported by comprehensive investigations. As much as 69% of papers lack the development of theoretical model and hypothesis testing although researchers agree that "theoretically-developed hypotheses" will contribute to advance theory in the field of logistics [15, 23]. The other fact is that only 27% of the papers that investigate LSP-buyer interaction [15]. This reality illustrates that only few studies explore provider and buyer simultaneously [24].

The other limitation is that many research analyses do not distinguish research findings based on the characteristics of LSPs and buyers, such as the age of LSP, the size of LSP, the service offered, the length of service, the size of buyer, the level of decision maker in buyer companies [25], thus the conclusions reported are not focus and can be confusing. For example, the age of LSP can influence customer assessment because the LSP's age relate to the level of experience and impact on implementation and operational processes [24]. The size of the LSP can be a critical factor because it determines the comprehensiveness of services offer, the wider scope of services offer, the extensiveness of geographical coverage and the price of services.

A lot of researches have analysed over multiple industries even though each industry has different requirements and characteristics. For instance, the electronic industry focuses on cost while the pharmacy industry focuses on service [24]. It would be advantageous if research findings are analysed for individual industry so that the results can have significant implications. Therefore it is the intention of this paper to comprehensively investigate the research gaps and opportunity in LSP research by identifying the mainstream themes and to evaluate each mainstream in a systematic manner.

VI. OVERVIEW THE MAINSTREAM THEMES IN LSP RESEARCH

Based on the literature review, research in LSP themes can be classified into nine broad categories as shown in Table 4. The mainstream themes consist of logistics outsourcing decision; criteria and steps for selecting LSPs; the LSP capability and role; performance of the LSP; relationship between LSPs and their customers; the growth strategy of the LSP; technology adoption in the LSP industry; the usage level of LSP in some countries and the literature reviews in LSP.

The logistics outsourcing decision mainstream theme involves articles which investigate logistics outsourcing decision, such as driver outsourcing, buying process and customer evaluation to LSP's performance. Specifically, the mainstream involves reasons for outsourcing [19, 26]; theoretical framework to identify factors influencing outsourcing decision and strategic orientation [27] as well as analytical framework for logistics outsourcing decision [8].

The criteria and steps for selecting LSPs mainstream theme comprises of articles which explore criteria for selecting LSPs. The research objectives in this mainstream are many, such as to investigate selection criteria and examine relationship between selection criteria and company competitive strategy and external environment [28, 29]; to differentiate selection criteria based on driving power and dependence level among selection criteria [30]; to develop conceptual model for LSPs buying process [20] and to identify selection steps for choosing LSPs [12].

The LSP capability and role mainstream theme encompasses articles which investigate LSP roles, their capabilities and classification. In detail, this theme investigates LSP roles in supporting customer performance and supply chain integration [31]; investigates the important logistics capabilities for LSPs which operate in distribution field [32]; classify LSPs based on service capabilities [13, 33, 34]; identify determinant of LSPs roles [6] and identify the various LSP roles in the supply chain based on the determinants of LSP roles [22]. Furthermore, the LSP performance mainstream theme contains articles which develop performance measurement [35-37]; investigate relationship between performance and its driver such as external and internal environment and operation strategy [38] and examine contribution of LSPs to customer performance [39].

The relationship between LSPs and their customers mainstream theme involves articles that explore relationships between LSPs and their customers. In detail, this theme involves researches which identify determinants of successful relationship [40, 41]; effect of relationship orientation of LSPs on relationship between LSPs and their customers [42]; linkage between relationship outcomes, relationship characteristics and customer attributes [43]; identify key variables of relationship between LSPs and shippers and their impact on shippers' productivity and competitiveness [44]; investigate managing relationship in point of view customers [16] and investigate dynamic aspects of relationship [45].

The LSP growth strategy mainstream theme consists of articles which study growth strategy for LSPs. In particular, this part investigates the value created by LSPs [46]; the growth strategy for each LSP category [11]; the relationship between LSP development and their strategy [47] and the influence of external environment and internal resources on LSP competitive advantage [48].

The technology adoption in LSP industry mainstream theme embraces articles which identify the impact of technology development and adoption on LSPs. The usage level of LSP in some countries mainstream theme investigates the usage of LSP in some countries in terms of drivers of outsourcing; decision maker level; used logistics service; benefits and disbenefits, selection criteria; implementation problem and future opportunity. Lastly, the literature reviews in LSP field mainstream theme involves articles that explore the development of LSP research.

TABLE IV

THE MAINSTREAM THEMES IN LSP RESEARCH

No.	Mainstream themes	Example Papers
1.	The logistics outsourcing decision	[19], [8], [26], [27]
2.	The criteria and steps for selecting LSPs	[29], [20], [28], [12], [30]
3.	The LSP capability and role	[6], [22], [33], [34], [32], [13], [31]
4.	The LSP performance	[35], [39], [36], [38], [37]
5.	The relationship between LSPs & their customers	[40], [16], [41], [45], [42], [43], [44]
6.	The LSP growth strategy	[46], [11], [47], [48]
7.	The technology adoption in LSP industry	[49], [50], [51]
8.	The usage level of LSP in some countries	[52], [53], [54], [55], [56], [57], [58], [59], [60], [61], [62]
9.	The literature reviews in LSP field	[24], [15], [63]

VII. EVALUATION FOR THE MAINSTREAM THEME DEVELOPMENT

The logistics outsourcing decision and the criteria and steps for selecting LSPs mainstream themes have been investigated extensively in the literature and have also been well researched. Both mainstream themes are interrelated which duly reported outsourcing reasons that determine selection criteria. Currently, there is no research which investigates the compatibility between outsourcing reason and criteria used by companies to select LSPs. The research opportunities for both mainstream themes are to investigate how the relationship between outsourcing reasons and selection criteria exist; how to measure the compatibility and do companies which have the high compatibility between outsourcing reasons and selection criteria achieve higher success rate compared to companies which have the lower compatibility.

In the LSP capability and role mainstream theme, research which investigates fundamental capability in LSP industry is limited. For future research, we need to explore key capability in each LSP category. We also need to know vital capability for each business segment because each business segment has its own unique characteristics which are different from the others. For instance, the capability needed for transportation sector is different from the capability for warehousing. For further research, we need to find out what the contributions of LSP capability on customer performance are, what the impacts capability on LSP performance and on sustainable LSP business are.

For the LSP performance mainstream theme, the efforts to identify performance drivers have been investigated sufficiently. In contrast, the developing of performance measurement for each LSP classification has not shown satisfactory result. Key performance index for each LSP classification have not been extensively and intensively explored. Attempt to investigate the contribution of LSP performance on customer performance has already been conducted although it is viewed as insufficient. For further research, we need to investigate how the impact of LSP performance for LSPs and their customers and we also need to develop a performance measurement model for each LSP classification.

The relationship between LSPs and their customers mainstream have developed greatly, starting from research which investigates determinant relationships, key variables of relationship, until the linkage between relationship characteristics and relationship outcomes. For further research, we need to investigate what LSP's and customer's endeavour in order to develop the relationships are; what determinants the relationship quality between LSPs and their customers and what the impact of relationship quality on LSP and customer performance.

The LSP growth strategy mainstream theme has been well investigated such as developing strategy based on LSP characteristics; developing balance strategy between focus on problem solving capability and focus on customer adaptation; managing internal resources, capability and external environment. For future research, we recommend to examine the success level of each strategy that has been developed.

The technology adoption mainstream theme has not been investigated extensively. Papers which discuss this mainstream theme are very limited. The LSP industry needs high investment in technology adoption, such as expertise, expensive equipment as well as information and communication technology. For future research, we suggest to conduct research that investigates what the positive and negative impacts of technology on LSPs; for positive impacts, what has been done by LSPs to optimize the impact; for negative impacts, what has been done by LSPs to minimize the impact; do customers perceive the technology adoption by the LSPs contribute to relationship outcome; do the technology adoption by the LSPs contribute to customer performance.

For mainstream theme on usage levels of the LSP in some countries, early publications in this mainstream theme are mainly from the U.S. and Europe. However from 2005 onwards, research development in this area has extended to Asia Pacific, especially India and China, starting from using popular services, benefits and disbenefits of LSPs' services, implementation problems and opportunities. This mainstream theme can be extended to other countries which are yet to be investigated.

In the literature reviews in LSP field mainstream theme, papers which investigate the research development in LSP field are scarce, which prompted the authors in conducting a comprehensive analysis of identifying mainstream themes in the area of LSP research. Examples of research opportunity identified in this mainstream theme are behaviour in network analysis, developing key performance index in LSP performance or specifying relationship between LSPs and their customers, contribution of LSP on buying organisation, and impact of e-commerce on LSP business.

VIII. CONCLUSION

This study has identified nine research mainstream themes in LSP field at different development levels. The literature reviews, the technology adoption, the LSP capability and the LSP performance mainstream themes have received fairly low attention in LSP research, especially the technology adoption theme. The different development levels of mainstream theme identify research gaps and opportunities for further study in the LSP discipline area. There are some research opportunities that worth investigating; these include investigating key capability for each LSP classification; developing performance measurement for each LSP classification; investigating the impact of technology adoption on LSP and customer performance. Moreover the LSP research needs to be conducted in different countries that are yet to be investigated. Finally, the literature review mainstream theme support findings in this study which indicate research in both LSP and customer point of view need to be thoroughly investigated.

ACKNOWLEDGMENT

This study was funded by The Ministry of National Education of the Republic of Indonesia.

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ISBN : 978-602-97809-0-1

Review of Supplier Selection Methods: Suitability for Malaysian Electricity Supply Industry

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Abstract - **Malaysian electricity supply sector is increasingly using outsourcing as a means to control costs and risk. Consequently, supplier selection has become a major strategic decision for buyers. Supplier selection is a multi-criteria decision making problem which includes both qualitative and quantitative factors. A trade-off between the tangible and intangible criteria is important in selecting the best supplier. A reliable suppler selection method should be able to handle this need in order to support the modern procurement requirement of having a systematic and transparent decision making approach. This paper presents a review of supplier selection processes and decision making methods reported in academic and other literature. This review showed that methods using mathematical frameworks to support the decision-making were more successful in dealing with increased complexity related to decision making.**

Keywords **— Supplier selection, decision makers, process, method**

I. INTRODUCTION

Electricity utilities have undergone a major transition worldwide in order to enhance efficiency many steps have been taken. One of the key initiatives which has been adopted by the electricity supply industry is outsourcing. The heuristic approach from theorists is to concentrate on what is the company core competency then outsource anything else. However there are numerous reasons as to why a company may wish to outsource. Ying [1], for example, summarized that these reasons as follows:

- cost reduction
- improvement of quality, service and delivery
- improvement of organizational focus
- increasing flexibility; and to facilitate changes

Overall, the success of the supply chain created by a company is dependent on the capability of the suppliers. Therefore supplier selection *per se* is critical for any Supply Chain Management SCM system. In order to select appropriate suppliers for a supply chain, it can thus be deduced that there is a need to objectively evaluate suppliers. The overall objective of supplier evaluation is to determine the optimal supplier offering the best all-around package of product and services for the customer [2]. The purchasing company should question what are the potential long term risks of particular outsourcing. The more reliable the supplier is, the lesser negative effects shadowing the production performance of the buying company. Suppliers must be able to meet the performance requirements or the expectation of the purchasing firm and be capable of continuous improvement [3].

Research on supplier selection protocols can be traced back to the early 1960s when it was called 'vendor selection'. In the early phase of research and publication related to supplier selection and evaluation, the principle evaluation criterion was that of cost. However, even at an early stage in this area of research, Dickson [4] identified 23 different criteria for supplier selection including quality, delivery, performance history, warranties, price, technical capability and financial position amongst others. Indeed this remains a key concern for researchers seeking to 'optimise' supplier selection, since the decisions made are complicated by the fact that various criteria must be considered [5]. Practitioners must know how to use the best method from different types of methods to select the right supplier. Moreover, with the latest implementation practices of Total Quality Management (TQM) and Just-In-Time (JIT) concepts by wide range of companies, the supplier selection question has become extremely important [6]. Indeed a further level of complexity is added because many decision makers or purchasing managers select suppliers based on their experience and intuition (i.e. heuristic techniques) which might not be considered to be 'best practice' in selection protocol [7]. Ying [1] pointed out that the main weakness of many practitioners is not applying any structured supplier selection decision-making technique in supplier selection which has led subsequent authors [8] to propose the usage of multi-criteria decision making techniques to be employed in order to make the process more deterministic.

The main aim of this paper is to review the supplier selection methods in various industries in order to find the viable methods for supplier selection for Malaysian electricity supply industry. This paper is intended as a preliminary literature review, prior to a full research project intended to address critical supplier selection questions for the Malaysian Power generation sector.

II. SUPPLIER SELECTION PROCESS

Purchasing plays an integral role in supplier selection. Purchasing of products and services can be grouped according to a classification created by Faris et al. [9] as either a new task situation, modified rebuy or straight rebuy. Later, Kraljic

ISBN : 978-602-97809-0-1

[10] proposed a revised purchasing classification framework which categorized purchases into either strategic, bottleneck, leverage or routine. De Boer [11] incorporated both classifications into a modified framework to offer a purchaser a manageable number of typical, different supplier selection situations with associated ways of carrying out and organizing the supplier selection process. De Boer et al. [12] outlined that there are four key steps making up the supplier selection process as illustrated in Fig. 1.

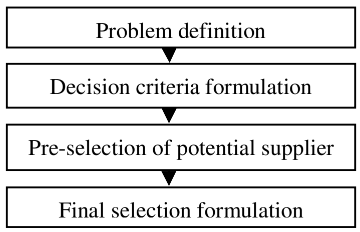

Fig. 1 Supplier selection process (From De Boer et al. [12])

At the beginning, decision makers, especially purchasing managers, face different purchasing situations which require them to carefully identify the requirements of a decision along with the available alternatives [13]. This formulation influences several activities such as inventory management, production planning and control, cash flow requirements and product or service quality [14]. Decision criteria formulation is critical in order to select the best suppliers available. The process has significant levels of complexity due to the existence of various (i.e. objective and subjective) selection criteria. Supplier pre-selection (or pre-qualification [15]) is intended to eliminate those potential suppliers who are not capable of delivering the required capability or service level. Typically this is done through the requirement prior to bidding of providing evidence of prior experience or capability within the competency that the purchase is intended to cover. Indeed this is the principle component of the PIPS procurement protocol developed by Kashiwagi [16]. The reduction of potential supplier candidates reduces the workload on the purchasing manager's group and allows a greater level of depth in the assessment of those bids passing this stage. During the final selection process, successful suppliers are identified and orders are allocated among them based on selected decision model.

III. SUPPLIER SELECTION METHODS

There are a number of methodologies which have been developed to assist in evaluating suppliers. Some methods have been popular selection for years, while other methods have been introduced recently. Selection criteria and measures used are changing and will continue to change as information technology permeates through organizations [17]. Supplier selection approaches include:

A. *Categorical Method*

A traditional method that classifies each supplier's performance in specific areas defined by a list of relevant performance attributes [18]. This method is simple to use, inexpensive, and the evaluation can be done quickly. The suppliers' performance on each attribute is assessed in categorical terms such as "good", "neutral" and "unsatisfactory". Then the buyer determines the supplier's overall scores. The supplier obtaining the most "good" rating is considered the best. The drawback of this method is that all attributes are assumed to have equal importance. The categorical method also relies heavily on the experience and ability of the individual buyer [20].

B. *Weighted Point Method*

Weighted point method is also known as linear weighted average method [18]. This method utilises a relative importance weighting assigned to each attribute so that a composite performance index can be calculated and a comparison made. The evaluator rates the performance of suppliers with respect to each attribute. Purchase price is one of the key attributes that will be assessed, but will not be the only attribute. These other attributes are usually referred to as 'non-price attributes' [19]. The performance scores are multiplied by the attribute importance weighting to calculate a supplier's overall rating. The supplier with the highest weighted score is the best. The purchasing organization is thus able to include numerous evaluation criteria and assign them with weights according to the organization's needs. Although this method no longer treats the criteria as having equal importance, the subjectivity of the decision maker in assigning weights remains as an issue [20].

C. *Cost-Ratio Method*

This method evaluates suppliers' performance based on a cost analysis [21]. The total cost related to quality, delivery and service are calculated and expressed as percentage of the total value of the purchase. The total purchase cost includes the selling price plus the purchaser's internal operating costs associated with the purchases. As an example, the costs associated with delivery include communications, meetings with supplier and emergency transportation costs. Overall cost ratio is applied to the supplier's quoted unit price to obtain the net adjusted cost figure. The obtained adjusted cost price is used as the basis for performance comparison among the bidders. The supplier who can offer the lowest cost ratio is considered the best. This method is more precise compared to the earlier mentioned methods. The cost-ratio method is a complex approach, requiring a comprehensive cost-accounting system to generate the precise cost data [21]. Furthermore, it assumes all the required data are easily available – which is often not the case.

D. *Vendor Profile Analysis*

Thompson [22] introduced a modified weighted average method to address the uncertainty involved in the assignment of ratings. A Monte Carlo simulation technique is used to replace the rating based purely on intuitive judgement. The use of Monte Carlo simulation simplifies the decision maker's input to the evaluation process and provides output that has considerably more information for the decision maker. As an

ISBN : 978-602-97809-0-1

example, the simulation provides the level of performance anticipated from each supplier. The degree of uncertainty associated with the overall performance of each vendor is shown by the variance value. The degree of overlap assists the decision maker to identify the potential similarities in performance between suppliers. This extra information allows the forecast of each supplier's performance level and potential for deviation from the expected level. However this method cannot quantify qualitative criteria effectively and it is difficult to be applied by ordinary users as good understanding of Monte Carlo technique is required.

E. Dimensional Analysis

Willis et al. [23] propose the application of a mathematical technique called dimensional analysis in supplier selection evaluation. This technique provides a means of combining several criteria of different dimensions and varying relative importance into a single dimensionless entity. The evaluation process involves a series of one to one comparisons and only one supplier is evaluated at a time. When this method is applied to measure supplier performance, the different dimensions refers to the various criteria in the selection decision such as price, quality and delivery. Each criterion has a particular unit of measure. In order to create a dimensionless entity, each criterion is divided by the desired company standard. The dimensional analysis model applied by Willis et al. [23] is given by the following equation:

$$VPI = \sqrt[W]{\prod_{i=1}^{n} \left(\frac{X_i}{Y_i}\right)^{w_i}}$$

Where:

VPI = vendor performance index

X_i = performance criterion score for supplier X

Y_i = standard performance score for criterion i

i = 1,2,..., nth criterion

w_i = weight assigned to criterion i (relative importance)

$$W = \sum_{i=1}^{n} |w_i|$$

A series of pair-wise comparisons of suppliers is needed to obtain the ranking when there is a group of suppliers. The main drawback of this method is that the process becomes very time consuming if there are a large number of suppliers to be evaluated.

F. Analytical Hierarchy Process (AHP)

Narasimhan [14], Nydick and Hill [24] and Partovi et al. [25] suggested the use of the analytic hierarchy process (AHP) approach for supplier selection problems because of its inherent capability to handle both qualitative and quantitative criteria in suppliers' selection. AHP is a mathematically based multi-criteria decision making (MCDM) tool and was originally introduced by Saaty [26]. This method allows the decision maker to structure complex problems in the form of a hierarchy. AHP also has the ability to monitor the consistency with which a decision maker makes a judgement [27]. The hierarchy has at least three levels: the goal, the criteria and the alternatives. The goal is to select the best overall supplier and the alternatives are the different proposals provided by suppliers. All criteria are compared fairly to determine their relative weights. Subsequently, the alternatives are compared fairly with regard to each criterion. The final outcome of this process is a score for each alternative. AHP avoids the main drawback of the traditional methods of assigning weights purely based on personal judgement and intuition of decision maker. However arguably it is still possible to 'stack the deck' in favour of a particular supplier solution with this system if an unscrupulous purchaser runs it.

G. Total Cost of Ownership

This method attempts to include all quantifiable costs in the supplier choice that are incurred throughout the purchased item's life cycle [12]. Optimum use of all discounts available can lead to substantial savings. Price is an important criterion, but not only the factor affecting purchasing cost. In addition to price component, cost factors such as quality shortcomings, transportation cost, ordering cost, reception cost need to be taken into account. Using this method, the purchaser will award the job to the supplier with the lowest unit total cost.

The total cost of ownership philosophy maintains that the least expensive supplier is not necessarily the best choice if one takes into account all the possible additional costs to be generated across the supply chain [28]. This approach enables substantial cost savings to be achieved and it offers an opportunity to compare different purchasing strategies objectively. It can also be used in buyer-supplier negotiations to discuss recent performance [28]. The total cost model is useful if it is precisely calculated. Indeed it can achieve significant savings over the life of the purchased product or service. However the technique is expensive to implement due to its complexity, and difficult to implement because of the implied requirement to be able to correctly identify all the critical elements. The technique is also less attractive than some other because it requires more time to fully complete the evaluation process and thus harder to make timely decisions.

H. Multiple Attribute Utility Theory (MAUT)

This approach enables the decision-maker to structure a complex problem in the form of a simple hierarchy and to subjectively evaluate a large number of quantitative and qualitative factors in the presence of risk and uncertainty. This makes the techniques especially useful for handling multiple conflicting criteria inherent in international supplier selection. International supplier selection is very complicated and risky, owing to variety of uncontrollable and unpredictable factors such as exchange rate, tariffs and government policies which might affect any decision taken. Utility is a measure of desirability or satisfaction and provides a uniform scale to compare and/or combine quantitative and qualitative factors. A utility function is a device which quantifies the preferences of a decision maker by assigning a numerical index to varying levels of satisfaction of a criterion [29]. The major strength of this approach is its ability to deal with both deterministic and stochastic decision environments [30].

I. Mathematical Programming Method

Mathematical programming is an optimization method to select several suppliers in order to maximize an objective function subject to supplier/buyer constraints. Various mathematical programming methods are used in supplier selection literature such as listed below:

1) Linear Programming: This technique is widely used. For example Moore and Fearson [31] utilized linear programming to optimize supplier evaluation model based on price. Anthony and Buffa [32] similarly used this method to minimize total purchasing and storage costs based on budget, demand, satisfaction and storage constraints. Talluri and Narasimhan [33] developed two linear programming models to maximize and minimize the performance of a supplier against the best target measures set by the buyer. These authors went on to develop another model to evaluate and select potential suppliers with respect to the strengths of existing suppliers and exclude underperforming suppliers from a telecommunication company's supply base [34]. Similarly Ng [35] developed a weighted linear programming model with an objective of maximizing supplier score in the supplier selection.

2) Goal Programming: Karpak et al. [36] constructed a goal programming model to evaluate and select the suppliers. Three goals were considered in the model: cost, quality and delivery reliability. The model is intended to determine the optimal amount of products ordered, while subjecting to buyer's demand and supplier's capacity constraint. One of the drawbacks of this method is the lacking of consideration for qualitative factors. To overcome this, Cebi and Bayraktar [37] integrated goal programming and AHP which considers both qualitative and quantitative criteria.

3) Data Envelopment Analysis (DEA): Data envelopment analysis (DEA) is another method that aids decision makers in classifying the suppliers or their bids into a group of efficient suppliers and a group of inefficient ones. This non-parametric method allows efficiency to be measured without having to specify either the form of production function or the weights for the different inputs and outputs chosen. This methodology defines a non-parametric best practice frontier that can be used as a reference for efficiency measures [38]. Its use in supplier selection was primarily discussed by Weber and Ellram [39].

J. Artificial Intelligence (AI)

Artificial intelligence models are based on computer-aided systems that in one way or another can be 'trained' by a purchasing expert or historic data [12]. These programs usually act very autonomous and provide the user with a ranking of the potential suppliers. Two methods in this area are:

1) Neural Networks: Albino and Garavelli [40] suggest the use of neural networks for sourcing problems, especially in the very complex case of subcontracting in the construction industry. Neural networks are systems learning directly from examples and therefore able to cope better with complexity and uncertainty than traditional methods because AI based approach are designed to be more like human judgement [12]. In modelling a problem, after considering variables and environment for that specific problem, defining the variables and environment to a different problem, three phases are considered namely, programming, testing and implementing. Initially the system is trained with a special training set representing the decisions and preferences given by the decision makers for different situations. From the training sets, the system will learn the decision maker's behaviour and relation between input and output. Next in the testing stage, the system will be tested for analyzing of results with some examples which were not used in the training set. Comparisons are then made to the actual decision by the decision maker. Once implemented, the system will generate a final rating for each of the potential suppliers [40].

2) Case-Based Reasoning (CBR): Case-based reasoning (CBR) is a subset of Knowledge Based Systems (KBS). CBR systems, used as purchasing decision support tools, result in faster, more accurate, more consistent, higher quality and less expensive decisions [41]. CBR is a problem solving technique in which past cases and experiences are re-used to find a solution to particular problems [42]. CBR simulates human-thinking processes and problem-solving strategies. The central tasks involved in CBR methods are to identify the current problem situation, find a past case similar to the new one, and use that case to suggest a solution to the current problem, evaluate the proposed solution and update the system by learning from this experience [43]. Aamodt and Plaza [44] described CBR as a cyclical process comprising the four 'Re's:

- retrieve the most similar case(s),
- reuse the case(s) to attempt to solve the problem,
- revise the proposed solution if necessary,
- retain the solution as part of a new case.

Choy and Lee [45] presented an intelligent generic supplier management tool using the CBR technique for outsourcing to suppliers and automating the decision making process when selecting them.

K. Statistical Method

Statistical methods deal with stochastic uncertainty related to supplier selection. Published statistical models only accommodate for uncertainty with regard to one criterion at a time. Although uncertainty is evident in most of the purchasing decisions, only very few methods could really handle this problem [12]. The first work using statistical method was done by Hinkle et al. [46] adopting cluster analysis to select best supplier. Existing models to deal with uncertainty include a decision support system by Ronen and Trietsch [47] which focuses on lead-time management for large projects. Braglia and Petroni [38] presented a multivariate statistical method to evaluate existing suppliers' performance.

IV. CONCLUSIONS

Malaysia is currently undergoing reformation of its electricity supply industry into more effective, transparent and competitive electricity trading market. Under this restructuring process, many competitive local players have been created which are known as Independent Power Producers (IPPs). With the intense competition, these players are expected to provide continuous and efficient power supply for the whole nation. Therefore, Malaysia Power generation sector is forced to take advantage of any opportunity to optimize its business processes.

Supplier selection is a vital phase in the purchasing process. Selecting the right suppliers is not purely based on pricing comparison, it depend on wide range of quantitative and qualitative criteria. Purchaser should be able to select the right decision making tool which is easy, reliable and affordable. The application of a relevant structured decision-making technique is even more important in the complex construction industry of today. Not only for quality decisions but equally important is consistency and transparency under complex multi-criteria conditions, involving tangible and intangible criteria. There is a need for developing a systematic supplier selection process of identifying and prioritizing relevant criteria and evaluating the trade-offs between technical, economic and performance criteria. Most of the literatures regarding supplier selection concentrate on manufacturing industries. It will be a valuable effort to investigate the applications of such decision methods in other sectors.

This preliminary review of literature is the initial component of a PhD research project. The rationale for this research being predicated on the need to improve, and if possible optimize, the supplier selection methodology adopted in Malaysian Power generation sector. It is important to supply electricity to customers consistently and continuously by ensuring a balance between demand and supply at all times. Therefore, the electricity generating, transmitting and distributing infrastructures are critical to the ongoing ability of the power generation sector in Malaysia to deliver these explicit requirements. In order to continue to deliver customer expectations, these various infrastructures need to be replaced, upgraded or newly constructed to accommodate both current and anticipated future electricity demand. To meet the current demand of 14,733 MW of required power, the generation, transmission and distribution system must be reliable. As a prerequisite of this requirement, the quality of equipment plays an important role. Therefore, purchasing should be done carefully. There is a need to investigate the supplier selection practices in this industry as it is a unique sector by itself. Not all decision methods used by manufacturing industry might be relevant to the power industry.

The present-day supply management policy is to maintain long term partnerships with key suppliers, and to use fewer but more reliable suppliers. 'Reliability' in this context is not an easily quantifiable attribute of any tender document, therefore choosing the most appropriate suppliers involves much more than scanning price lists for the most favourable quoted cost for works. There is an inevitability that supplier selection choices in the future will depend on a wider range of both price and non-price criteria – and indeed reliability is but one such criteria. As complexity of such decisions increases, with a greater emphasis on non-price criteria, there is an increasing need to study the supplier selection criteria in Malaysian Power generation sector.

At present there appears to be no reported literature relevant to supplier selection criteria in the power generation sector of Malaysia or the wider world. Current research has therefore focused on the identification of similar supplier selection problems and solutions in other industries. Of particular importance in this research is the determination of a set of criteria rankings relevant to the power generation industry. From the review, it is suggested that usage of an expert system will be an advantageous approach to study issues of supplier selection in the electrical supply industry. This is attributable to its characteristics of having a heavily structured decision making system. However, an extended study shall be conducted to ascertain this finding applicable in the Malaysian context.

As practiced, supplier selection is based on perceived importance of selection criteria. However, in reality, numerous other attributes may overrule the criterion perceived to be important on a case by case basis. As supplier selection is a multiple criteria decision making, the selected criteria such as price, quality, delivery, risk and others might influence each other. There is a room for investigating the effect of interdependencies among the criteria towards the decision making process of selecting suppliers particularly for this sector.

Longer term, in order to deliver on the aspirations that Malaysia has towards economic and social development, an efficient, reliable and affordable power generation network is essential. These contradictory aspirations will exercise the Malaysian power generation industry for some years to come. It is the intention of this research to provide at least one of the numerous tools that will be required in order to deliver efficiency, reliability and cost effectiveness in the pursuit of power generation infrastructure. The next anticipated phase will be the development of a conceptual framework identifying selection best practices. This framework will form the basis of a research survey tool that will be developed and validated through a research process anticipated to start at the end of 2010. Subsequent findings will be published through this and other media.

ACKNOWLEDGMENT

The authors would like to thank Universiti Tenaga Nasional (UNITEN) Staff Development Scheme and Auckland University of Technology (AUT) for their support.

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ISBN : 978-602-97809-0-1

Push and Pull Joint Economic Lot Sizing Model with Remanufacturing

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Abstract – **Environmental friendly become important issues since every country has regulation for maintaining cleaner environment. Remanufacturing is an alternative used by manufacturing companies for complying to the government regulations about environment safety and also for acquiring part or material in a cheaper way. This paper focuses on the development of inventory system models that take into account remanufacturing. This research proposed four integrated inventory system start from raw material inventory needed, manufacturing inventory, remanufacturing inventory itself and serviceable inventory. Two models have been introduced, the push and pull system models and numerical examples is given as an application for the models..**

Keywords: **Economic Lot Sizing, Remanufacturing, Push and Pull Model**

I. INTRODUCTION

For many countries environmental concerns become a trigger for governments to make regulations for manufacturing companies to take active roles in controlling environment pollution caused by the product they soldl. Reverse logistics is one option for collecting and transporting used product from the consumer to the manufacturing compony for product recovery.

The reverse logistics not only provides environmental friendly products but also take back used product at its end of life.Within the reverse logistics, reversed the flow of goods ranging from consumer to industrial drawn again to be reprocessed. Related research product flow back to the factory to be further explored among others by [1], [2] and [3]. They discussed about how the product has reached consumers pulled back in manufacturing.

In reverse logistic, such product can be remanufactured, recycle or disposal on the environmentally save way. Reused and reprocessed used item can reduce need of origin raw material and improving efficiency an old product. One of process that mostly used is remanufacturing. A product may be remanufactured by either independent remanufacturing companies or original equipment manufacturers (OEM). Company can appoint a third party company to remanufacture a product or part of product.

Considering the use of used product to reprocess will change the inventory system start from raw material needed until how to fulfill customer demand. Significantly, it would change manufacturing lot size that have to be produced and the number of raw material to order from supplier. A number of researcher have been studied about economic lot sizing model of product return, this can be seen in [4] and [5]. For examples, the study about determining economic lot size for finished product inventory [4], [5], designing an economic lot sizing for two-echelon inventory system (depot and distributor) with push remanufacturing system [6], designing two echelon inventory system (recoverable and serviceable) with identical and non identical batches of production [7], and in [8] designing two-echelon inventory system using heuristic method for economic lot sizing push and pull remanufacturing system. These research reported that remanufacturing option will affect an economic lot sizing of production or shipment, but they did not discuss about the whole inventory system in industry.

In fact, to minimize total cost of system, we have to consider all of cost that occur in the whole systems of inventory. It starts from ordering raw material from supplier, setup manufacturing and remanufacturing process, shipping finished product from production plant to warehouse, and all of holding activities in each of them. So far, [9] have studied about integrated inventory, unfortunately he is not including remanufacturing option yet. He just explained inventory about raw material, manufacturing plant, and buyer finished product.

In this paper we reported the development of models based on the results done in [8] and [9].

II. MODEL DEVELOPMENT

An economic lot size model has been developed with four-echelon inventory [10], *raw material-assembly lines*, *process raw material*, *ready raw material* and *finished product inventory*. Another development is an integrated inventory model between supplier, manufacturer and buyer can be find in [9]. Both of the works explained integrated inventory, but did not consider remanufacturing as an option for recovery of the product.

Previous work that includes remanufacturing inventory has been discussed in [8] in which the use of manufacturing and remanufacturing inventory is to satisfy demand. However, this research did not includes the raw material inventory as in [9] and [10].

This research is an extention of the model developed in [10] by adding raw material inventory and manufacturing

ISBN : 978-602-97809-0-1

inventory [9] and remanufacturing inventory [8]. This research will focus on four-echelon inventory start from raw material inventory until serviceable inventory, where serviceable inventory is fulfill from manufactured and remanufactured product.

It has been developed two models, one is push system model and another is pull system. These two system models are shown in Fig. 2 and 3.

Finished goods that is used to fulfill demand called se*rviceable inventory*. Manufacturing process is run with constant rate, where the production rate (p) is bigger than customer demand rate (λ). Remanufacturing process run in the return product rate (γ), with assumption, all of return product can be remanufactured. Both of demand and of return have assumption follow a Poisson process.

In push system, remanufacturing and manufacturing products is delivered to the warehouse as serviceable inventory when they reach remanufactured optimal quantity (Q_r) and manufacturing product will deliver with Q_m number with a cycle of shipment period is (Q_r/γ). For pull system, products deliver to warehouse only when inventory in warehouse reach level zero. The implication is there is no over stock in warehouse. Raw material inventory have two kind of supply. First, raw material is supply for x times manufacturing lot size. Second, raw material is supply x times for one manufacturing lot size.

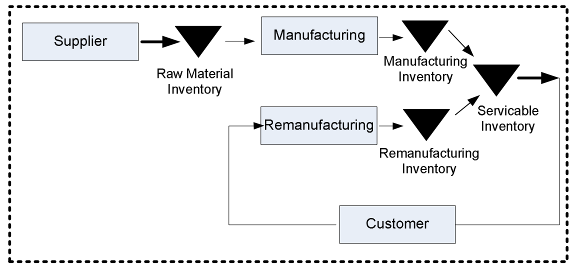

Fig.1. Four Echelon Inventory System with Remanufacturing

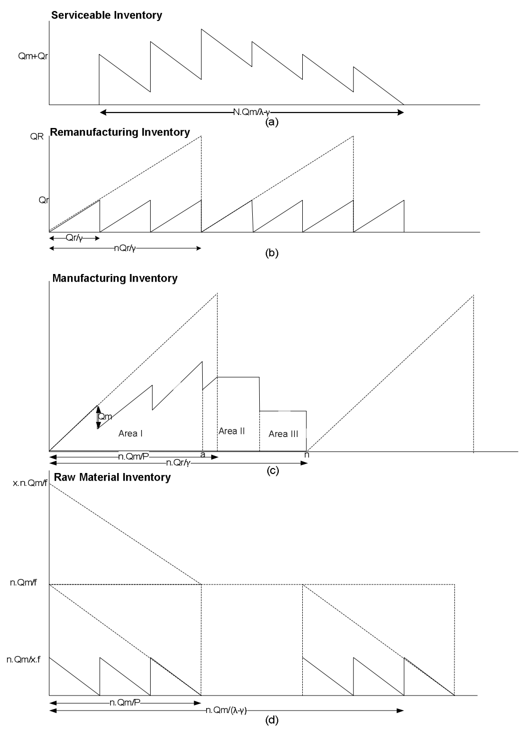

Fig. 2. Push System Inventory Model

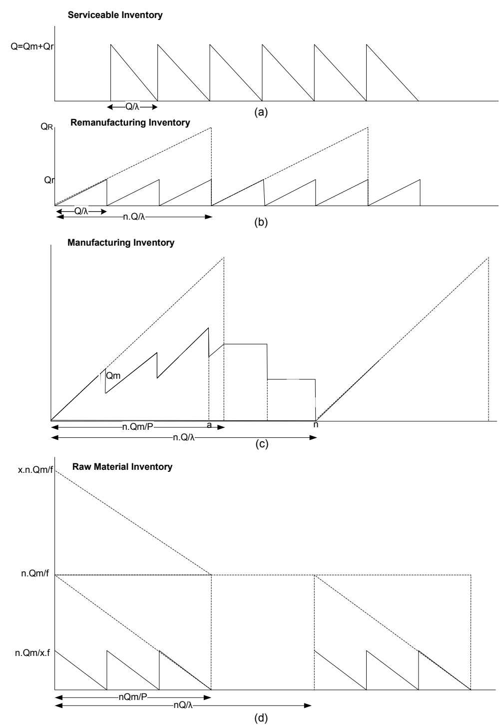

Fig. 3 Pull System Inventory Model

III. MODEL FORMULATION

Performance indicator of this model is economic lot sizing and the objective function is to minimize integrated total cost for four-echelon inventory. Based on that indicator, the decision variables may be defined for two inventory systems. The decisions variables are four decision variables for push system: *Qm*, Q_r, *n* and *x* and 3 decision variables for pull system, *Q*, *n* and *x*.

Belows are the notations used in the models:

- λ : Demand (units/year)
- γ : Product returns (units/year)
- p : production rate (units/year)
- n : Number of manufacturing delivery lot sizes for every production setup
- x : Number of manufacturing lot sizes needs for production every raw material order
- Qm : Manufacturing delivery lot size per shipment to warehouse (units/delivery)
- Q_r : Remanufacturing delivery lot size per shipment to warehouse (units/delivery)

ISBN : 978-602-97809-0-1

Q_M : Manufacturing lot size per production run (units/cycle)
Q_R : Remanufacturing lot size per production run of remanufacturer (units/cycle)
Q_{RM} : Raw material ordering lot size (unit/order)
h_s : Serviceable Inventory holding cost (\$/unit/year)
h_m : Manufacturing Inventory holding cost (\$/unit/year)
h_r : Remanufacturing Inventory holding cost (\$/unit/year)
h_{RM} : Raw material inventory holding cost (\$/unit/year)
K_m : Manufacturing setup cost per batch (\$/batch)
K_r : Remanufacturing setup cost per batch (\$/batch)
S : Delivery cost from production plant to warehouse (\$/delivery)
C_{RM} : *Raw material* ordering cost (\$/order)

Both of inventory system model use assumptions as follow:

- Remanufactured parts are assumed as good as new.
- Demand and product return rate is independent.
- Return rate always lower than demand rate for every cycle
- *n* between number of manufacturing delivery times and number of remanufacturing delivery times are similar.
- Shipment and production capacity for both manufacturing and remanufacturing is unlimited

A. The Push System Model

- ***Serviceable Inventory***

Holding cost

There are two area of inventory. Area I is area since the first shipment from production plant until the last production shipment (n). Area II is area from the last shipment of from production plant to the point where inventory in warehouse is zero.

Holding cost in the warehouse becomes Eq. (1).

$$\frac{\frac{Q_r}{2\gamma}\left[\begin{array}{c} n(n+1)(Q_m+Q_r)+(m^2-2mn)\,\lambda\frac{Q_r}{\gamma} \\ -(m-n)(m-n-1)Q_r \end{array}\right]}{\frac{(n.Q_m)}{\lambda-\gamma}} h_s \qquad (1)$$

Shipping cost

Shipping comes from production plant to warehouse. A cycle of one shipment is Q_r/γ. Manufacturing product is send at the same time with remanufacturing product, as shown in Eq. (2)

$$\frac{\gamma}{Q_r} S \qquad (2)$$

- ***Remanufacturing Inventory***

Setup cost

Remanufacturing setup cost determined by product return rate (γ) divided by n times remanufacturing delivery lot size, as shown in Eq. (3).

$$\left(\frac{\gamma}{nQ_r}\right) K_r \qquad (3)$$

Holding cost

The product return rate is assumed to be constant and the cycle of shipping is fixed. The remanufacturing holding cost become Eq. (4).

$$\left(\frac{Q_r}{2}\right) h_r \qquad (4)$$

- ***Manufacturing Inventory***

Setup cost

The need of manufacturing product is λ-γ. Number of manufacturing setup is depend on manufacturing product needed for every n times manufacturing delivery lot size (Q_m).

$$\left[\frac{\lambda-\gamma}{n.Q_m}\right] K_m \qquad (5)$$

Holding cost

Manufacturing is setup one time to fulfill serviceable inventory as many as *m* times of demand periods. A manufacturing lot size (Q_M) uses to fulfill demand on warehouse as many as *n* times Q_m so they can add remanufacturing inventory in warehouse to complete demand. A cycle of manufacturing inventory is similar with a cycle of remanufacturing inventory (Q_r/γ). Thus, a manufacturing inventory becomes Eq. (6).

$$= \left(\frac{nQ_m}{2} + \frac{Q_m}{2} - \frac{\gamma n {Q_m}^2}{2PQ_r}\right) h_m \qquad (6)$$

It needs a factor that called *multiplier factor* $\frac{Q_r(\lambda-\gamma)}{Q_m\gamma}$, which indicate that manufacturing needed is not equal with demand. So, Eq (6) becomes Eq. (7).

$$\frac{(\lambda-\gamma)\left(\frac{nQ_r}{2}+\frac{Q_r}{2}-\frac{\gamma n Q_m}{2P}\right)}{\gamma} h_m \qquad (7)$$

- ***Raw Material Inventory***

Ordering cost

Case 1: 1, 2, 3, …, x

Raw material ordered x times manufacturing setup $\left[\frac{\lambda-\gamma}{n.Q_m}\right]$. Besides, raw material is procured and converted become product by manufacturer with conversion factor *f*. Therefore, the raw material ordering cost becomes Eq. (8a).

$$\left[f.\frac{\lambda-\gamma}{x.nQ_m}\right] C_{RM} \qquad (8a)$$

Case2: 1/1, ½, 1/3,…, 1/x

In this case, raw material ordered x times for every manufacturing setup. Raw material ordering cost becomes Eq. (8b).

$$\left[f.x.\frac{\lambda-\gamma}{nQ_m}\right] C_{RM} \qquad (8b)$$

Holding cost

Case1: 1, 2, 3, …, x

Total raw material holding cost is sum of both production running and not (Eq. (9)).

$$\left[\frac{\gamma n {Q_m}^2 x}{2Q_rPf} + \frac{(\gamma)(n.Q_m)\left(\frac{x(x-1)}{2}\right)\left(\frac{Q_r}{\gamma}-\frac{Q_m}{P}\right)}{Q_r x f}\right] h_{RM} \qquad (9)$$

Similar with concept of *multipler factor* in manufacturing holding cost, Eq. (9) becomes Eq. (10)

$$\left[\frac{(\lambda-\gamma)\frac{n}{2f}\left(\frac{Q_m\gamma}{P}+Q_r(x-1)\right)}{\gamma}\right] h_{RM} \qquad (10)$$

Case 2: 1/1, 1/2, 1/3, …, 1/x

In this case, inventory incurred only when production is running, and raw material holding cost for case 2 shown in Eq. (11).

ISBN : 978-602-97809-0-1

$$\left[\frac{\gamma n.Q_m^{\;2}}{2Q_r x f P}\right] h_{RM} \tag{11}$$

Eq. (12) is an equation after using *multipler factor*.

$$\frac{nQ_{\mathrm{m}}(\lambda-\gamma)}{2fPx} h_{\mathrm{RM}} \tag{12}$$

- **Integrated Total Cost**

The Integrated Total Cost was formulated in Eq. (13) and (14).

Case 1: 1, 2, 3, …, x

Integrated Total Cost of case 1 is the sum of (1), (2), (3), (4), (7), (8a), and (10).

$$TC(Q_r, Q_m, n, x) = \left[\begin{array}{c} \dfrac{\frac{Q_r}{2\gamma}\left[\begin{array}{c} n(n+1)(Q_m+Q_r)+(m^2-2mn)\,\lambda\frac{Q_r}{\gamma} \\ -(m-n)(m-n-1)Q_r \end{array}\right]}{\frac{(n.Q_m)}{\lambda-\gamma}} h_s \\ +\frac{\gamma}{Q_r}S + \frac{\gamma}{\mathrm{nQ_r}}K_r + \frac{\mathrm{Q_r}}{2}h_r + \frac{\lambda-\gamma}{n\mathrm{Q_m}}K_m \\ +\dfrac{(\lambda-\gamma)\left(\frac{nQ_{\mathrm{r}}}{2}+\frac{Q_{\mathrm{r}}}{2}-\frac{\gamma nQ_{\mathrm{m}}}{2P}\right)}{\gamma} h_m + f\,\frac{\lambda-\gamma}{xnQ_m}C_{RM} \\ +\dfrac{(\lambda-\gamma)\frac{n}{2f}\left(\frac{Q_m\gamma}{P}+Q_r(x-1)\right)}{\gamma} h_{RM} \end{array}\right] \tag{13}$$

Case 2: 1/1, 1/2, 1/3, …, 1/x

Integrated Total Cost of case 2 is the sum of (1), (2), (3), (4), (7), (8b), and (12).

$$TC(Q_r, Q_m, n, x) = \left[\begin{array}{c} \dfrac{\frac{Q_r}{2\gamma}\left[\begin{array}{c} n(n+1)(Q_m+Q_r)+(m^2-2mn)\,\lambda\frac{Q_r}{\gamma} \\ -(m-n)(m-n-1)Q_r \end{array}\right]}{\frac{(n.Q_m)}{\lambda-\gamma}} h_s \\ +\frac{\gamma}{Q_r}S + \frac{\gamma}{\mathrm{Q_r}}K_r + \frac{\mathrm{Q_r}}{2}h_r + \frac{\lambda-\gamma}{n\mathrm{Q_m}}K_m \\ +\dfrac{(\lambda-\gamma)\left(\frac{nQ_{\mathrm{r}}}{2}+\frac{Q_{\mathrm{r}}}{2}-\frac{\gamma nQ_{\mathrm{m}}}{2P}\right)}{\gamma} h_m \\ +f.x\,\frac{\lambda-\gamma}{nQ_m}C_{RM} + \frac{nQ_{\mathrm{m}}(\lambda-\gamma)}{2fPx}h_{\mathrm{RM}} \end{array}\right] \tag{14}$$

Eq. (13) and (14) have four decision variable, they are *x, n, Qm* and *Qr*

- **Variable *x***

This variable is found with doing iteration from x = 1 to x = i, where total cost of x=i+1 is bigger than that of x=i.

- **Variable *n***

Similar with obtaining variable x, variable n is found with undertaking iteration from n=1 to n= j, where total cost of n=j+1 bigger than that of n = i for every x.

Q_m and Q_r are obtained through the first derivative of Eq. (13) or (14) with respect to Q_m and Q_m and setting it equal with zero.

- **Variable *Qm***

Case 1: 1, 2, 3, …, x

$$Q_{\mathrm{m1}}^{\;*} = \sqrt{\frac{\left(K_{\mathrm{m}}+\frac{C_{\mathrm{RM}}f}{x}\right)}{n^2\left(\frac{1}{2P}\left(\frac{1}{f}h_{\mathrm{RM}}-h_{\mathrm{m}}\right)+\frac{1}{2(\lambda-\gamma)}h_{\mathrm{s}}\right)}} \tag{15}$$

Case 2: 1/1, 1/2, 1/3, …, 1/x

$$Q_{m2}^{\;*} = \sqrt{\frac{xfC_{\mathrm{RM}}+K_{\mathrm{m}}}{n^2\left(\frac{1}{2(\lambda-\gamma)}h_{\mathrm{s}}-\frac{1}{2P}h_{\mathrm{m}}+\frac{1}{2fPx}h_{\mathrm{RM}}\right)}} \tag{16}$$

- **Variable *Q_r***

Case 1: 1, 2, 3, …, x

$$Q_{r1}^{\;*} = \sqrt{\frac{2\gamma^2\left(S+\frac{K_{\mathrm{r}}}{n}\right)}{\begin{array}{c}(\lambda-\gamma)\left(\frac{n(x-1)}{f}h_{\mathrm{RM}}+(n+1)h_{\mathrm{m}}-nh_{\mathrm{s}}\right)\\ +\lambda h_{\mathrm{s}}+\gamma h_{\mathrm{r}}\end{array}}} \tag{17}$$

Case 2: 1/1, 1/2, 1/3, …, 1/x

$$Q_{r2}^{\;*} = \sqrt{\frac{2\gamma^2(S+\frac{K_{\mathrm{r}}}{\mathrm{n}})}{h_{\mathrm{s}}(\lambda)-\mathrm{n}h_{\mathrm{s}}(\lambda-\gamma)+h_{\mathrm{m}}(\lambda-\gamma)(n+1)+\gamma h_{\mathrm{r}}}} \tag{18}$$

Last, find other variable using that four decision variable.

- Get the optimal Q_{RM} with:
  $Q_{RM} = x\,(n.Q_m)/f$ (if case 1 is be the optimal)
  $Q_{RM} = (n.Q_m)\,/xf$ (if case 2 is be the optimal)
- The optimal Q_M with: $Q_M = n.Q_m$
- The optimal Q_R: $Q_R = n.Q_r$

B. The Pull System Model

The Pull System Model is developed in the same fashions. The following is the developed model for the Pull System.

- **Integrated Total Cost**

Similar with push system inventory model, there are 2 cases of Integrated Total Cost.

Case 1: 1, 2, 3, …, x

$$TC(x,n,Q) = \frac{Q}{2}\left(\begin{array}{c} h_s+\frac{\gamma}{\lambda}\mathrm{h_r}+\left(n\left(\frac{2\gamma}{P}-\frac{\gamma^2}{\lambda P}-\frac{\gamma}{\lambda}-\frac{\lambda}{P}+1\right)-\frac{\gamma}{\lambda}+1\right)h_m \\ +\frac{1}{f}\left(\frac{(x-1)(\lambda-\gamma)(\frac{1}{\lambda}-\frac{1}{P}+\frac{\gamma}{DP})}{1}+\frac{\left(1-\frac{\gamma}{\lambda}\right)^2\lambda nx}{P}\right)h_{\mathrm{RM}} \end{array}\right) + \frac{\lambda}{Q}\left(S+\frac{1}{n}K_r+\frac{1}{\mathrm{n}}\mathrm{K_m}+\left(\frac{f}{nx}\right)C_{RM}\right) \tag{19}$$

Case 2: 1/1, 1/2, 1/3, …, 1/x

$$TC(x,n,Q) = \frac{Q}{2}\left(\begin{array}{c} h_s+\frac{\gamma}{2}\mathrm{h_r}+\left(n\left(\frac{2\gamma}{P}-\frac{\gamma^2}{DP}-\frac{\gamma}{\lambda}-\frac{\lambda}{P}+1\right)-\frac{\gamma}{\lambda}+1\right)h_m \\ +\left(\frac{\left(1-\frac{\gamma}{\lambda}\right)^2\lambda n}{fPx}\right)h_{\mathrm{RM}} \end{array}\right) + \frac{\lambda}{Q}\left(S+\frac{1}{n}K_r+\frac{1}{\mathrm{n}}\mathrm{K_m}+\left(\frac{fx}{n}\right)C_{RM}\right) \tag{20}$$

Eq. (19) and (20) has three-decision variable: x, n, and Q. Variable x and n is found as similar with push system does.

- **Variable *Q***

Case 1: 1, 2, 3, …, x

$$Q^* = \sqrt{\frac{2\lambda\left(S+\frac{C_{\mathrm{RM}}f}{nx}+\frac{K_{\mathrm{m}}}{n}+\frac{K_{\mathrm{r}}}{n}\right)}{\begin{array}{c}h_{\mathrm{s}}+\left(\left(\frac{2\gamma}{P}-\frac{\gamma}{\lambda}-\frac{\lambda}{P}+1-\frac{\gamma^2}{\lambda P}\right)n-\frac{\gamma}{\lambda}+1\right)h_{\mathrm{m}}+\frac{\gamma}{\lambda}h_{\mathrm{r}} \\ +\left(\frac{1}{f}\frac{(\lambda-\gamma)^2nx}{\lambda P}+\left(\frac{1}{\lambda}-\frac{1}{P}+\frac{\gamma}{\lambda P}\right)(x-1)\,(\lambda-\gamma)\right)h_{\mathrm{RM}}\end{array}}} \tag{21}$$

Case 2: 1/1, 1/2, 1/3, …, 1/x

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$$Q^* = \sqrt{\frac{\lambda\left(S+\frac{xf}{n}C_{\mathrm{RM}}+\frac{1}{n}K_{\mathrm{m}}+\frac{1}{n}K_{\mathrm{r}}\right)}{\frac{1}{2}h_{\mathrm{s}}+\frac{\left(\left(\frac{2\gamma}{P}-\frac{\gamma}{\lambda}-\frac{\lambda}{P}+1-\frac{\gamma^2}{\lambda P}\right)n-\frac{\gamma}{\lambda}+1\right)}{2}h_{\mathrm{m}}+\frac{\gamma}{2\lambda}h_{\mathrm{r}}+\frac{(\lambda-\gamma)^2 n}{\lambda f P x}h_{\mathrm{RM}}}} \quad (22)$$

Procedures of pull model are almost same with the push one. In the pull model, the first is to calculate an optimal value of Q (after x and n found). The difference is in last stage.

- Get the optimal Qr using : $Q_r = \gamma \frac{Q}{\lambda}$
- The optimal Qm using: $Q_m = Q - Q_r$
- The optimal Q_{RM} using:
  $Q_{RM} = x\,(n.Qm)/f$ (if case 1 is be the optimal)
  $Q_{RM} = (n.Qm)\,/xf$ (if case 2 is be the optimal)
- Get the optimal Q_M using: $Q_M = n.Qm$
- Get the optimal Q_R using: $Q_R = n.Q_r$

Parameter given from [9] and [8] are used to test that formulation:

P	= 3200 units/year	K_m	= \$ 400/unit
λ	= 1000 units/year	h_m	= \$ 4 /unit
γ	= 70% λ	K_r	= \$ 400 /unit
f	= 0,8	h_s	= \$ 5/unit
S	= \$ 25/unit	h_r	= \$ 4 /unit
C_{RM}	= \$ 2500 /unit	h_{RM}	= \$ 2 /unit

The numerical parameters above enter to the model and find the optimal variable as follow:

Push system model:
x* = 2 ; n* = 18 ; Q_r* = 52 Qm* = 23, QM=414, Q_R=936, Q_{RM}* = 1035, Total Cost :\$3291,21.

Pull system model:
x* = 5 ; n* = 20 ; Q* = 65, Q_r* = 45, Qm* = 20, QM=400, Q_R=900, Q_{RM}=2000, Total Cost \$2623,94.

IV. ANALYSIS

Sensitivity analysis will be done to cover several parameters setting, with respect to costs and return rate. Firstly, to test raw material ordering cost (C_{RM}) sensitivity with significant change from \$ 25 to \$ 2500, and other parameters remain unchanged.

TABLE 1
Comparison of Result by Changing (C_{RM})

System	Parameter	Result								
	CRM	x	n		Qm	QM	Qr	QR	QRM	TC
Push	\$2500	2	18		23	414	52	936	1035	3291
	\$25	1	8		28	224	106	848	280	2102
		x	n	Q	Qm	QM	Qr	QR	QRM	TC
Pull	\$2500	5	20	65	20	400	45	900	2500	2617
	\$25	2	16	76	23	368	53	848	230	2044

Decreasing raw material ordering cost by 99% can effect to the total cost to decrease until 64% for push model and 74% for pull model. In addition, raw material lot size (Q_{RM}) decrease 73% for push model and 91% for pull model. Comparing these two results, it can be seen that the raw material ordering cost is one of the key factors that significantly will affect the total cost (TC) and the lot size of (Q_{RM}). Therefore, it is important to negotiate raw material ordering cost, because the lower ordering cost, the lower raw material ordering lot size and inventory.

Secondly, to discuse the sensitivity of the finished product (serviceable inventory) holding cost (h_s). Increasing 33%, 133% and 233% of h_s will cause the higher TC as 3%, 19% , 33% for push model and 4%, 8%, 12% for pull model. From the model above, it can be seen that push model is more sensitivity of h_s than pull model. It is because the inventory in warehouse might increased continuously and attention should be payed to the remanufacturing period only.

TABLE 2
Comparison of result by changing h_s

System	Parameter		Result							
	CRM	hs	x	n		Qm	QM	Qr	QR	QRM	TC
Push	\$25	\$3	1	13		23	299	71	923	274	1952
		\$4	1	10		26	260	89	890	325	2006
		\$7	1	6		32	192	127	762	240	2328
		\$10	1	5		32	160	143	715	200	2601
	CRM	hs	x	n	Q	Qm	QM	Qr	QR	QRM	TC
Pull	\$25	\$3	2	14	87	27	378	60	840	236	1965
		\$4	2	15	81	25	375	56	840	234	2044
		\$7	2	18	68	21	378	47	846	236	2115
		\$10	2	21	59	18	378	41	861	236	2210

Third, the comparison of the product return rate (γ) to the system can be seen in Table 3.

TABLE 3
Comparison of Result by Changing γ

System	Parameter		Result								
	CRM	γ	x	n		Qm	QM	Qr	QR	QRM	TC
Push	\$25	300	1	3		118	354	64	192	443	3136
		500	1	5		59	295	90	450	369	2583
		700	1	8		28	224	106	848	280	2102
	CRM	γ	x	n	Q	Qm	QM	Qr	QR	QRM	TC
Pull	\$25	300	3	12	73	52	624	21	252	260	2667
		500	2	13	75	38	494	37	481	309	2403
		700	2	16	76	23	368	53	848	230	2044

Table 3. show lower total cost as raising effect of return rate. When return rate inflated 67% and 133%, manufacturing lot size decrease 16% and 37% (push), 21% and 41% (pull) and total cost of system become 17% and 33% (push), and 10% and 23% (pull). That results show that remanufacturing option give more effects to the company who adopt push system rather than pull system. As it can be seen, the total cost of

TABLE 4
Comparison of Result between System with/ without Remanufacturing Option

Pull system without Remanufacturing							
Decision Variable x=1 ; n=7 ; Q=71				QM=497 ; QR=0 ; QRM=622			
Serviceable Inventory		*Manufacturing Inventory*		*Raw Material Inventory*		*Remanufacturing Inventory*	
Shipment Cost	**Holding cost**	**Setup Cost**	**Holding cost**	**Ordering Cost**	**Holding cost**	**Biaya setup**	**Holding cost**
352	178	805	825	40	194		
Total Cost		**Total Cost**		**Total Cost**			
530		1630		234			
Integrated total cost							
2394							
Pull system with Remanufacturing							
Decision Variable: x=2 ; n=16 ; Q=76				QM=368 ; QR=848 ; QRM=230			
Serviceable Inventory		*Manufacturing Inventory*		*Raw Material Inventory*		*Remanufacturing Inventory*	
Biaya Pengiriman	**Holding cost**	**Setup Cost**	**Holding cost**	**Ordering Cost**	**Holding cost**	**Biaya setup**	**Holding cost**
329	190	329	707	33	21	329	106
Total Cost		**Total Cost**		**Total Cost**		**Total Cost**	
519		1036		54		435	
Integrated total cost							
2044							

the push system is much lower than that of the pull system, although manufacturing lot size in pull system generate lower than the push one.

The last, the results of the comparation of the model with and without remanufacturing option in Pull model. From table 4. the remanufacturing of used product may decrease inventory cost in all three echelons and affecting the remanufacturing inventory cost. However, integrated total cost with remanufacturing is lower than that for not considering remanufacturing option.

VI. CONCLUSIONS

This paper has presented the development of the pull and push system model. It is found that the pull system has lower total cost than the push system. It is because the amount of inventory in the push system (serviceable inventory) is higher than that of the pull system. Amount of inventory in pull system only provide when it is used, so there is no over stock in the warehouse, it means that the holding cost of the pull system inventory is much lower than the push system.

The results of sensitivity analysis shows that raw material ordering cost, serviceable holding cost, and remanufacturing rate will effect significantly in the total cost of the push system. However, considering remanufacturing option will effect significantly to company in order to get the lower cost and to be more environmentally responsible.

This research has several limitations, among other things, this research did not include transportation cost of product return and defect rate from product return and also did not consider the cost of disassembly and assembly of products return and the new one. These limitations should be taken into account in the next study.

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ISBN : 978-602-97809-0-1

Value Stream Mapping: Eliminating Waste and Adding Value

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Abstract **- This paper explains the nature of Value Stream Mapping and provides the idea of this lean method by defining it and explaining the purpose and benefit of using it in production process. Furthermore, this paper elaborates the steps of conducting VSM and explains how to apply the method on a process. To make the explanation clear, detail exposure of implementing the steps and examples is provided.**

***Keywords*— Value Stream Mapping, Current State Map, Future State Map**

I. INTRODUCTION

There are several definitions proposed by academics and practitioners about Value Stream Mapping (VSM). The following definitions gathered from the literature provide important aspects of a more complete definition, presented at the end of this section. VSM is a pencil-and-paper tool that helps users recognize the flow of material and information as products make their way through the value stream. The value stream includes the value-added and wasted activities that are needed to bring a product from raw material through delivery to the customer [1]. While Tony Manos describes Value Stream Mapping as a tool that combines processing steps and information flow to be used to create a solid operation plan that will make the most of the available resources. Value is added to the product or service by changing the form or function to meet customers needs [2].

Further, Womack [3] define it as a lean tool that can help companies to level production, resulting in spectacular reductions in throughput time and costs, and improved quality. Therefore, I complete define Value Stream Mapping as a tool, a stream map drawn on a piece of paper, or a method used by manager or engineer to visualize all the steps required in production or service process, and all information and material flow from raw material to the customer. This information is used to identify waste in the process and to optimize result by planning a more efficient and effective process which reduces the waste and adds value.

II. THE NATURE OF VALUE STREAM MAPPING

These days, when increasing demands for high levels of performance makes most of organisations in the world attempt to build efficient processes in their working system, an effective concept is needed to guide this effort. Lean is one of the most widespread concepts applied in many manufacture companies. One of lean powerful tools applied to assist the creating of efficient process is VSM.

A. Brief History

This method of reducing waste in the process to achieve the optimum benefit inside an organisation was pioneered in the 1980s by Toyota's Chief Engineer, Taiichi Ohno, and Shigeo Shingo. It was then popularised by Mike Rother and John Shook in their book Learning to See. When developed this concept Ohno identified seven common wastes in every production process. They are overproduction - producing items for which there are no orders; waiting time - employees standing about; unnecessary transport - moving material unnecessarily over long distances; over-processing - using more steps to produce a product than necessary; excess inventory - retaining unnecessary inventory between work–in-process steps; unnecessary movement – any wasted motion by man or machine; and defect - making incorrect products [4]. Using the VSM all these waste are trying to be identified and eliminated.

B. Purposes and Benefit of Using Value Stream Mapping

Value Stream Mapping is designed to visualize the system of the process from start to finish in system perspective. It is also used to clearly see the overall process stream and recognise the waste in the process; hence, they can be eliminated. This method also recognizes each important action needed to create the desired value [3]. Therefore we can provide optimum value to the customer through a complete value creation process with minimum waste. VSM also help us in providing plan for implementing step by step improvements procedures to the production process. Lastly, it facilitates us to transform the process into more efficient and

ISBN : 978-602-97809-0-1

effective way, reduce costs and enable broad involvement in creating valuable future state.

C. Disadvantages of Value Stream Mapping

Value Stream Mapping is a good method to reach optimal product, but it still has disadvantages. Researchers at The Ohio State University identified three weaknesses of VSM like: failure to show multiple products that do not have identical routings; lacks of economic measured value; and failure to capture the time value in money value.

III. The Steps in Conducting Value Stream Mapping

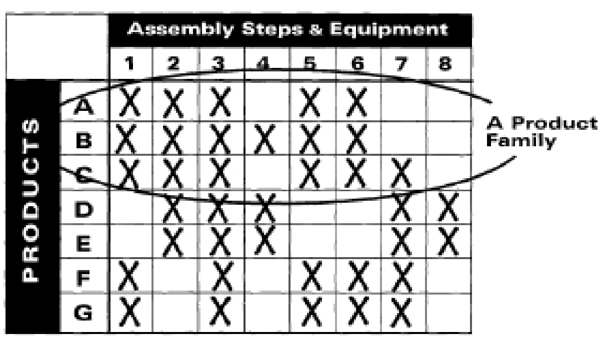
There are several approaches to determine the steps in conducting VSM. Following is the VSM step proposed by Tony Manos in [2]. The first step is understanding the scope of the value stream. The second step is forming a cross-functional team. The team is formed that includes supervisory or managerial level members from all through the organization. Includes the representatives from sales, customer service, scheduling, purchasing, operations, inventory control, maintenance, quality and information technology as contributors to VSM event. Customers or suppliers participation can also be a unique perspective.

The third step will be the core of conducting VSM. It called kaizen event, the continued improvement. In this stage, the team create the current state map and the future state map along with the draft plan. There are four important steps in this stage:

A. Determine the Product Family

A Product family is a cluster of products or services that have the same or similar processing steps. To determine the process family, a matrix is created as in Fig.1.

- Along the top row, write all the process steps your organization performs.
- In the first column, write down the parts (for example, components, stock keeping units, finished good items or services) your organization makes or provides.
- Place an X in the corresponding box if the part goes through the processing step.



PRODUCTS	Assembly Steps & Equipment 1	2	3	4	5	6	7	8
A	X	X	X		X	X		
B	X	X	X	X	X	X		
C	X	X	X		X	X	X	
D		X	X	X			X	X
E		X	X	X			X	X
F	X		X		X	X	X	
G	X		X		X	X	X	

0

Figure 1: Process Family Matrix
Source: Learning to See, Rother & Shook, 2006

After finishing this step, examine the matrix and find the parts that have a similar or the exact same processing steps and procedures that can be created together by the same workers using similar or related steps more efficiently in a manufacturing cell.

B. Draw the Current State Map

To create a current state map, gather the data and information by walking the flow and interviewing the worker who carry out the task. Do not depend on historical data or opinion [5]. The current state map must show the organisation's processes performed at the present work settings.

From walking the flow, the team can collect several types of information on a worksheet, such as cycle time or processing time, changeover time, reliability of equipment, quantities, number of operators and shifts, hardcopy information, electronic information, inventory levels, and queue or waiting times.

Data collected from walking the flow and the resulting team discussions then will be drawn on paper. VSM can be drawn using simple symbols or icons.

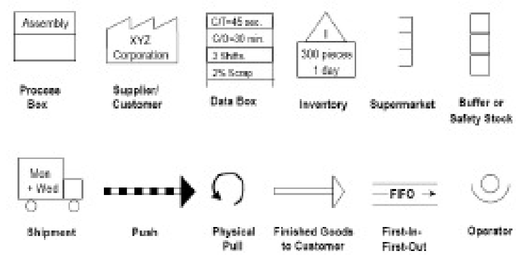


Figure 2: Material Flow Icons

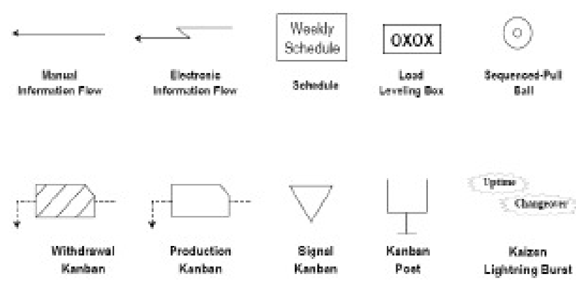


Figure 3: Information Flow Icons

There are key areas on the map. The upper right corner for customer information; the upper left corner for supplier information; the top half of the paper for information flow; the bottom half for material (or product) flow; and the gutters on top and bottom to calculate value added and non value added time.

ISBN : 978-602-97809-0-1

Calculate the cycle time vs. the inventory time (in days) for the material and information flow. Every VSM will be slightly different depending on the exact process, the creator who drew the map and how it was drawn.

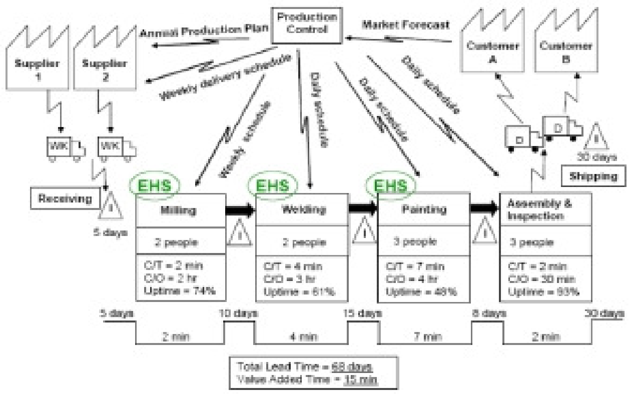


Figure 4: Current State Map Example
Source: Lean and Environmental Toolkit Training Module, 2006

After map the current state of the value stream, waste throughout the stream must be identified and removed to shorten lead-time and improve the value-added percentage. However, the only way to identify the waste is to understand the seven elements that do not add the value to the product [1].

C. Determine the Future State Map

The next step is setting the future state map. To develop a realistic future state map, team members need the basic knowledge of lean principles. Here is a short list of questions identified by Manos in [2] as guidance for creating a future state map with common elements that may fit most types of business:

- *What is the takt time?* Takt time is the time to finish a complete product. The formula of takt time is the time available (per shift) divided by the demand (per shift). For example: 22,000 seconds (time available) ÷ 200 pieces (demand) = 110 seconds/piece.
- *Are there constraints?* From the information gathered during the kaizen, look at processing times. If any of these are greater than takt time, it might be a constraint. This may cause overproduction waste or work in process (WIP) or extra processing time, such as overtime.
- *Where can inventory (or queue time) be cut or supermarkets used?* Look at raw material, WIP, buffer stock, safety stock and product inventories to see whether these can be reduced. Does it make sense to put in a supermarket replenishment system?
- *Where can you improve flow?* Is it possible to put materials into a cell or eliminate materials from stopping and waiting? If flow improvement is impossible, can a first in and/or first out lane be established between processes?
- *What other improvements are required?* For example, does the reliability of equipment need to be enhanced? Are the first pass yield or quality levels acceptable? Do we need to create a new layout for an area?

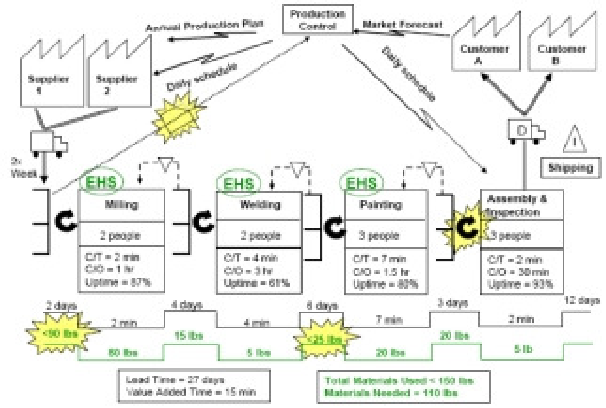
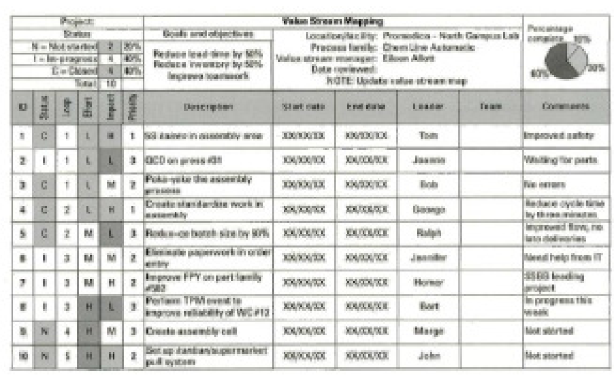


Figure 5: Future State Map Example
Source: Lean and Environmental Toolkit Training Module, 2006

On the map, place a kaizen burst around any items to indicate that they need improvement. These Items may include low equipment reliability or first pass yield, long changeover times, large batches, any waste such as overproduction, motion, transportation, waiting, defects or adjustments, and over or extra processing. Place the kaizen burst at any place where we are not sure whether improvement is needed. That can be determined later when the general plan is set.

D. Draft a Plan to Arrive at the Future State

The most important stage of VSM is creating or executing the draft plan. The draft plan is created based on the information from the future state map; it is a strategy about what action should be taken to arrive at Future State Map. The plan will need further modification especially in determining resources required, such as time, labour and budgets. A good plan will include the description of the project, name of the project leader, possible team members, a schedule of events and deliverables, an estimate of costs, and the impact, goals or benefits.



ID	Status	Loop	Effort	Impact	Priority	Description	Start date	End date	Leader	Team	Comments
1	C	1	L	H	1	5S kaizen in assembly area	XX/XX/XX	XX/XX/XX	Tom		Improved safety
2	I	1	L	L	3	SCD on press #31	XX/XX/XX	XX/XX/XX	Joanne		Waiting for parts
3	C	1	L	M	2	Poka-yoke the assembly process	XX/XX/XX	XX/XX/XX	Bob		No errors
4	C	2	L	H	1	Create standardize work in assembly	XX/XX/XX	XX/XX/XX	George		Reduce cycle time by three minutes
5	C	2	M	L	3	Reduce batch size by 50%	XX/XX/XX	XX/XX/XX	Ralph		Improved flow, no late deliveries
6	I	3	M	M	2	Eliminate paperwork in order entry	XX/XX/XX	XX/XX/XX	Jennifer		Need help from IT
7	I	3	M	H	2	Improve FPY on part family #582	XX/XX/XX	XX/XX/XX	Homer		5S/EO leading project
8	I	3	H	L	3	Perform TPM event to improve reliability of WC #12	XX/XX/XX	XX/XX/XX	Bart		In progress this week
9	N	4	H	M	3	Create assembly cell	XX/XX/XX	XX/XX/XX	Marge		Not started
10	N	5	H	H	2	Set up kanban/supermarket pull system	XX/XX/XX	XX/XX/XX	John		Not started

Figure 6: Example of VSM Plan
Source: Value Stream Mapping – An Introduction, Manos 2006

ISBN : 978-602-97809-0-1

IV. Conclusions

As a summary, Value Stream Mapping is a method used to visualize all the steps required in process, and all information and material flow from raw material to the customer. This data is used to identify waste in the process and to optimize result by planning a more efficient and effective process which reduces the waste and adds value. The steps of VSM can be summarized into four major steps: define the process family; draw the Current State Value Stream Map; create the Future State Value Stream Map; and develop the draft plan to arrive at Future State Value Stream Map.

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ISBN : 978-602-97809-0-1

Partnerships Strategic Management for Sustainable SMEs Industries

(Case Study of SMEs Industries in Bandung, INDONESIA)

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***Abstract* – The purpose of this research is to identify appropriate strategic management of Small Business Enterprises (SMEs) in order to compete in a global competition, especially after ACFTA (Asian – China Free Trade Agreement) has been applied in year 2010.**

The research is a case study of a *sentra* (limited area which fullfiled by many industries with similar products) of SMEs Industries in Bandung, the capital West Java Province, INDONESIA. A sentra of knitting textiles SMEs industries which popular as Sentra Rajutan Binongjati was selected, because of its productivity.

The data were collected by running scheduled Focused Group Discussions (FGDs) under related topics. Many stakesholders involved were SMEs entrepreneurs, the associations, big industries surrounding, local government, centre researchs, and mass public figures.

SWOT (strength, weakness, opportunity and threats) analysis techniques were used to develop a matrix as a basis of Protocol Document. This final document listed several strategic plannings in accordance to this sentra be well prepared to compete in global market.

Keywords* — *Global Competition, Strategic Management, SWOT Analysis, SMEs Industries, Bandung.

I. INTRODUCTION

Nowadays SMEs industries are facing serious potential challenges and also threat to compete in global market. This such competition is going to be more serious after implementation of *ASEAN - China Free Trade Agreement* (ACFTA). ACFTA is an agreement among China with Nations collaborated ASIAN Nations. In principal the purpose of ACFTA implementation is to broaden access to global market without boundaries of nations. ACFTA are aimed to improve trading of goods and services, and to improve better investment environment for higher quality standard of live among Asian Nations and China. [1].

On other words, the goal of ACFTA implementation is to improve economic cooperation by liberalization trading goods and services within ASIAN Nations – China. However, as a consequence, this implementation of free trade automatically caused negatif effects, because Chinesse products in Indonesia are available anywhere (easy to find) and are popular because of its low price.

In accordance to minimize negatif impacts of ACFTA, Indonesian Government makes some policies to protect several strategic local products. As for examples are: product of garments, electronics, food & beverages, iron & steel, and product of holtikultura. However, this government interventions seems not to be effective without participations among related stakeholders. This is because the such problems not only as sectoral but also as regional problems. Garment products is one of the most affected product by ACFTA implementation, because of its contribution to Indonesia's GDP of non-oil sector.

The research is a case study of SMEs Sentra Rajutan Binongjati in the middle of Bandung, which produces sweaters, knitting jackets, knitting blouses, etc. Bandung is the capital of West Java Province. In Indonesia, Bandung is well known as a fashion city. According to Indonesian Trading Ministry Reports of year 2005, almost 65% of textiles industries are located at Bandung [1].

II. STATE OF THE ARTS.

Based on international trading theories, trading goods or service among nations will give positive and also negative impacts. Industries which produce products for export will get positive impact, but on the other hand, negative impacts will be faced by local industries which serve local or domestic customers, and by local industries which have similar features with outsiders products, as for example are Chinese products[2].

ISBN : 978-602-97809-0-1

General Affair of Indonesia International Trade Cooperation [1], noted that global competition has two sides impacts to industries. Firstly, global competition is a potential challenge for domestic industries to broaden access to the market but global competition is also a threat for domestic domestic industries. After ACFTA implementation, access to global market will be broaden significantly, and climmate of investment will also be better. Technology transfer among business practician within nations will become more broaden than in the previous eras. However, the most important thing for Indonesia is that Industries should improve their efficiencies and productivities. Industries should give stressing to develop condusif business environment in term to have better competitive advantages of their products.

III. Research Methodology

*Objects Research***.** A sentra of knitting SMEs textiles industries, which popular as *Sentra Rajutan Binongjati*, is a sub-district area in the midle of Bandung. Its location are surrounded by Gatot Subroto and Kiara Condong street. The location is about 5 kms from the State Government Building or *Gedung Sate*. According to the data of Bandung population census of year 2004, the area had aproximately 14.000 citizens. Almost 95% of the citizens are SMEs entrepreneurs and its labour of knitting textiles industries. [1].

The emerging of knitting SMEs textiles industries of Binongjati started on era of 1970-s. The growth increased rapidly toward challenges and nowadays there are more than 4000 SMEs entrepreneurs with 10.000 total employment. This sentra daily produces about 4000 dozens of varies products such as : knitting shirt, jacket, sweaters, cardigans, etc.

In general, products of Sentra Binongjati listed as following:

Table 1. Products list of Sentra Knitting SMEs industries of Binongjati – Bandung

No.	Items	Description
1.	**Products** • Child Sweaters • Teenager Sweaters • Adult Sweater s • Jackets Sweaters • Moslem Fashions • Spandec • Others	 31,48 % 48,48 % 17,14 % 14,29 % 17,14 % 2,86 % -
2.	**Market (%)** • Bandung (20) • Jakarta (50) • Solo (15) • Surabaya (10) • Others (5)	Marketing by Entrepreneurs Association : KIRBI, ASPIRA, FOKUS etc.
3.	**Raw Materials** ▫ Acrilics ▫ Spandec threads	Raw materials are supported by agent or intermediate trader with higher price (by 150%)
4.	**Labour**	Total employment aproximately 10.000 labours. Mostly came from origins citizens, but for particular expert (embroidary expertise) came from other city such as Tasikmalaya, etc.

Data Collection Techniques and Methods of Analysis. Primary data were collected by running scheduled Focused Group Discussions (FGD). FGD is a type of *Group Discussion* on related topic. On these FGDs, several topics were discussed to get responds from the audiences. The audience came from many related stakeholders such as: SMEs entrepreneurs and the association, local government, public figures, and researcher. Representation from big textiles industries which were collaborated on Indonesian Exporter Association (AEI) also involved. Because of the audiences came from broad range industries and or organization, FGD were conducted several times regularly. On the other hand, secondary data were collected using related previous studies or publications.

Results of FGDs were documented and were analysed using SWOT analysis techniques. Final document which called as Protocol Document, was a basis for its Strategic Planning. Overall, the document listed brief strategies to broaden access both of local and international market.

Table 2. Strategic Planning of Binongjati knitting SMEs Industries

No.	Strategic Planning	Description
1.	Idea creation to develop shared *Showroom* on location.	The Showroom will be an icon of Knitting SMEs Industries. Its function as a sharing promotions buildings.
2.	Regular workshop programs in order to improve related skill of SMEs Entrepreneurs and its labours.	Subjects on workshop : 1) Product Design 2) Motivations 3) Management 4) Accounting 5) Entrepreneurship 6) Marketing.
3.	Administration, legal aspect and rights.	Subjects on : • *Residency permits* • *Business Licence* • *National Products Standardization, etc.*
4.	Promotion/ Marketing	• Active participation on exhibitions.

		• Sharing effort to broaden access to market. • Improving sustainable partnership among textiles stakeholders, especially with local government and textiles big companies. • Regular gathering expose or exhibitions of Rajutan Sentra Industries (Sentra Rajutan Expo/ Binongjati Fiesta/ Open House).

IV. FINDINGS AND DISCUSSION

Findings

1. One month after the agreement, SMEs Industries in cooperation with Big Textiles Industries, which are collaborated on Indonesian Exporter Associations (AEI), got a big number order from Europe to make 100.000 dozen of varied knitting clothes, blouse, etc, which should be delivered in two next months. The first order indicates that products of Binongjati knitting SMEs textiles industries were fairly accepted in European market. This was, of course indicating that there would be serious potential challenges to broaden access into global market.
2. In order to fullfill that first order, SMEs industries made cooperation with Big industries in which collaborated by Indonesian Exporter Ascociations, to join together, providing European Market, to achieve the target (100.000 dozen in number). In this cooperation, SMEs industries acted as producer, and big industries acted as marketing agent. Eventually, SMEs industries could not achieve the target. The delivery of products was delayed for one one longer. This condition happened because of many reasons as following.
   a. *Raw Material Supply*. In order to fullfill a big number of products, SMEs Industries needs a lot number of raw materials (spandex threads). Eventually there were not enough supply of spandex threads. The condition was getting worse because there were no big textiles industries produced adequate spandex thread in particular for SMEs industries. There were no big textiles industries focused to serve SMEs industries. As a consequence, SMEs industries got raw material as only a rest product (stok lot), from big textiles industries. SMEs should collect their need independently by collecting spandex threads from a broad range big textile industries. Finally, SMEs industries were barely hard to get raw material.
   b. *Human skill*. Disciplines and work attitudes of human aspects (management and labours) are the most important factors for teamwork to achieve production targets. In the case of Rajutan Sentra Industries, unfortunately, human factors were not appopriately well arranged, as for example: un-stable weekly productivity, deffect products (inconcistency on size of S, M, L, XL), dirty products (because of inapropiate handling), etc.

Discussions

▪ Acceptability of Europian market on Binongjati Rajutan products, indicated or signal that Indonesian products meet the qualification standards of European markets. Indonesian (Rajutan Sentra Industries products) were sounds have competitive advantages in global competition. Unfortunately the overall of process that caused delayed delivery to fullfill Eeuropean market, still need more improvement and attention of many stakeholders. Stakesholders need to participate on developing better strategies, to find improved solutions. Lists below are some aspects that need to be evaluated in order to find apropiate strategies for Binongjati Rajutan Sentra Industries to becomes more competitive on global competition.

a. SMEs Binongjati Rajutan Industries have many entrepreneurs who are collaborated on many sscociations, as for examples : KIRBI (Koperasi Rajutan Binongjati), ASPIRA (Asosiasi Pengusaha Rajutan Binongjati), FOKUS Rajut (Forum Komunikasi Pengusaha Rajutan Binongjati). In general, all of those entrepreneurs had already succeed to satisfy small order (in a smaller number), but unfortunately, if order comes in a huge number, its sounds to be a problems because it is difficult to find raw material in a huge number. The associations work independently without adequate integration and sinergicity. This condition need further solutions and cooperations, in order to make SMEs and big industries have longer mutual cooperation in the future, to be well prepared on global market.

b. On their first order, product desig (including product pattern, type of raw material, etc) came from big textiles industries. In the next future, SMEs would like to be directed by Higher Education Institution or Centre Research in order to improve SMEs capabilities on designing products. Further contribution of government as facilitator in such cooperation, will be kept any longer and more intense.

c. *Government Facilitation. SMEs* industries needs deeply contribution from local government especially in developing infrastructures on site, to build a share shopping facility at Binongjati Bandung as a tourism area. Those facilities hopefully would attract more customer to come to the area.

d. *Collaboration/ Partnership among industries.* Partnership or collaboration among SMEs industries, and also with big industries is a necessary to broaden acces to global market. In such this case, partnership only conducted by projects. In the next future, that such collaboration hopefully can be settled for longer time and better coordination, to gain bigger opportunities in global competitions. Better collaboration and better partnership pattern needs to be studied further on future studies/ researchs.

V. CONCLUSIONS

1. SMEs industries at Binongjati Sentra knitting Industries have no doubts in running the business. As long as people need clothes, there will be always demand on it. As a consequence, textiles industries should have their competitive advantages to survive. Global competition into the market is a common phenomenon on business.
2. SMEs industries, in accordance to win domestic market from outsider products (Chinesse product, etc), through government, to provocate Indonesian people be aware of all products made in Indonesia, and would like to use Indonesian products.
3. In order to compete on global market through free competition, SMEs industries need to improve inovative products for better competititve advantages by developing sinergis partnership and collaboration with apropiate industries.

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ISBN : 978-602-97809-0-1

Commitment Dimensions in the International Buyer-Supplier Relationship: A Case Study

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***Abstract* - Using in-depth interview, this study explores the dimensions on commitment in international buyer-supplier relationship in Malaysia. A high growth IT related firm has been purposively selected from the industrial hub of Melaka, Malaysia. Three interviews, one each on top level, mid level and low level management, have been conducted using semi-structured interview. As opposed to the formal commitment explained by extant literatures, comparison of commitment issues by three layers of management in this study reveals the existence of informal commitment in international business relationship. Informal commitment is the type of commitment that does not require any formal documentation. It is argued that informal commitment works on trust, mutual respect and benefits. Five dimensions of commitment mix found in extant literature include affective commitment, value based commitment, locked in commitment, obligation based commitment and behavioral commitment. This study added the sixth component as "efficiency based commitment." Efficiency based commitment refers to the situation where one company is committed to develop their internal efficiencies to serve the customers better. Efficiency based commitment enhances the competitive advantage of the firm and reinforces the counterparty in having long-lasting business relationship. Among three levels of management, top and mid level management were found to be subjective towards the business relationship; whereas the low level was found to be more objective, target oriented and disciplined. Finally, the commitment in business relationship is also affected by country culture and organizational style of doing things.**

***Keywords* – Commitment Mix, Informal Commitment, Malaysia**

I. INTRODUCTION

A. Background

Commitment has been commonly viewed as a basic prerequisite in sustainable inter-firm relationship. The level of commitment decides the intention of, therefore, trust and loyalty among the business customers. An ample variety of researches is available on commitment. After the starting in the 70s' with social component of the commitment in relationship among distribution channel members [1], academic literatures have moved through more specific commitment issues such as buyer-seller relationship ([2, 3]), inter-firm relationship ([4]), business-business relationship [5], export-relationship [6], and international business relationship [7]. Researches on commitment in specific industry [8, 9], retail-wholesale business [10] and service-industrial goods business [11] were also uncovered. A few but growing literature is considering country-specific status of business commitment. However, the studies are still limited largely to developed and western countries such as the U.S., European Union, Japan and China [12, 13].

Reference [13] explored and found a complex relationship between cultural context and commitment. Reference [14] argued that companies from other countries must understand Chinese cultural variables Guanxi (personal relationship) and Xinyong (personal trust) before entering into any inter-firm relationship. Reference [12] found major difference in long-term orientation or sustainability assumption of commitment between companies in Japan and United States. They argue that institutional factors (law and rituals of any county and industry) and task environment (industry regulation and competition) affect the level of inter-firm commitment. As a result, inter-firm commitment is found to be highly contextually dependent and each context, based on either the difference in culture or geography, deserves individual analysis [15]. The situation is even worse in emerging economies with massive cultural diversity, lack of effective institutional framework and an increasing amount of foreign trade [15].

B. Research Objective

The purpose of this study is to conceptualize the dimensions of commitments in buyer-supplier relationship in Malaysia. Malaysia is a country characterized by multi-racial business culture, high growth SME sector and swiftly moving towards a knowledge intensive economy [16]. As the recent trend in commitment literature is showing country specific studies due to unique cultural and institutional environment, exploring the dimensions of commitment in a culturally diverse country like Malaysia would reveal new insights. Reference [15] argued that commitment in business relationship is very challenging in emerging nations. However, due to the increasing business opportunities in the emerging countries, more in-depth exploration of the commitment under the relationship marketing paradigm is required. As various extant literatures observed a mixture of theoretical and practical orientation and cultural dilemma in searching for dimensions of commitment in business relation, Reference [13] explored the commitment mix. Commitment mix is the combination of five different dimensions of commitment. These dimensions have different meaning and suit with cultural and contextual differences in organizational settings. The five dimensions are affective commitment, value based commitment, locked in commitment, obligation based commitment and behavioral commitment. Based on these five dimensions, this study would explore the dimensions of commitments in a buyer-supplier setting in Malaysia.

C. Research Questions

Following the importance of business commitments in international business transactions from the extant literatures; this study intends to undertake an exploration of business commitment from a Malaysian context. Extant literatures on inter-firm commitment reveal the following important issues:

1. Commitment is highly cultural and context dependent [13, 15].
2. Inter-firm commitment studies were largely done on western service organization instead of emerging country industrial product selling organization [12, 17-20].
3. Malaysia is growing fast as a multi-cultural emerging power in global business arena. Maintaining sustainable business commitment would be tough challenge for businesses [16].
4. Studies must be undertaken to uncover the dimensions of commitment from Malaysian Perspective.

From the existing gaps in the extant literatures, as commitment studies are new in Malaysian buyer-supplier relationship, the study extends two broad research questions:

Q1: What are the important dimensions of commitment in an international business transaction?
Q2: What role efficiency and informal commitment play in international business transaction?

Based on above questions, therefore, the principal focus of this study is to explore whether inter-firm relationship in Malaysian buyer-supplier context follow the same five commitment dimensions, what the factors affecting the variation in commitment level and what are the new insights in business commitment due to unique cultural and business characteristics in Malaysia?

D. Significance of the Research

A high level of commitment, which is characteristically long-lasting, necessitates time, cost, human effort, product and services development [13]. Cultural dissimilarity and geographic distance multiply the challenge in sustaining inter-firm commitment. Most of the studies on inter-firm commitment were conducted in western countries on service industry perspective, where as more rigorous exploration of the commitment mix is urgent to portray country specific information. Due to cultural diversity and emerging business opportunities, Malaysia has become a challenging place for sustainable international trading, especially in buyer-supplier relationship. This study is intended to explore the commitment mix in Malaysian businesses those are engaged in international trading in IT and engineering product buyer-supplier context. As the recent commitment literature reveals country and industry specific commitment studies, this study on Malaysia would result in new insights and updates to existing literature.

II. LITERATURE REVIEW

A. Introduction

A long-lasting relationship with customers is necessary in a buyer-supplier relationship to gain competitive advantage in an international market, where the market is typically unknown. The possibility of information asymmetry divides the commitments into two components: the psychological and the behavioral. The psychological dimension is related to the beliefs and attitude about the current relationship among the parties and the desire for a continued and long-lasting relationship [21]. The psychological dimension has been widely studied under another name, "attitudinal commitment" [9, 22]. Psychological commitment is largely motivated towards having a long-lasting and socio-economically sustainable relationship between buyer and suppliers [1, 3, 23, 24]. The behavioral dimension, which is also termed as "resource commitment", indicates further development in relationship after psychological commitment in terms of increase in investment in new resources among the buyers and suppliers [13]. The resource commitment assists in extending the relationship from commitment into loyalty, which results in mutual benefits buyer-supplier relationship.

Trust is a natural cohort of commitment. Trust among business customers is considered one of the important requirements in sustainable business relationship. Trust comes from attraction of customers for each other to engage into a committed relationship. This type of commitment is termed as "affective commitment" [13]. Affective commitment results in long-term friendship, personal confidence and interpersonal interaction over time [25]. Commitment is also related to business performance, therefore, cost and value addition become important issue in relational marketing. Over a long period of time how each business is contributing to other business's development, is a cognitive concern in commitment. This type of commitment can have two components. The negative cognitive commitment or so called "lock in commitment" arises when cost and penalties associated with switching customers are prohibitive [13]. Under lock in commitment, since the relationship is ongoing, the investment is not lost and this gives continuity for long-term relationship in franchise obligation, long-run capital involvements and new product and services development. The other side, positive cognitive commitment, which is also called the value-based commitment, refers rational economic calculations related to commitment. This includes the direct profit, efficiency gains and resource mobilization resulted from the commitment [26].

Reference [27] (cited in [13]) argued that commitment goes far beyond economical and personal value addition from

ISBN : 978-602-97809-0-1

relationship. There is a moral duty or social obligation that comes along the commitment in business relationship. This is obligation based commitment. Obligation based commitment is supported under the combined framework of institutional and task environment, where both buyers and suppliers are ought to fulfill certain formal and informal rituals [12, 13, 21]. The last component of commitment mix [13] is the behavioral commitment, which is sometimes termed as "resource commitment". Resource commitment entails to explore the ongoing relationship between businesses in terms of involvement in more investment in human, financial and physical resources [13]. It explains the long-term behavior of the commitment and indicates the direction of business relationship.

B. Relevant Theories

Buyer-supplier commitment refers to the extent to which a firm engages into close and sustainable relationship with another firm to distribute their goods in an international trading environment [8], which is tremendously dominant in keeping a cooperative relationship and competitive advantage in business [28-30]. Due to attitudinal (psychological dimension) component in the commitment, an increasing portion of the commitment literature has been covered under "relationship marketing" paradigm [13, 31]. Other theories explaining commitment, "social exchange theory" and "agency theory", are based on resource based view or so called "behavioral or resource commitment" [13].

Relationship marketing concept comes under social exchange theory from the relational exchange perspective. Theory of Asymmetric Information shares the gap in commitment or dimensions of distrust that occur due to the gap in information sharing between distributor and supplier, which is again partly described by social exchange theory [32-34]. However, the interweave of the theories are commonly explaining the relational exchange between buyers and suppliers, which directs the inter-firm commitment to be largely based on theory of relationship marketing [31]. This study is largely based on the theory of relationship marketing, which explains the dimensions and extent of relationship between buyer-supplier in international business commitment.

C. Previous Empirical Findings

Reference [13] conceptualizes five dimensions of commitment in commitment mix and run association test with trust, cooperation and lack of conflict, and find higher correlation. They have extended the analysis to show the difference in level of commitment in buyers and sellers engaged in business originated from Europe, Australasia and North America. The country-wide analysis show that the affective and value based commitments are on the top of the list and locked in commitment and obligation based commitment scored very poorly. Reference [12] measure the distributor commitment in industrial trading between United States and Japan after controlling for institutional and task environment factors. The hypothesis test results indicate that task environmental factors are related significantly to distributor commitment regardless of the channel contexts and that the effect of an institutional factor varies across the channel contexts.

Reference [15] explores the trust and commitment among supplier-incumbent industrial distributor relationship in Vietnam. This study tries to fill the gap of literature by focusing on commitment and trust in industrial good producing and supplying companies [12]. Another big addition is that this study has explored the developing market phenomena as urged in commitment literature as very much context dependent and culturally diverse [12, 13]. Reference [33] investigates the impact of psychological contracts on trust and commitment in supplier-distributor relationship in motorized vehicle industry. Taking the view of social exchange theory, the study finds the construct, psychological contract, is shown to have a positive impact upon the level of trust and commitment within the relationship. However, perceived violations of the contract terms were found to reduce the distributor's level of trust.

Reference [11] examined the role of commitment in marketing service relationships between Dutch office equipment manufacturer and its industrial customers. The results of the study reveal that affective commitment is related to trust in the customer's honesty and benevolence, quality of the outcome of the service process, and customer satisfaction with the service being delivered. The quality of the service process has an indirect effect on affective commitment, as it is related to satisfaction. Furthermore, it is shown that affectively committed customers have a much stronger intention to stay in a relationship with a service provider than financially committed customers. The results are somewhat similar to that of the Reference [13]. Affective commitment is rated to be very important in business relationship.

Vision 2020 explores the Malaysian society and economy as Dr. Mahathir Mohamad, former Prime Minister of Malaysia says:

> *"By the year 2020, Malaysia can be a united nation, with a confident Malaysian society, infused by strong moral and ethical values, living in a society that is democratic, liberal and tolerant, caring, economically just and equitable, progressive and prosperous, and in full possession of an economy that is competitive, dynamic, robust and resilient [35]".*

The above paragraph covers a highlight of the future Malaysian society to be committed under just institutional and task environment, which is morally and ethically fit. Theoretically, this type of society fits into ideal socio-economic paradigm under social exchange theory that covers the affect of relationship marketing.

Reference [16] argued that Malaysia's population represents a pluralistic mix of several cultures. While ethnic Malays are in the majority, representing fifty eight percent of

ISBN : 978-602-97809-0-1

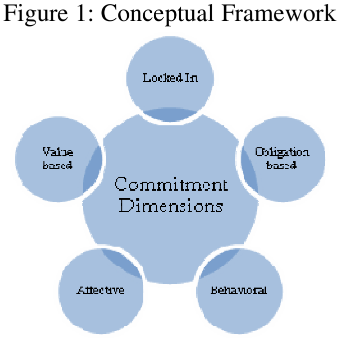
the population, Chinese (twenty four percent) and Indians (eight percent), whose perspectives and customs are significantly different, largely dominate the business culture. Reference [36] explored the relationship between organizational commitment and employee turnover. Through a questionnaire survey of Malaysian engineers established that employee perception and attitudinal characteristics have a significant influence on organizational commitment, while organizational commitment and behavioral characteristics directly affect organizational outcomes. The research demonstrates that positive employee perception enhances organizational commitment, which, in turn, leads to positive organizational outcomes. However, this relationship was explored from a single company perspective instead of business-business commitment.

Reference [37] explores similar issues like [36], the commitment of employees, in semi-conductor packaging organizations in Malaysia. They have related employee commitment with dimensions of Total Quality Management (TQM). Findings of the study reveal that teamwork, organizational communication, organizational trust and teamwork are positively associated with affective commitment. The study also shows that the organizational communication is perceived as a dominant TQM practice and is strongly associated with affective commitment. The available literatures on Malaysian business show that studies on inter-firm commitment, especially on international trading relationship, are still at the infancy.

D. Theoretical Constructs and Conceptual Framework

This study intends to explore the commitment mix [13] in Malaysian buyer-supplier relationship context. Commitment mix is the combination of five types of commitments: value-based, affective, locked-in, obligation, and behavioral commitment. Since, the existing literature lacks in providing a commitment framework in international business relationship in Malaysian business context, due to cultural and business specific characteristics, this study urges to explore the commitment mix. Therefore, the preliminary form of constructs includes these five types of commitments. Alongside extant literatures, variables under each of these component constructs are explained in details in [13].

Figure 1: Conceptual Framework



Source: [13]

III. RESEARCH METHOD

This is an exploratory study to understand the dimensions of commitment in buyer-supplier setting for Malaysian business. As the population of this study is gigantic in terms of the total number of foreign supplier and local distributors, to have more focus for the study, this study will only concentrate on companies in industrial IT and engineering related product buyer-supplier. Purposive sampling was used to select the company of interest that fits the interest of this study. In line of the earlier study on commitment mix [13]; to explore the dimensions of commitment mix, in-depth interviews with the top level, mid level and low level managers of the targeted company were conducted. Semi-structured questionnaire was used as an interview guide. As the level of commitment depends on interpersonal communication and capabilities [12, 13], the unit of data collection is the managers of the selected firms. All the interviews were tape recorded and transcribed with professionals for further use.

This study is intended to explore the dimensions of commitment in international buyer-supplier relationship in Malaysian business context. Interpretivism can explain the phenomena and can help in research design since exploration is the main objective. The study will clarify the practice of various types of commitments. Due to customized type of study, this study involves substantial manipulation by the researcher. This manipulation helped to boost up the internal validity of the research. It’s a one shot, contrived study. The unit of analysis is individuals in charge of commitment and relationship. This study used primary data collected from direct (non-disguised) method using depth interview. Personal interview method was followed.

The purpose of this study is to highlight on the businesses distributing and supplying IT and engineering products to Malaysian markets. Therefore, purposive sampling is appropriate [38]. Purposive sampling selects the samples based on certain purpose in mind. The sampling technique falls under non-probability sampling. Ministry of Industry has the list of companies engaged into various distribution related trading in Malaysia. This list was used as the starting point. However, the list was screened for purposeful use in this study. Melaka is one of the industrial hubs in Malaysia. The company selected was having three factories and the head office in Melaka. Therefore, it was convenient to interview all the three levels of management. After selecting the company, an appointment date was fixed with the chief operating officer (top level) of the company. Interview protocol suggested by [39] was followed strictly. The interview took around 2 hours. By taking his permission, the interview was tape recorded. The interviewee was requested to set appointment with a mid level and a low level management employee to be interviewed. Consequently, the marketing manager and the line manager at the factory 1 were selected for interview. The

ISBN : 978-602-97809-0-1

interviews with the mid level and low level management were also recorded and took around 1 and half hours for each.

IV. RESEARCH FINDINGS

In depth analysis of multiple interviews contributed to a holistic understanding on new dimension and type of commitment in international business. Table 1 gives the definitions of new and existing commitment dimensions. Table 2, 3 & 4 give the statements/ quotes by the interviewees, which can be related to each commitment type. Table 5 illustrates the similarities and differences regarding commitment dimensions among three different levels of management. Analysis of table 5 gives a comparative scenario on how different levels of management consider commitment dimensions. As it was found in earlier literature (see [13]), due to various risk and country specific factors, commitment in international transaction is mostly formal. The formal commitment uses written contract to engage into any international business. However, in the present case, the interviewed company did not have any sort of formal document initiated either from the buyer or from the supplier to start the relationship. In most of the cases the transaction was based on payment order and telephone calls. In support of information policy CEO's statement is:

> *"Agreement is through Payment Order (PO). First a Quotation is transmitted via email or fax showing all the specifications that we want. If both parties agree, we call our banker to pay based on the payment order and quotation."*

Apart from the existing five dimensions of commitment, all the three levels of management are arguing to effectively build up the internal capacity and efficiency to serve the customers. Both the parties are already committed to redesign their internal system for mutual benefit. However, efficiency based commitment extends the essence mutual benefit. The argument of mid level management is that:

> *"Sometimes it becomes difficult to match our requirement with that of the customers and as a result we loose important deals"*

This argument is also supported by the low level management:

> *"Work discipline is much more important than other benefits. If I cannot deliver the goods on time or if I cannot pay the money on time, my overall commitment falls"*

These two arguments clearly indicate an urge for building internal system and efficiency to be fully committed towards the demand of the customers. It is argued by the low level management that *"an undisciplined commitment has far reaching negative impact than a broken commitment"*. So, it can be concluded that informal commitment needs greater internal development to be successful in international business. In contrast to the formal commitment, where more intangible issues such as trust and relationship are necessary [12, 13, 15, 33], informal commitment put significant emphasis on tangible issues such as continuous orders and internal efficiency and development. In fact it is logically true that without building a stable and efficient internal system, buyers-sellers cannot have long-term trust on each other. Therefore, it is very crucial to have efficiency based commitment interweaved in the overall business setting.

Under affective commitment, the lone incongruity was from low level management as regard to the break up of a relationship in the crisis time. Whilst top and mid level management seemed to be more poignant and intangible in keeping a crisis led relationship, low level management wants to have a second look. Under value based commitment, the expectation of low, mid and high level management reveals important prerequisite for those who want to start a new business relationship. While high level management put emphasis on cost effectiveness and technology transfer, the mid level looks into more intangible issues such as trust worthiness and low level cares about disciplined internal system. The comment by the low level management goes like:

> *"A stable and disciplined operating system is a prerequisite. We do not want to break the harmony of the system that we develop. It is costly to build system overnight"*

All three levels disagreed with the convention that quantity decides the term in business dealings. Top level puts quality over quantity, mid level puts a combination of hard work, continuous transaction and mutual respect over quantity, and low level gives importance to trust and experience to differentiate between good and bad business customers. This shows that low level management is much more objective than others. None of the three groups is sure about whether their counterparties are avoiding them or not. For top and mid level management, this phenomenon depends on various situations. However, low level management continues with their objectivity saying that mutual benefit decides whether parties should avoid each other or not.

Under obligation based commitment, one area of dispute was morality in business. From his long experience, the CEO commented that Chinese people put business before morality. It is more objective commitment rather moral issue, which is similar in principle with the low level management. However, similar to [13], the mid level manager experienced a sense of morality toward the business relationship in the long run as he was commenting:

> *"Morality is an issue in the long run. It makes the trust deeper."*

Both mid and low level management experienced bad reputation caused by broken commitment, which is a "not serious matter" for the top level management. The broken commitment is dealt at the higher level. So this result opens up place for new study. Mid level manager became further subjective while top and low level are saying that commitment is fulfilled by increasing number of order. However, the mid level argues that commitment gives both direct and indirect benefits. So, not only increasing orders, there might be other things to consider. All three levels commented against quantity taking the place of quality. Low level management, however, commented slightly differently: *"important issues are quality, quantity and time management"*. Under the efficiency based commitment, which is the new dimensions, all three levels of management agreed that to have full commitment internal system and processes must be developed in terms of training the employees, sending them for learning different languages and face to face communication, and upgrading the technology to effectively serve the customers.

V. CONCLUDING DISCUSSION

A. Discussion of the Findings

Understanding buyer-supplier commitment in an international setting has been the academic interest for long time. Elemental interest of these studies was to investigate the business-business relationship in formal (written) atmosphere (see [13] for details). This study explores the dimensions of commitment in buyer-supplier relationship in an international setting and finds the existence of informal commitment. Informal commitment is the type of commitment where contracts are initiated by mutual trust, relationship and negotiation, and contracts are sustained by experience and mutual benefits. Apart from informal component of commitment, the study also finds that dimensions of commitment goes one step further than what was earlier found in [13]. Reference [13] explored and examined the presence of five components of commitment mix namely, affective commitment, value based commitment, behavioral commitment, locked in commitment and obligation based commitment. The new contribution in the type of commitment is named as "efficiency based commitment". Efficiency based commitment refers to the type of commitment where companies believe that stronger level of commitment depends on internal development. The more efficient internal system company has, the more committed the customer towards that company. To build that efficient internal system, company has to rely on technology-driven process, employee training and knowledge building programs.

Malaysia is a growing economy. It has business relationship with various countries. Due to unique cultural mix of native Malay, Chinese and Indian; Multinational Corporations (MNCs) have been progressive in establishing their business partnerships with Malaysian firms. This study explores the dimensions of commitment in buyer-supplier relationship in this multi-national setting in Malaysia. Developing on the model by [13], this study runs three interviews one each on top level, mid level and low level management of a purposively selected company located in Melaka industrial zone, Malaysia. This company is a high growth buyer company and majority of their trade relationship is with Chinese suppliers. The company has been successful in reproducing small scale industry machineries. They buy semi-manufactured machineries from China and redesign the machines for Malaysian market. Even though this is a typical company scenario is a growing economy; however, the study has captured the unique culture-business mix for buyer-supplier case from Malaysia and China.

The findings of this study are quite different than the earlier studies. The interesting part of the study was that the company has been successful in establishing an informal commitment (non written commitment) based on trust and relationship with the customers in China. There is lack of research in informal commitment in an international business setting. Therefore, this finding will enhance the existing knowledge base in this area. Additionally, the commitment mix is now comprised on six dimensions instead of five dimensions earlier identified by [13]. The new dimensions, efficiency based commitment, refers to the presence of continuous internal development to serve the customers. It is argued that efficient internal system will work as competitive advantage that will reinforce the counterparty having a long lasting relationship in an international business.

B. Limitations and Future Research

As the study is done to explore the dimensions of commitment in Malaysian business environment, more studies may come up highlighting on the new model. All earlier studies used survey methods asking the managers in charge of the relationship management about the commitment dimensions. Since, this study is used for exploration purpose and a single case was used. It is suggested to have extended studies using survey method on Malaysian context. Informal commitment in an international setting can also be studied. Studies on dimensions of informal commitment will add more information to the existing knowledge base of broader relationship marketing paradigm.

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ISBN : 978-602-97809-0-1

Appendices:

Table 1: Definitions of the Dimensions of Commitment

Commitment Dimensions	Definition
(1) Affective Commitment	Includes a desire to develop and strengthen a relationship with another person or group because of familiarity, friendship, and personal confidence built through interpersonal interaction over time.
(2) Value Based Commitment	Involves rational calculation of gain from continuing in a relationship such as profits, efficiency gains (between 2 parties only), information, referrals, and resource access.
(3) Locked In Commitment	Arises when the costs and penalties associated with switching partners are viewed as prohibitive.
(4) Obligation based commitment	Sense of moral duty and responsibility toward relationship partner. It is a tendency to perform activities and achieve objectives that are expected but not formally included in a contract.
(5) Behavioral Commitment	The allocation and development of resources, including human, financial, and physical, in a particular relationship in the form of dedicated relationship-specific asset.
(6) Efficiency Based Commitment **(new dimension)**	A form of commitment that is related to developing internal efficiency to serve the need of the partners. (it's more on internal development)

Note: Definition for dimensions 1 to 5 was taken from [13]. Definition for Efficiency based commitment (6) is developed from the interview/ findings.

Table 2: Dimensions of Commitment by Top Level Management

Commitment Dimensions	Statements/ Quotes
Affective Commitment	1. I enjoy the relationship with my partner. 2. I have positive feelings about the relationship that brings me trust. I become loyal to the supplier. The supplier is trust worthy. 3. But anything may happen; risk is a part of business. But I trust my partner. I cannot ensure whether he will help me in my bad times, but I have my own planning for bad times. 4. Crisis may come. Problems arise during transfer of goods and money. Banks may create problem, personal money transfer is risky sometimes. But we do not break the relationship. it is commitment. His business depends on my word, my company depends on his commitment. So it is big deal.
Value Based Commitment	1. My supplier even manually design the machines for me, they send me quotations with the manual designing because they get benefit more than cost out this commitment. Sometimes, they need to change their work schedule, they need to hire new employee at a short time basis to serve my demand. It's actually depends on relationship. Sometimes the suppliers want me to pay in advance, I try to pay. I convince the bank. So if relationship is ok, everything is ok. 2. No difference in Malay, Chinese, business is business 3. I look at the value, cost effectiveness, cultural similarity and technological benefits page 4. I will look into delivery and quantity to differentiate between good and bad partners 5. After sales support is a big issue (warranty for six months)
Locked In Commitment	1. Contracts/ deal drive the business. No question of avoidance. We both partners have commitments to fulfill. My supplier is also afraid of his reputation. So, we have good business. Just have to be carefully at the beginning. 2. If there is any problem with payment, or order; Chinese normally don't reply, break the relationship. But I try to wait, take risk. See what happened. Even with China, if you miss payment once, you are forbidden. You are gone. So, must have trust and commitment, no other way. 3. If a relationship is broken, we normally don't try to restart. Restarting is problem. Restarting is complex.
Obligation based commitment	1. I don't break compliance for relationship. I wait for good time. I may choose to switch between partners, we have few partners in china. But I don't break law. 2. Partners only rely on business. Not interested about morality sometimes. But we negotiate. We manage. The suppliers are not interested about cultures. But we have culture. We respect culture. So, we negotiate, we maintain a relationship. 3. I bring the machines from China and reproduce them for Malaysian use. Malaysians can use my machine to produce their goods faster, can sell more efficiently. I do not sell any machine that harm the social status. So, my business contribute to social development.
Behavioral Commitment	1. If commitment broken, it may or may not hamper the market value. It depends of the relationship, deep relationship. but sometimes it creates problem. Bank creates problem. But no big problem. Only problem at the beginning, when contract comes, it becomes ok. 2. As business grows, we try to look at continuous relationship. we want to make our commitment strong and fulfill that commitment with increasing amount of orders. Sometimes problem, but we try based on negotiation and relationship. but try to maintain relationship. I try to see the quality also. For example, supplier from Shanghai is of better quality than that of the Guangzhou. 3. In business, amount does not matter. The matter is continuous amount. One big amount and you stop for long time, is not a good business. The business has to be continuous even if it is for small amount.
Efficiency based Commitment	1. No middle man is good, face to face, direct visit to china. 2. I train my people how to communicate with Chinese, as my boss trained me via GMI (German Malaysian Institute). 3. I look at the value, cost effectiveness, cultural similarity and technological benefits 4. After sales support is a big issue (warranty for six months) 5. My supplier even manually design the machines for me, 6. I give importance to relationship while redesigning my process,

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Table 3: Dimensions of Commitment by Mid Level Management

Commitment Dimensions	Statements/ Quotes
Affective Commitment	1. Alhamdulillah (Praise be to Allah), we enjoy a very good and promising relationship with our partners. 2. InshaAllah (God Willing) in future this relationship has a positive result. We are very optimistic about this relationship. 3. We have trust on our partners. 4. Since our relationship is based on commitment and benefit for each other, we normally don't look at moral. However, our partner's business depend my words. So, if I pay late he might be in trouble. So, I try to cover my responsibility as soon as possible. I feel guilty for the late payment if there is any.
Value based Commitment	1. The differentiator between good and bad partner is done through a hard work, continuous transaction and respect for each others' business. 2. Beside a profitable relationship, I prefer to have a trustworthy relationship in the long-run. For this, sometimes we ask for financial and trade benefits from the partners. However, everything depend our relationship. This leads to an overall fair value for both the businesses. 3. In business you have to be clever to earn profit 4. Sometimes I need to change my working system for my partner. We try to make things simple and fast. Our other clients and customer depend on our working system. 5. So, we decide everything with our partner and change our working system accordingly if needed. But we depend on the ultimately benefit, if positive, ok.
Locked In Commitment	1. Before getting into relationship, we do lots of analysis. We never look back. We look at front. So, we never feel sorry for our relationship with the partner. We are doing good in business because of good partners. 2. It is not very difficult to switch partners. IT has great helps, everything online. You can give order online and you can pay online. But the thing is when you change partners you have bad name in the market. 3. Even during crisis, we negotiate with our partners for late payment. We normally don't try for late payment, but it happens sometimes. Our partners are mostly from China. They are always on time, so we have to be on time. This is all based on a regular commitment with our partners. 4. We do not continue any relationship which is broken by the partner. Or which is broken due to lack of communication from the part of the partner. We try to be picky. Because our relationship is informal. Without any paper or formal agreement.
Obligation based Commitment	1. In business you have to be clever to earn profit. But you should not break the law, even though your business is breaking with your partner. Our partners also respect our law and customs. They have different culture and we have different. But we follow law. 2. God wiling, we do our business for social value and development. We do not engage into any contract that may hamper society and our customer base. Because this relationship and business is not for long term. But we want long term business. 3. Our relationship is based on commitment and benefit for each other, moral is a secondary issue when you are fit at your commitment. However, our partner's business depend my words. So, someway or other morality is an issue.
Behavioral Commitment	1. We try to maintain a good relationship but sometimes problem. So, we learn the reason for which the relationship is broken. We offer the benefits to new partners. They are happy. 2. The partners really work hard for us. Sometimes we make quick order. They work day and night to send us the goods. They really invest a lot for this relationship. But normally the effort depends on the benefit and the product quality maintained by both the party. 3. We do not continue any relationship which is broken by the partner. Or which is broken due to lack of communication from the part of the partner. We try to be picky. Because our relationship is informal. Without any paper or formal agreement.
Efficiency based commitment:	1. Business commitment depends on focus. We must have disciplined relationship with our partners. 2. I put more emphasis on trust, clear cut deals before starting a long term relationship 3. We also share the technology and ideas among the partners. 4. Sometimes I need to change my working system for my partner. 5. Once in a while we have meeting with our partners. They try to do everything for serving our demand. 6. We try to maintain a good relationship but sometimes problem. So, we learn the reason for which the relationship is broken.

Table 4: Dimensions of Commitment by Low Level Management

Commitment Dimensions	Statements/ Quotes
Affective Commitment	1. We enjoy the relationship with the partner. We celebrate when we successfully deliver any business to the partners. 2. If we can continue like this, the partners would give us better business in future. We are in profit with these partners. They know our demand and quality. 3. We trust our partners. They cooperate with us. 4. If we can continue like this, the partners would give us better business in future. We are in profit with these partners. They know our demand and quality.
Value based Commitment	1. Our experience and trust will differentiate between good and bad partners 2. Benefit is normally decided by upper level. My concern is to maintain a proper work discipline. But

	obviously without benefits, profit, no business can grow. We would like to cooperate with our partners. 3. We look into quality before anything while getting into a long-term relationship with any partner. 4. At the operating level, sometimes you need to redesign the system for serving the need of the partners. Our partners first ask us about our demand and design their work process for our contract according to our demand. 5. If needed we also need to change various system component towards demand of the partner. But I would like to work as it is. Don't want to change much. Changing is also costly. But we have to do it since we are in commitment.
Locked In Commitment	1. Switching is not easy. But it depends on how our relationship is growing with the partners. 2. Both parties want benefits, profit. If no, we normally think about alternative. 3. Yes, it is very risky and costly to switch partners. Switching breaks the relationship. 4. While we face some crises, we first try to solve. It is not easy to forgo any commitment. We try to negotiate. We talk to our partners for solutions. 5. Sometimes there are relationship problem. We try to build partnership. We try get into mutual business. So negotiation and participation can reduce problem.
Obligation based Commitment	1. Oh no! We cannot break law. Malaysian govt. is following us. We complete our legal bindings everywhere. Sometimes with some Chinese we have problem. So, we stop business because of law problem. 2. We sometimes think about alternatives. But these are high level decisions. If we see other opportunities then we of course take this. But we fulfill our commitment first. 3. No morality. Its all practical. Give and take. Commitment based on practical business deals. 4. We care about society. We reproduce machines for the use of Malaysians by buying raw machines from the partners from China. We are contributing to the small business in Malaysia. For me, both commitment and social responsibility are needed. 50-50.
Behavioral Commitment	1. Broken relationship is problem. Again you have to start with a new partner. Lots of cost. 2. Partners put lots of effort. They don't hide anything from us. They invest a lot to give us the right quality. 3. Our business relationship, beside profit and trust, also depends on market demand. Demand of the industry decides whether our commitment should be long-term or short –term. 4. For redesigning the work system, I consider the cost-benefit to the company. Commitment works but if I am in loss, commitment is valueless.
Efficiency based Commitment	1. Discipline is the most important thing in commitment. We must deliver our commitment in specified time. 2. Benefit is normally decided by upper level. My concern is to maintain a proper work discipline. But obviously without benefits, profit, no business can grow. We would like to cooperate with our partners. 3. Commitment based on practical business deals. 4. We try to build partnership. 5. We invest to redesign our internal system for serving the need of the partners.

ISBN : 978-602-97809-0-1

Table 5: Differences and Similarities in Commitment Dimensions among Three Levels of Management

Commitment Dimensions & Items	High Level	Mid Level	Low Level	Remarks
Affective Commitment				
1. We enjoy the relationship with our partners.	√	√	√	All three groups agreed
2. We have a positive feeling about the relationship that brings me trust.	√	√	√	All three groups agreed
3. We trust my partner.	√	√	√	All three groups agreed
4. We do not break the relationship even in big crisis time.	√	√	X	Low level: a business deal depends on many things.
Value based Commitment				
1. Our partner manually designs the system according to our requirement.	√	√	√	All three groups agreed
2. Our business is also redesigned based on the requirement of the partner.	√	√	√	All three groups agreed
3. We prefer professionalism in business.	√	√	√	All three groups agreed
4. We prefer cost effectiveness and technological benefit at the time of starting any relationship.	√	X	X	Mid level: Looks into more intangibles such as trust worthiness, fair value and an extent of morality. Low level: a stable and disciplined operating system is a prerequisite. We do not want to break the harmony of the system that we develop. It is costly to build system overnight.
5. Quantity is key term in differentiating good and bad partner.	X	X	X	Top management gives important to Quality over quantity. Mid Level: The differentiator between good and bad partner is done through a hard work, continuous transaction and respect for each others' business. Low level: experience and trust will differentiate good and bad partners.
6. We like partnership that adds long-term value to our business.	√	√	√	All three groups agreed
Locked In Commitment				
1. Our partner does not avoid us.	X	X	X	Top Management: Depends on situation. However, we never avoid. We do thorough analysis before getting into any business. Mid level: same as top level. Low level: It depends on how the partner is benefited.
2. Informally our business is locked in with the partner's business, so we cannot break the relationship.	√	√	√	All three groups agreed
3. If for any circumstance the relationship is broken, we normally do not restart the relationship.	√	√	√	All three groups agreed
Obligation based Commitment				
1. We are respectful to the law of the country and business over the commitment.	√	√	√	All three groups agreed
2. We integrate morality with business principles.	X	√	X	Top Management: It depends largely on the business culture. Normally Chinese people like business more than morality. Mid Level: Morality is an issue in the long run. Low level: No morality, work discipline is more important.
3. We feel a commitment towards social development as well.	√	√	√	All three groups agreed

Behavioral Commitment				
1. Broken commitment does not affect the market value in the long run.	√	X	X	Mid Level: Broken commitment creates a bad name. Low level: increases cost of starting again, therefore, reduces profitability. Creates bad reputation in the market.
2. Commitment is fulfilled by increasing number of order.	√	X	√	Mid Level: No only increasing orders, there can be direct or indirect benefits to be shared for the commitments to be fulfilled.
3. Quantity gets more importance than quality.	X	X	X	Top Management: Quality is more important. Mid level: Same as top management. Low level: important issues quality, quantity and time management.
4. Our partner provides us with continuous order.	√	√	√	All three groups agreed
Efficiency based Commitment				
1. We prefer to train our people during the relationship building process for a fruitful partnership.	√	√	√	All three groups agreed
2. We send our employees to learn different languages to handle partners from other languages.	√	√	√	All three groups agreed
3. We try to update our technology and processes to provide cutting edge solution to our partners.	√	√	√	All three groups agreed
4. We prefer our employees to learn face to face communication to avoid middle man.	√	√	√	All three groups agreed

ISBN : 978-602-97809-0-1

ICIEBM

Proceedings

The International Conference on Industrial Engineering and Business Management 2010

CHAPTER 9 :
Simulation and Modeling (SMG)

editor :
Arya Wirabhuana, Muchammad Abrori, Kifayah Amar

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Department of Industrial Engineering
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Proceedings

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ISBN : 978-602-97809-0-1

Designing Simulation Model Using Pro Model for Patient Service System

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Abstract **– Simulation is the limitation of a dynamic system using a computer model in order to evaluate and improve system performance. Tulus Medika Polyclinic as case study in this paper, currently serving two health services, namely public service and dental service. Tulus Medika Polyclinic has large number of patients resulted a queue where patients have to wait in a long period of time to obtain medical care, especially if there is a patient's health condition that is not possible to wait any longer. The problem that arises is how to determine how many doctors that possible to serve patients. This research aims to design a simulation model of patient, that can assist management in systems analysis and decision making of current conditions system so it can improve the quality of service to patients. From the research design of a simulation model using Pro Model software, obtained the result that the proposed improvement to occur in the form of performance improvements increase the number of patients served by a change of 63.88%, the time change in the system for the general doctor patients for 60.2% and the change in time within the system to the dentist at 38.9%.**

Key Words - **Model, Queue, Simulation, Pro Model.**

I. Introduction

Expectations of the public to obtain quality health services with a relatively cheaper cost is one of the challenges that must be able to be realized by all health facilities including hospitals, health centers, clinics or polyclinic responsible for providing health services to the community. In addition to hospitals, today is already flourishing medical centers in urban and rural areas. A large number of polyclinics in Bandung increasingly diversified choice for community clinics in Bandung to determine which one will be chosen to seek treatment. One of the clinics are quite busy in the area of East Bandung is Tulus Medika Polyclinic.

Tulus Medika Polyclinic is a medical clinic which is located at Gatot Subroto street No. 667 Bandung. Tulus Medika Polyclinic currently serving two health services, namely public services and dental services. Hall room treatment is not large enough with a relatively large number of patients resulted in a queue where patients have to wait in a relatively long period of time to obtain medical care, especially if there are medical conditions that do not allow patients to wait no longer. This is one of the challenges facing the management Tulus Medika Polyclinic in providing the best service to patients.

One solution that can be used to perform decision making is simulation models. Simulation models are increasingly being used to solve problems and to aid in decision-making. The developers and users of these models, the decision makers using information obtained from the results of these models, and the individuals affected by decisions based on such models are all rightly concerned with whether a model and its results are “correct” [Sargent, 2009]. By using simulation to model the process of patient care that occurred in Tulus Medika Polyclinic, the management will get the consideration of alternatives appropriate action to improve current conditions.

In practice, simulation is usually performed using commercial simulation software like Pro Model. Pro Model is a simulation and animation tool designed to model manufacturing systems of all types quickly and accurately. Pro Model provides such an intuitive and straightforward approach to modeling. While most systems can be modeled by selecting from Pro Model’s complete set of modeling elements (e.g. resources, downtimes, locations, etc.) and modifying the appropriate parameters, complete programming capability is also provided if needed for modeling special situations. Built-in language features include if-then-else logic, Boolean expressions, variables, attributes, arrays and even access to external spreadsheet and text files [Harrel and Field, 2001].

To meet the needs and research challenges described above, this research has the objective: “How to design a simulation model using Pro Model of patient service system, that can assist management in systems analysis and decision making of current conditions system so it can improve the quality of service to patients?”

II. Literature

A. *Simulation*

Simulation is the modeling of a process or system in such a way that the model mimics the response of the actual system

ISBN : 978-602-97809-0-1

to events that take place over time. Simulation avoids the expensive, time-consuming, and disruptive nature of traditional trial-and-error techniques. By using a computer to model a system before it is built or to test operating policies before they are actually implemented, many of the pitfalls that are often encountered in the start-up of a new system or the modification of an existing system that can be avoided [Harrel, *et. al.*, 2004].

In regards to measuring customer satisfaction, simulation is one of the few tools capable of measuring financial indicators, operational indicators and customer satisfaction indicators in the same analysis [Miller and Ferrin, 2005]. Simulation is nearly always performed as part of a larger process of system design or process improvement. Simulation is essentially an experimentation tool in which a computer model of a new existing system is created for the purpose of conducting experiments. The model acts as a surrogate for the actual or real-world system [Harrel, *et. al.*, 2004].

B. Pro Model

Pro Model is a simulation and animation tool designed to quickly yet accurately model manufacturing systems of all types, particularly supply chain systems. Engineers and managers find the manufacturing oriented modeling elements and rule-based decision logic extremely easy to learn and use. Users are particularly delighted when they discover that Pro Model is capable of modeling their most complex systems. Because it provides such an intuitive and straightforward approach to modeling, it is also attractive to professors in engineering and business programs who are interested in teaching modeling and analysis concepts without having to teach computer programming.

Simulation results are informative and may be displayed in tabular or graphical form. Many simulation software products require special commands to generate statistics that are difficult to interpret for non simulation. Pro Model allows quick and convenient selection of reports and provides automatic tabular and graphical reports on all system performance measures. Output reports from several simulation runs can even be compared on the same graph [Benson, D, 1997].

The modeling elements of ProModel provide the building blocks for representing the physical and logical components of the system being modeled. Physical elements of the system such as parts, machines, or resources may be referenced either graphically or by name. Names of modeling elements may be any word containing up to 80 alphanumeric characters [Benson, D, 1997].

III. RESEARCH METHODOLOGY

The method used in this paper is descriptive method of analysis. First, define the purpose of the simulation project and what the scope of the project will be. Second, identify, gather and analyze the data defining the system to be modeled. Third, develop the simulation model of the system. Fourth, validate the model and the fifth run the simulation for each of the scenarios. The last, present the results and make the recommendations (see Fig. 1).

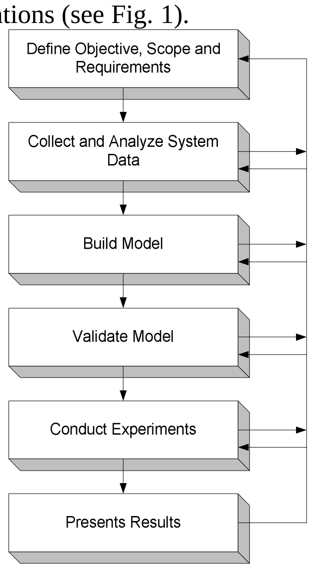

Fig. 1 Research Methodology

IV. SYSTEM DESCRIPTION

A part from general data is also needed to design a simulation model data are used as input for simulation and validation of the simulation. Determining experimental procedures, such as how many replications and how to gather statistics, depends on whether we should conduct a terminating or non-terminating simulation. This case study includes a terminating simulation, where one in which the simulation starts at a defined state or time and ends when it reaches some other defined state or time. An initial state might be the number of parts in the system at the beginning of a workday. A terminating state or event might occur when a particular number of parts have been completed [Harrel, *et. al*., 2004]. A common type of terminating system is one that starts empty, runs for a while, and then empties out again before shutting down.

A terminating simulation of this case can be described in entity flow diagram of real systems in Figure 2. Patient will register in which time registration is 7:00 to 10:00 o'clock, if a patient comes more than 10:00 a.m., the patient can not be served and will not register to be served. In this situation, a terminating simulation would be run in which the simulation run length would be 3 hours. Patients who sign up until 10:00 hrs will be served until all the patients served on the day. Patients register at the registration and then wait if the doctor is busy serving other patients. If doctors are not busy, then the patient will be served soon.

Services for patients are three kinds, namely: public services, dental services and ministry of steam therapy. It is also common for dental services, but no recommendations for steam therapy. After the patients served at the pharmacy, the patient will go home. The conceptual model can be illustrated in Fig. 3

Terminating simulations are not intended to measure the steady state behavior of a system. A steady state condition is not one in which the observations are all the same, or even

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one for which the variation in observations is less than during a transient condition. It means only that all observations throughout the steady state period will have approximately the same distribution [Harrel, *et. al*., 2004]. Based on the definition above, the case study in this paper includes a steady state condition, because from the input data analysis using Stat-Fit for patient time arrival, time in general doctor system and time in dentist system, all observations have approximately the same distribution (see Fig. 4, Fig 5 and Fig 6).

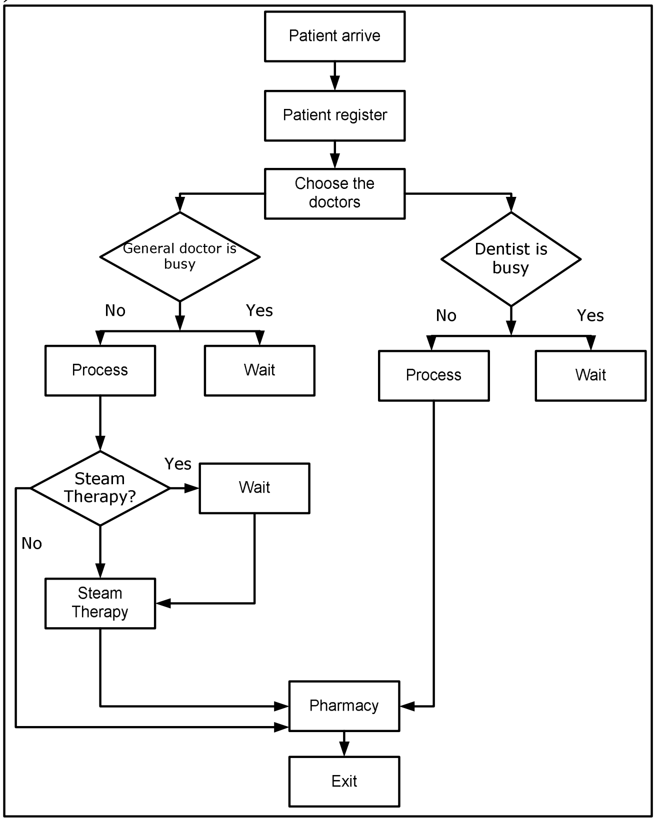


Fig. 2 Entity Flow Diagram

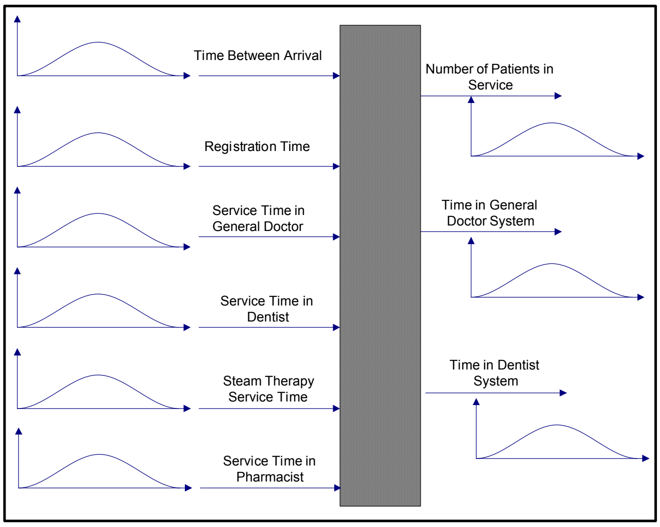
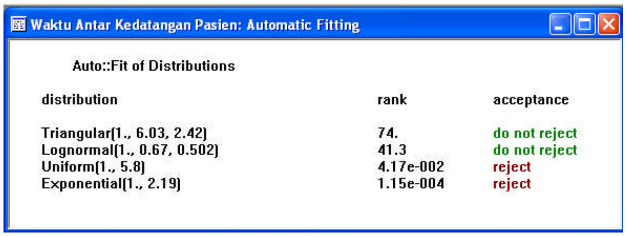
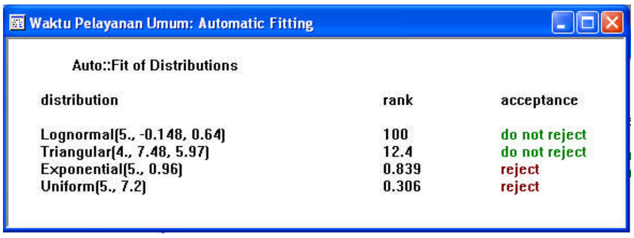


Fig. 3 Conceptual Model



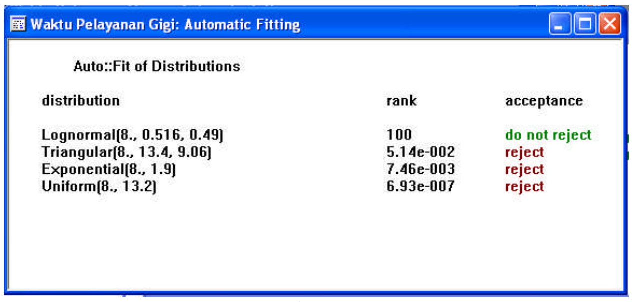
distribution	rank	acceptance
Triangular(1., 6.03, 2.42)	74.	do not reject
Lognormal(1., 0.67, 0.502)	41.3	do not reject
Uniform(1., 5.8)	4.17e-002	reject
Exponential(1., 2.19)	1.15e-004	reject

Fig. 4 Distribution of Patient Time Arrival



distribution	rank	acceptance
Lognormal(5., -0.148, 0.64)	100	do not reject
Triangular(4., 7.48, 5.97)	12.4	do not reject
Exponential(5., 0.96)	0.839	reject
Uniform(5., 7.2)	0.306	reject

Fig. 5 Distribution of Time in General Doctor System



distribution	rank	acceptance
Lognormal(8., 0.516, 0.49)	100	do not reject
Triangular(8., 13.4, 9.06)	5.14e-002	reject
Exponential(8., 1.9)	7.46e-003	reject
Uniform(8., 13.2)	6.93e-007	reject

Fig. 6 Distribution of Time in Dentist System

V. BUILDING OPERATIONAL MODEL

A simulation model is a computer representation of how elements in a particular system behave and interact. Current simulation model lay out illustrated in Fig. 7.

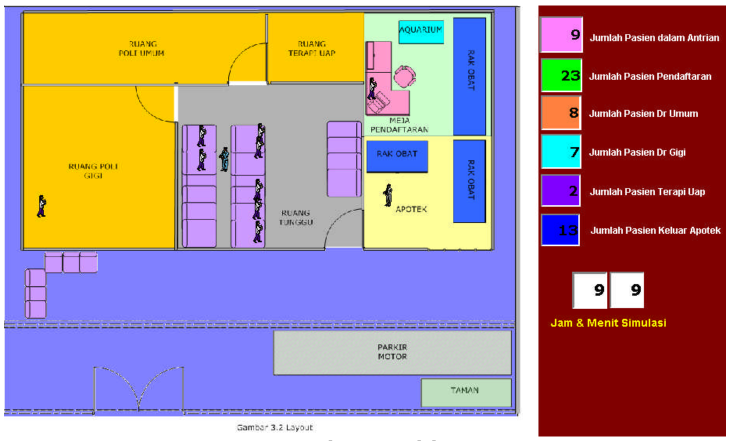


Fig.7 Current Simulation Model Lay Out

IV. MODEL VERIFICATION AND VALIDATION

According to Harrel, et al (2004), verification is the process of determining whether the model operates as intended. It is concerned with building the model right. It is utilized in the comparison of the conceptual model to the computer representation that's implements that conception. During the verification process of this case study, the authors try to detect unintended errors in the model data and logic, and remove them. By using trace and debugging facilities as one of the verification techniques in Pro Model software, event occurrences and state variables can be examined and compared with hand calculations to see if the program is operating as it should. The following logic, for example, might be inserted in the case study model logic to test whether a resource is available at a specific time (see Fig. 8).

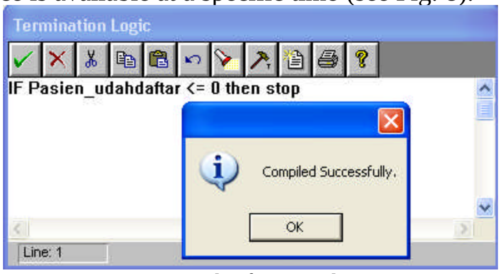


Fig. 8 Example of a Compile Logic

Validation is the process of determining whether the model is a meaningful and accurate representation of the real system. Validation actually begins with the data-gathering stage of a simulation project before a model is even built. There is no simple test to determine the validity of a model. Comparing with the actual system is one of techniques when validating a model. Both the model and the system are run under the same conditions and using the same inputs to see if the result match. Data used as the reference is 25 replications, because the data has met the minimum limit replication to be done. Field observation data when compared with the simulation data can be seen in Table 1, Table 2 and Table 3.

Using a statistical test obtained by value sigma> 5% then the value was in the area of acceptance, then received so it can be concluded that the number of patients served, time in general doctor system and time in dental system in a real system and simulation system is the same or not significantly different. We can conclude that the model created is valid.

TABLE 1
COMPARISON OF NUMBER OF PATIENTS

Replication	Number of Patients (Simulation)	Number of Patients (Real System)
1	33	34
2	31	35
3	33	30
4	33	32
5	34	29
6	33	35
7	34	31
8	34	30
9	34	33
10	34	34
11	33	
12	34	
13	31	
14	32	
15	34	
16	34	
17	31	
18	33	
19	36	
20	35	
21	34	
22	32	
23	34	
24	36	
25	32	

TABLE 2
COMPARISON OF TIME IN GENERAL DOCTOR SYSTEM

Replication	Time in General Doctor System (Simulation)	Time in General Doctor System (Real System)
1	88.72	95
2	91.05	78
3	99.07	89
4	89.34	90
5	105,44	86
6	104.79	95
7	119.22	100
8	112.7	85
9	89.09	75
10	94.5	110
11	93.19	
12	100	
13	105.59	
14	82.27	
15	91.1	
16	98.51	
17	78.15	
18	84.99	
19	107.44	
20	98.54	
21	112.22	
22	87.23	
23	107.58	
24	108.71	
25	83.21	

TABLE 3
COMPARISON OF TIME IN DENTIST SYSTEM

Replication	Time in Dentist System (Simulation)	Time in Dentist System (Real System)
1	88.72	95
2	91.05	78
3	99.07	89
4	89.34	90
5	105,44	86
6	104.79	95
7	119.22	100
8	112.7	85
9	89.09	75
10	94.5	110
11	93.19	
12	100	
13	105.59	
14	82.27	
15	91.1	
16	98.51	
17	78.15	
18	84.99	
19	107.44	
20	98.54	
21	112.22	
22	87.23	
23	107.58	
24	108.71	
25	83.21	

V. PROPOSED MODEL

A. Identification of Alternatives Problem Solution

A good solution to the problem in our opinion is applicative problems solving and does not cause new

ISBN : 978-602-97809-0-1

problems for the real system at this time. So, we to provide an alternative proposal that could be applied today, without the need for additional capital and significant facilities for its implementation.

By considering the conditions in Tulus Medika Polyclinic today, particularly the building area of possible alternatives are currently being developed by Tulus Medika Polyclinic for solving problems in minimizing the queuing time are:

1. Increase the number of general doctors.
2. Increase the number of drugs, especially for the pharmacist services.

From the two alternatives described above, the proposal can be done are add a general doctor become two doctors and add one pharmacist become two pharmacists. The proposed simulation model lay out illustrated in Fig. 9.

B. Develop Proposed System

The proposed system illustrated in Fig. 9. Although operating time is now at 7:00 a.m. to 10:00 a.m., whereas the proposed operational time is at 7:00 a.m. to 11:30 a.m., from the above analysis we can conclude that the operational time of service is the same system on current conditions or proposals which are both seven hours (see. Table 4).

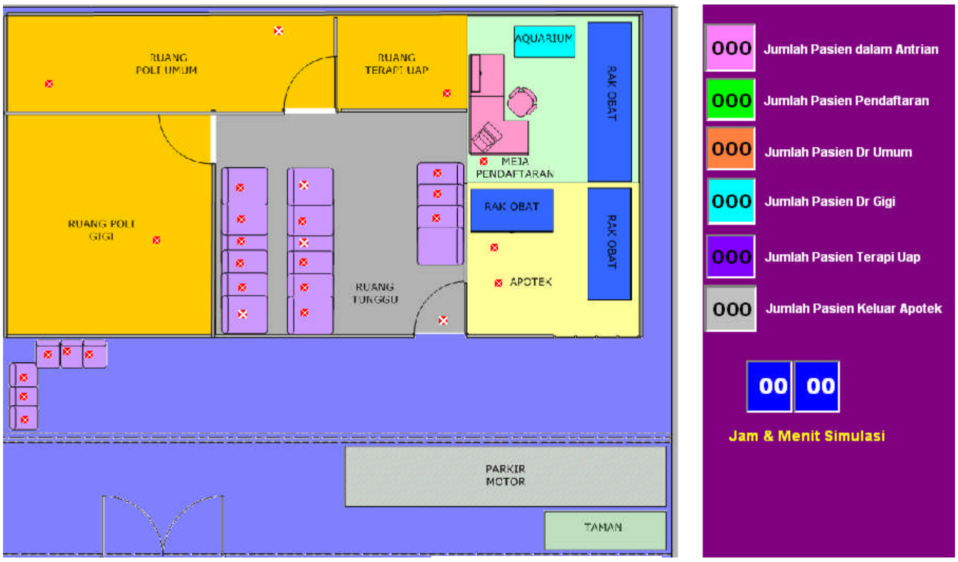


Fig.9 Proposed Simulation Model Lay Out

TABLE 4
COMPARISON OF SERVICE TIME BETWEEN CURRENT AND PROPOSED SYSTEM

Replication	Time in System (Current)	Time in System (Proposed)
1	7	7
2	7	7
3	7	7
4	7	7
5	7	7
6	7	7
7	8	7
8	8	7
9	7	7
10	7	8
11	7	7
12	7	7
13	7	7
14	7	7
15	7	7
16	7	7
17	7	7
18	7	7
19	7	7
20	7	7
21	7	7
22	6	7
23	7	7
24	8	7
25	7	7

VI. SYSTEM ANALYSIS

A. Current Analysis System

Current performance data for the number of patients was 31 people in minimum value, 36 people in maximum value, while the standard deviation is 1.35. For general physician patients, time in the system was 78.15 minutes in minimum value and 119.22 minutes in maximum value with an average value is 97.31 minutes and the standard deviation is 10.87 minutes. For dentist patients, time in the system was 27.93 minutes in minimum value and 51.07 minutes in maximum value with an average value is 37.34 minutes and the standard deviation is 6.18 minutes. This condition is very harmful for the patient especially if the patient's health condition was not possible to wait for long.

B. Proposed Analysis System

Current performance data for the number of patients was 53 person in minimum value, 59 person in maximum value, while the standard deviation is 1.80. For general physician patients, time in the system was 25.55 minutes in minimum value and 47.38 minutes in maximum value with an average value is 29.50 minutes and the standard deviation is 4.46 minutes. For dentist patients, time in the system was 25.08 minutes in minimum value and 31.17 minutes in maximum value with an average value is 27.46 minutes and the standard deviation is 61.52 minutes. This condition is much better than the current conditions, where there is a time decrease for public services and dental services.

C. *Comparison of Current and Proposed System*

The comparison between the current and proposed system are illustrated in the chart below:

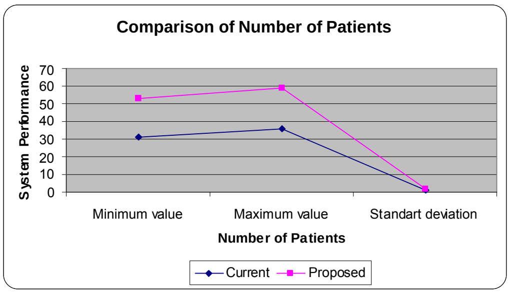


Fig.10 Comparison Chart of Number of Patients between Current and Proposed System

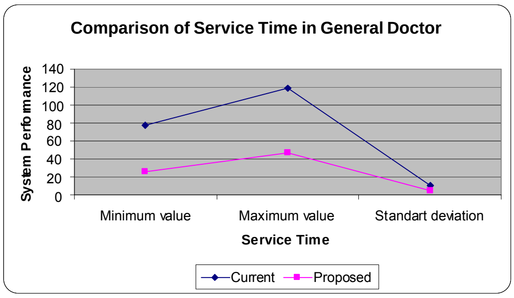


Fig.11 Comparison Chart of Service Time between Current and Proposed General Doctor System

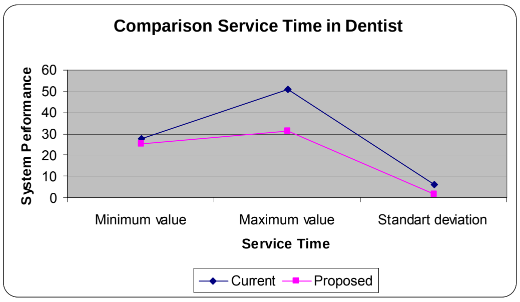


Fig.12 Comparison Chart of Service Time between Current and Proposed Dentist System

VII. CONCLUSION

This paper proposed new system by designing a simulation model of patient, that can assist management in systems analysis and decision making of current conditions system so it can improve the quality of service to patients. There has been a significant change between the current and the proposed system that can be described in Table 5, Table 6 and Table 7.

TABLE 5
COMPARISON OF NUMBER OF PATIENTS BETWEEN CURRENT AND PROPOSED SYSTEM

System Performance	Current System	Proposed System	Percentage of Change
Minimum value	31,00	53,00	70,96%
Maximum value	36,00	59,00	63,88%
Standart deviation	1,35	1,80	33,3%

TABLE 6
COMPARISON OF SERVICE TIME BETWEEN CURRENT AND PROPOSED GENERAL DOCTOR SYSTEM

System Performance	Current System	Proposed System	Percentage of Change
Minimum value	78,15	25,55	67,3%
Maximum value	119,22	47,38	60,2%
Standart deviation	10,87	4,46	58,9%

TABLE 7
COMPARISON OF SERVICE TIME BETWEEN CURRENT AND PROPOSED DENTIST SYSTEM

System Performance	Current System	Proposed System	Percentage of Change
Minimum value	27,93	25,08	10,2%
Maximum value	51,07	31,17	38,9%
Standart deviation	6,18	1,52	75,40%

ACKNOWLEDGMENT

Special thanks to Dr. Suprayogi, MT as a Lecturer of Modeling and Simulation at Department of Industrial Engineering, Institut Teknologi Bandung Rida Norina, MT for partner discussion so that this paper can be completed.

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ISBN : 978-602-97809-0-1

Policy Analysis to Reduce Opportunity Lost In Newspaper Industry with System Dynamic Approach

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Abstract **- Press publishing companies in the publishing business usually have difficulties in determining the amount of circulation policies. This policy was conducted by the Circulation Manager with intuitive and based on previous experiences that prediction resulted make a lot returns. The company's main revenue comes from advertising. The other problem is the income from sales experienced an opportunity lost which means that this income cannot cover the cost of production. This research was conducted with a system dynamics approach. System dynamics is a methodology used to study a problem with a systematic perspective, approaching a system by describing the reciprocal interaction between the components of real systems. Therefore, the dynamics model made very good to explain the structure and trends of system behavior. From the simulation run for two years resulted an opportunity lost average per day in one month tends to increase. Based on the bonferroni method, the best experimental design is to sell newspapers for half price so that an opportunity lost average per day within one month decreased by 17%**

Keywords**: System Dynamics, Circulation, Opportunity Lost**

I. INTRODUCTION

In the competition of mass media, other than print media such as electronic media (radio and television) and internet media are also in the competition although not as competitive as in print media. It is because the national media became a direct threat to local media such as newspapers. In an effort of a company in this competition, these companies are often confronted with various difficulties, such as trouble grabbing market share that would give revenues and profits to the company. The company's main revenue comes from advertising section. The other problem is the income from sales experienced an opportunity lost which means that this income cannot cover the cost of production.

In order to settle a comprehensive strategy that able to solve the problem, a complex mathematical modeling is needed. The mathematical model is build upon a complex interaction between factors interconnected within the dynamic system. A model that can describe the dynamic behavior of the system is system dynamics.

Some research on the system dynamics, among others, performed by Penlope TF, (2007). Penlope uses system dynamics as limited resource settings in supply chain management of media companies. This study includes variables such as consumer demand, the quantity of products, competitor products, market segmentation, cost, price, revenue, inventory, and product design. Emmanuel DA, *et.al,* (2005) undertook a study on the evolution of co-manufacturing and marketing strategies as a resource and capability development process by developing a system dynamics model.

II. PROBLEM FORMULATION

Based on the background, we can formulate a subject of research to be conducted is:

1. What is the appropriate policy strategies to reduce the *opportunity lost?*
2. How large a decrease in *lost opportunity* if the company obtained by applying the new policy?

III. LITERATURE REVIEW

A. System Dynamics

System Dynamics was first introduced by Jay Wright Forrester from Massachusetts Institute of Technology, Cambridge, Massachusetts, USA in 1956. At first, the SD is used to solve problems of business systems / business. But along with its development, elementary widely used for various social issues, economics, management, and physical systems. The background of SD came from three primary disciplines, namely the traditional management of the social, feedback theory or cybernetics, and computer simulation.

Advantages of the most prominent of *the System Dynamics* approach include the following:
1. SD is able to fulfill a set of system requirements and managerial issues to shape modeling framework.
2. SD capable combines traditional management with management science to obtain more information and the approaches and solve problems more effectively.

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3. SD uses the power of human beings think and overcome their weaknesses by dividing the work between managers and technology. Generating input structure is being done by managers conducted by computer simulation.
4. SD uses several different sources of information: a written mental and numerical data in order to better contain and representative model.

SD model can make *feedback* for decision-makers about the least possible conflict of a series of policies by simulating and analyzing system behavior on different assumptions.

B. Causal/ Feedback Loop

Causal Loop Diadram (CLD) is a diagram showing the pattern of changes in variables and polarity. Polarity is divided into positive and negative. Positive polarity indicates the influence of the next component of comparable value. The negative polarity will be inversely affected.

Richardson and Pugh (1981) defines feedback loop as a closed sequence of causes and effects that is a closed path of action and information.

C. Flow Diagram

The flow chart used to analyze the relationship between variables form a system that would be used for the manufacture of its mathematical model. In this flow diagram shows the type of variable and type of relationship between variables.

Flow diagram has the following characteristics:

a. Distinguishing between physical subsystems and information subsystem
b. Differentiating between the types of variables such as level, rate and auxiliary
c. Has a one correspondence with the mathematical equation
d. Showing different delay in the system
e. Shows the average / smoothing of variable
f. Clearly indicates the specific functions that are used in the formula of mathematical equations
g. Distinguishing the symbols used in a different depiction of each variable.

Variables in the flow diagram can be classified as follows:

a. Level *(stock)*
   This variable indicates a condition of the system at any time. This variable is declared with a scale accumulated quantity as a result of the flow of activity over time. Level will be influenced by the Rate (flow)
b. Rate *(flow)*
   Rate is the variable that will affects the level variable. This variable describes an activity, movement and the flow that contribute to changes in time in a level of unity that is expressed in a scale rate of change.
c. Auxiliary
   Auxiliary is the variable which includes basic calculations on other variables. This is an additional variable to simplify the relationship between the level and rate. This variable is expressed in the mathematic equation which is basically a part of the rate equation.
d. Constant
   Constant is a variable type that contains of permanent value to be used in the calculation auxiliary or variable flow.
e. Link
   Link is a tool for connecting between one variable with another variable.

D. Validation

Validation is a step to ensure that the model behavior / character of such real systems. And most significantly, an approach to validation is to compare a model with the output of the real system.

In statistical validation can use several methods, among others:

1. Test equality of two average
   Test whether the two data have the same average. The formula used to test the hypothesis of equality of two averages:
   $$t = \frac{\bar{x} - \mu}{\sigma / \sqrt{n}}$$
2. Test equality of two variance
   Its a tests whether the two data sets have the same variance. The formula used is:
   $$F = \frac{s_1^2}{s_2^2}$$
3. Chi square test.

Test whether the results of simulation models have a match with the observed real system. The model used is the chi-square test. Regional acceptance as follows:

$$\chi^2_{calculate} < \chi^2_{table}$$

E. Experimental Design

Experimental design is a design of an alternative model created with the aim of comparing the initial model has been created with an alternative model that will be created. Experimental design is an additional step to perform the experiment in order to obtain accurate simulation. The purpose of the experimental design was made as follows:

1. Creating an alternative model of the initial models
2. Designing an experiment that aims to obtain a simulation model that most closely approximates the behavior of real systems.

F. Bonferroni Method

Bonferroni Method is the method used to determine the best scenario an alternative model of a real system. Bonferroni can be done if there were more than two alternative scenarios.

ISBN : 978-602-97809-0-1

The best scenario selection phase of the Bonferroni Method is as follows:

1. Determine the desired magnitude of the differences between scenarios (€) and the amount of degrees of freedom t $_{\alpha / (K-1), R0-1}$
2. Creating replication $_{(R0)}$ of the system for each scenario
3. Counting sample average Ŷ.i, i = 1,2, ... K, for all scenarios, and then calculate the variance also:
4. Calculating sample size
5. Making R - Ro additional replication of the system to optimize output data Yro+1i, Yri $_{2i}$............Yri, for i = 1, 2, ... K
6. Calculating overall sample average for i = 1, 2, ... K
7. Choosing the system that has the largest or smallest Yi (in accordance with objective function) as the best system.

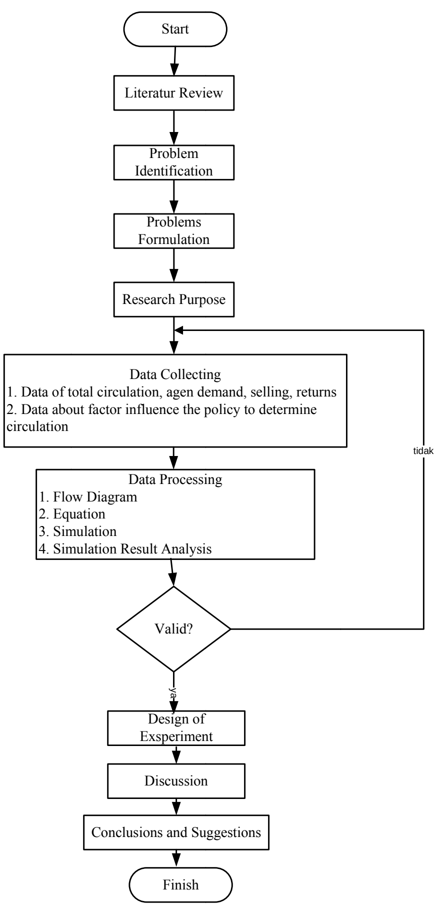

Fig. 1 System Dynamics Simulation Methodology

IV. RESEARCHED METHOD

The data used in this study is the amount of circulation data for 16 months, starting in January 2009 to April 2010 on two hundred agents. The step of research can be seen in Fig.1.

V. DATA PROCESSING

Data required in this study include the number of circulation, number of copies sold, the percentage of returns, the composition of the paper, etc.

A. Causal Loop Diagram

Initial step in data processing in the case of using system dynamics is the development of causal loop model that explains the basic pattern of relationships between components in the observed system. Making this model was based on an interview to the Circulation Manager shown in Fig. 2.

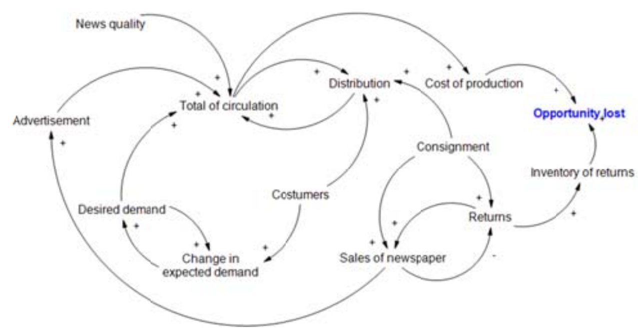

Fig. 2 Causal Loop Diagram

Fig.2. shows that the manager determines the amount of circulation or the circulation of copies to be sent on request from agents every day, this indicates a positive loop. Another policy is based on the number of advertisments incoming and the quality of news on the day. Two of these parameters are also a positive loop in determining the amount of their circulation.

After detemining total circulation, the newspaper will be produced and distributed to eight regional distributions and delivered by the fleet, this loop also shows a positive effect on the number of total circulation. In the causal loop delivery is distributed based on the classification of customers is fixed and consignment customers.

Conditions exist on the system returns the consignment will be returned by the agent each month end. From there we could see the company suffered an opportunity lost when compared to production costs, product returns by the company will be stored in a warehouse and will be sold again in the form of pounds to collectors. Likewise there are copies sold which will affect the number of advertisers.

Loop demand on this day will see the trend. Its to find the value of the expected changes in demand so it can fulfill the demand in the next day the pattern of positive loops

B. Flow Diagram Modeling

From the causal loop subsequently converted into a mathematical model by incorporating variable of data processing. Generated model has more components of the causal loop, because each component of the causal loop can have multiple parameters when it should be changed into a mathematical model.

The model builded can be seen in Fig.3.

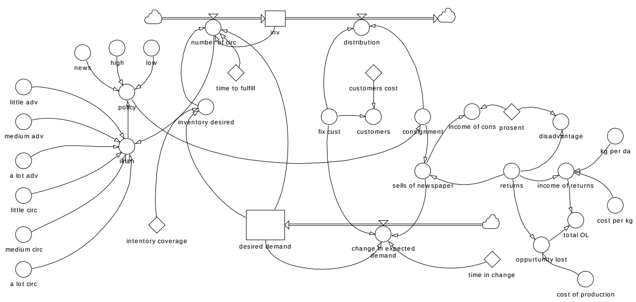

Fig. 3 Flow Diagram

The simulation results for the component and returns the number of circulation figures shown in the table and graph below:

TABLE 1
DATA COMPARISON OF REAL AND SIMULATED TOTAL CIRCULATION

Year	Month	Total Circulation	
		Real	Simulation
2009	January	33215	33401
	February	32800	32498
	March	33090	33882
	April	33295	31415
	May	32305	34130
	June	34355	32497
	July	34485	34630
	August	34230	33453
	September	32585	32563
	October	32210	32522
	November	32185	34340
	December	33230	34039
2010	January	33310	33304
	February	32715	32953
	March	32555	33516
	April	33425	32897

TABLE 2.
DATA COMPARISON OF REAL AND SIMULATED DATA RETURNS

Tahun	Bulan	Returns	
		Real	Simulation
2009	January	2529	2536
	February	2618	2428
	March	2893	2485
	April	2237	2229
	May	2204	2569
	June	2358	2895
	July	3065	2780
	August	2553	2231
	September	2270	2272
	October	2272	2758
	November	2357	2607
	December	2931	2131
2010	January	2648	2965
	February	2686	2487
	March	2547	2124
	April	2369	2288

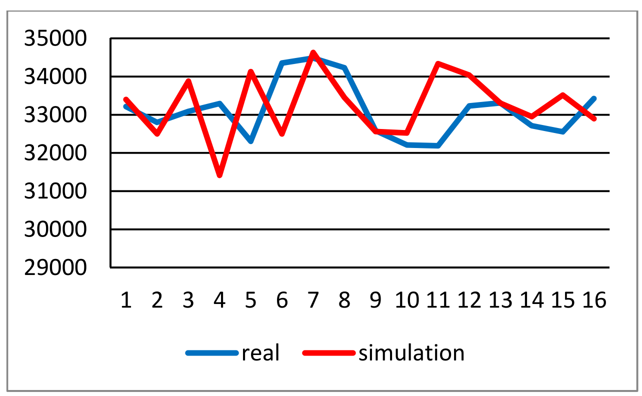

Fig. 4 Comparison Chart of Real and Simulation of Circulation

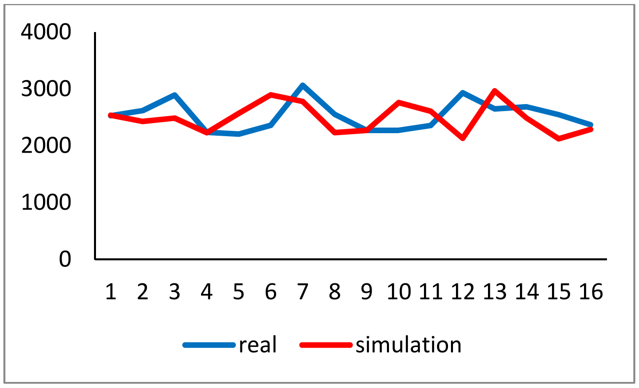

Fig. 5 Comparison Chart of Real and Simulation Returns

C. Model Validation

In order for a model that can represent the real system is built to the extent necessary and in accordance with the purpose of modeling studies must be validated on a model that has been created. Validation is done by testing a model of behavior compared with behavior that may occur in real systems

In this study, using statistical validation including: Test the equality of two - average, Test the equality of two variances and chi square test. And the results show valid as the table below:

TABLE 3
VALIDATION RESULTS

No	Method	DATA	
		Circulation	Returns
1	Test equality of two average	VALID	VALID
2	Test equality of two variance	VALID	VALID
3	Chi square test	VALID	VALID

D. Experimental Design

In this case, changes may be made to the initial model, among others:

1. Design policies the amount of circulation based on advertising and news quality.
2. Selling returns newspapers at half price
3. Lowering the percentage of total circulation
4. Lowering the percentage of total newspaper circulation and sells returns with half-price

E. ANOVAs Test

To know the difference or variance of an opportunity lost is a significant between the initial models with the experimental design was made which will be applied by the company. Then the initial model and the four models need to be tested experimental design with analysis of variance (ANOVA). The conclusion is $F_{count} > F_{\alpha(v_1,v_2)}$, Then H_0 is rejected it means there is a difference - average at least one significant among the treatments. Thus, experimental design can be done.

F. Bonferroni Method

In the last step of this research is the selection of the best experimental design of four experimental design proposals which will be applied by the company in making policy in reducing the opportunity lost. The selection of this experimental design using the Bonferroni Method to choose the system that has the smallest Y_i accordance with minimization of the objective function that is an opportunity lost as the best system. And the system chosen is the design of 2th experiment which is to sell returns newspapers for half price which have the smallest value Y_i = 125,858.4.

VI. SIMULATION OUTPUT ANALYSIS

In this study, the simulation is run for two years i.e. from 2009 until 2011. From the resulting output can be used as reference to determine the mathematical relationship between each variable. It also can determine the appropriate policies to reduce the opportunity lost of copies to be printed a few months future.

Analysis of initial model showed that the percentage increase in the value of an opportunity lost a little more than the percentage decline. Average opportunity lost in the initial model of IDR.3,758,865.00 For the classification of good news happening on June, July, August, 2009, January and April 2010. For advertisement classification, the most common advertisement is in July 2009 and April 2010. Total circulation is directly linear to the number of copies sold and the number of demands from agents using a consignment system that is most common in June, July, August, 2009 and April 2010. Returns provided by most agents in March, July and December 2009. Customers in time series has increased each month from January 2009 until July 2009, but then declined until November 2009 and March 2010.

In the first experiment design, graphic comparison between the results of the prediction with the simulation results show the similarity, so the company can make a reference design experiment to determine the amount of circulation per - day basis average opportunity lost is IDR 3,422,162,00 If this experimental design is applied, it can reduce the opportunity lost IDR. 336,703.00 The first experiment can be 4th priority based on selection bonferroni method.

In the second experiment, average opportunity lost is IDR. 3,113,809.00 If this experimental design is applied, it can reduce the opportunity lost IDR. 645,056.00 In this second experiment design is a design that has an opportunity lost for at least the company are advised to choose this design as a priority based on the Bonferroni Method. If the second experimental design was applied for the future has been

ISBN : 978-602-97809-0-1

foreseen or in accordance with the self-replicating, companies can reduce an opportunity lost average of IDR. 2,819,193.00

In the third experiment design, graphic comparison between the results of the prediction with the simulation results show the similarity, so the company can make a reference 3rd design experiments to determine the amount of circulation per - day basis – average opportunity lost is IDR. 3,470,190.00 If this experimental design is applied, it can reduce the opportunity lost of IDR. 288,675.00 This third experiment design can be used as priority number three based on the selection of the best experimental design using bonferroni method

In the fourth experiment design, graphic comparison between the results of the prediction with the simulation results show the similarity, so the company can make a reference 4^{th} design experiments to determine the amount of circulation per - day basis average opportunity lost is IDR. 3,112,050.00 If this experimental design is applied, it can reduce the opportunity lost of IDR. 646815,-. This fourth experiment design can be used as priority number two based on the selection of the best experimental design using bonferroni method.

VII. CONCLUSIONS AND SUGGESTIONS

A. *Conclusions*

Based on data processing and discussion that has been done, then some conclusions can be drawn include the following:

1. The appropriate policy strategies to reduce opportunity lost is to adopt a policy of selling the returns newspaper with half the price of IDR. 600.00
2. Decrease in opportunity lost if the company obtained by applying the policy to sell the returns newspapers with half the price of IDR. 645,056.00 per day

B. *Suggestions*

From the above conclusions, the suggestions can be submitted are as follows:

1. Companies can apply the new policy is to sell returns newspapers with half-price as a 1^{st} priority
2. Other policies that could be used to consider include reducing the supply for each agent a maximum of four copies per agent, designing policies based on advertising and news quality as well as merger from sell returns newspaper with half-price and reducing the supply for each agent a maximum of four copies per agent.
3. Recommendations for future research is to analyze the company's cash flow that comes with the main revenue comes from advertising, promotion and salaries of employees to know the profits that the company so that have more representative model.

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ISBN : 978-602-97809-0-1

Designing a mathematical model for dynamic cellular manufacturingsystems with route selection and purchasing machines

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Abstract - **This paper presents a novel integer non-linear programming model for the layout design of dynamic cellular manufacturing systems. The proposed model incorporates several design features including intracell layout, operation sequence, operation time, alternative process routings, duplicate machines, purchase machine, machine capacity, route selection, production volume of parts, part movements in batch and cell reconfiguration. The objective is to minimize the total costs of intercellular material handling, forward and backward intracellular material handling, setting up route, machine relocation, purchasing new machines, machine overhead and machine processing. A comprehensive numerical example is solved by the Lingo software to verify the performance of the proposed model.**

Keywords - **Dynamic cellular manufacturing; Intracell layout; Route selection; Alternative process routings**

I. INTRODUCTION

Cellular manufacturing (CM), an innovative manufacturing strategy derived from group technology concept, is an approach that can be used to improve both flexibility and efficiency in today's modern competitive manufacturing environments such as flexible manufacturing systems (FMS) and just-in-time (JIT) production. Researchers have listed the following benefits of CM implementation: setup time reduction, work-in-process inventory reduction, material handling cost reduction, machine utilization improvement and quality improvement [1,2]. An increasingly significant issue in CM is shorter product life cycles. Ignoring the new products incoming at the future would impose subsequent unplanned changes to the CMS and cause production disruptions and unexpected costs. Hence the product life cycle changes should be incorporated in the design of cells. This type of model is called the dynamic cellular manufacturing system (DCMS) [3]. A process plan refers to a list of the operations necessitated in order to transform raw materials into completed parts, along with the precedence necessities between those operations. Also, a process route refers to a sequence of specific machines that a part should flow through them to complete its processing, as required by the process plan [4]. Multiple process routes would be present for a known process plan of a part if one or more of the operations of that part can be processed on alternate machines (either different type or identical ones) physically located at the different locations of cells (either different cells or same cell). Consequently, the advantages of incorporating alternative process routing in CMS design can be summarized as follows: lower capital investment in machines, more independent manufacturing cells, enhanced throughput rate and higher machine utilization. Available time-capacity of machines need to be enough to satisfy the production volume required by part demand in CMS design. The exact number of machines required to process the parts has to be predetermined before solving the CM problem [5].

Rheault et al. [3] nominated the cell formation problem in dynamic environment as the DCMS. Akturk and Turkcan [6] solved the part-family and machine-cell formation problems along with the intracell layout problem simultaneously. Their proposed approach has an advantage of considering features such as production volumes, processing times, operation sequences and alternative routes. Mungwattana [7] proposed a mathematical model and a solution approach for designing cellular manufacturing systems under dynamic and stochastic production environment employing routing flexibility. Solimanpur et al. [8] constructed a multi-objective integer programming model for the design of cellular manufacturing systems with independent cells. The proposed comprehensive mathematical model considers several features such as: machine requirements, processing costs, processing times, sequence of operations, investment in the purchase of machines, multiple process plans, production volumes, capacity of machines, etc. Nsakanda et al. [4] presented a comprehensive model for designing a cellular manufacturing system with combining the cell formation problem, the machine allocation problem and the part routing problem by considering multiple process plans for each part. Saidi-Mehrabad and Safaei [9] presented the dynamic cell formation model in which the number of formed cells at each period can be different with the objective of minimization of machine cost, relocation and the intercell movement costs. Defersha and Chen [10] developed a dynamic cell formation problem incorporating several design factors such as: cell reconfiguration, alternative routings, sequence of operations, duplicate machines, machine capacity, workload balancing, production cost as well as other realistic constraints. Tavakkoli-Moghaddam et al. [11] presented an integer-linear programming model for a dynamic cell formation problem with alternative routing. The objective of the proposed model is to minimize the sum of the intercell movement costs and machine costs, simultaneously. Ahkioon et al. [12] formulated the integrated approach to CMS design as the mixed integer non-linear programming model incorporating production planning and system reconfiguration decisions with the presence of alternate process routings, operation sequence, duplicate machines, machine capacity and lot splitting. Safaei and Tavakkoli-Moghaddam [13] integrated the multi-period cell formation and production planning in a dynamic cellular manufacturing system with the aim of minimizing machine, inter/intra-cell movement, reconfiguration, subcontracting, and inventory holding costs. Ahi et al. [14] applied the multiple attribute decision making (MADM) concepts and proposed a two-stage method to determine cell formation, intracellular machine layout and cell layout as three fundamental features in the design of CMS.

The aim of this paper is to present a new mathematical model with an extensive coverage of important manufacturing features including intracell layout, operation sequence, operation time, alternative process routing, route selection, duplicate machines, machine capacity, returning and removing machines, production volume of parts, part movements in batch and cell reconfiguration.

II. Mathematical model and problem descriptions

In this section, the integrated problem is formulated under the following assumptions:

1. Each part type has one or more processing routes (alternative process routings) of which at most one route can be set up to produce that part type in each period.
2. In each route of a part, several operations are processed on different machines based on a given sequence.
3. The processing times for all operations of each part type on different machine types are known and deterministic.
4. The demand for each part type in each period is known and deterministic.
5. Parts are transferred between and within cells. Intercellular movement happens whenever successive operations of a part type are carried out in different cells. Also, the intracellular movement happens whenever successive operations of a part type are processed on different machines in the same cell. Moreover, in the manufacturing systems with straight line type layout, the backward movement acquires more expenses than forward movement. Hence, we also consider that backward movement cost for each part type is greater than forward movement cost.
6. All machine types of equal dimension should be located in the locations of cells with straight line type layout.
7. Parts are moved between cells and within cells in a batch. Intercell and intracell movements related to each part type have different batch size and different costs.
8. Machines should be placed in the locations whose distance from each other is known in advance and therefore the distance matrix of locations in a given cell k, $D=[d_{uu'k}]$, is known in which $d_{uu'k}$ represents the distance between locations u and u' of cell $k\left(u,u'=1,...,U_k\right)$. Furthermore, to calculate the intercell movement distance, the distance between cells is derived from the distance matrix of cells , $D=[d_{kk'}]$, in which $d_{kk'}$ represents the distance between cells k and k' $(k,k'=1...,C)$.
9. In each period that there is surplus capacity, we can remove idle machines from the system to decrease the maintenance cost and provide empty locations in cells and whenever it's necessary to increase the machine capacity of system, we can return those machines to the system.
10. Each machine type has a limited capacity expressed in hours during each time period and constant over the planning horizon.
11. Machines can have one or more identical duplicates to satisfy capacity requirements and reduce/eliminate intercell movements.
12. The relocation cost of each machine type between two periods is known. Even if machine is removed from or retuned to the system, this relocation cost is incurred. All machine types can be moved to any location in the system. This cost is paid for several situations: to install a new purchased or returned machine in a given location, to uninstall a removed machine and to transfer a machine between two locations.
13. The constant cost of each machine type is known and implies maintenance and other overhead costs such as energy cost and general service. This cost is also considered for each machine in each period if that machine is utilized on the system to process parts. So the idle machines removed from the system don't impose that constant cost.
14. Operating cost of each machine type is dependent on the workload allocated to the machine.
15. The number of cells is known.

A. Model formulation

Sets:

t index set of periods ($t=1,2,...,T$)
i index set of part types ($i=1, 2, \ldots, P$)
r index set of routes of part i ($r=1,2,...,R_i$)
s index set of operations of part type i in route r ($s=1, 2, \ldots, S_{ri}$)
j index set of machine types ($j=1,2...,M$)
k index set of cells ($k=1, 2, \ldots, C$)
u index set of locations of machines in cell k ($u=1, 2, \ldots, U_k$)

Parameters

γ_i^{inter} Material handling cost between cells per part type i per batch size.
$\gamma_{fi}^{\text{intra}}$ Forward material handling cost within cells per part type i per batch size.
$\gamma_{bi}^{\text{intra}}$ Backward material handling cost within cells per part type i per batch size.
α_j Maintenance and overhead cost of machine type j.
γ_j Purchase cost of machine type j.
δ_j Relocation cost of machine type j.
β_j Operating cost per machine type j per unit time.
ϕ_{ri} Set up cost to route r of parte i.
λ_{sirj} Processing time of operation s of part i along route r with machine j.
T_j Capacity of one machine type j available per period
$D_i(t)$ Demand for part type i in period t.
B_i^{inter} Batch size for intercell movement of part type i.
B_i^{intra} Batch size for intracell movement of part type i.
L_k Lower bound of the number of machines in cell k.
$d_{uu'k}$ Distance between locations u and u' in cell k.
$d_{kk'}$ Distance between cells k and k'.
A: large positive number.
a_{srij} 1 if operation s of part i along route r must be processed on machine type j, 0 otherwise.

Decision variables:

$X_{srijuk}(t)$ 1 if operation s of part type i along route r is processed on machine type j assigned to location u of cell k during period t, 0 otherwise.
$Z_{juk}(t)$ 1 if machine type j is located in location u of cell k during period t, 0 otherwise.
$N_j^{+}(t)$ Number of machine type j returned to system in period t.
$N_j^{-}(t)$ Number of machine type j removed from system in period t.
$N_j^{P}(t)$ Number of machine type j purchased in period t.
$R_{ir}(t)$ 1 if route r is set up to produce part type i in period t, 0 otherwise.

Objective function:
Minimize

$$\sum_{t=1}^{T}\sum_{i=1}^{P}\sum_{r=1}^{R_i}\sum_{k=1}^{C}\sum_{k'=1}^{C}\sum_{u=1}^{U_k}\sum_{u'=1}^{U_k}\sum_{s=1}^{S_{ri}-1}\sum_{j=1}^{M}\sum_{j'=1}^{M} \left\lceil \frac{D_i(t)}{B_i^{\text{inter}}} \right\rceil \gamma_i^{\text{inter}} d_{kk'} X_{srijuk}(t)\, X_{\substack{s+1,rij'u'k'\\ k\neq k'}}(t) \tag{1.1}$$

$$+\sum_{t=1}^{T}\sum_{k=1}^{C}\sum_{k'=1}^{C}\sum_{u=1}^{U_k}\sum_{u'=u+1}^{U_k}\sum_{i=1}^{P}\sum_{r=1}^{R_i}\sum_{s=1}^{S_{ri}-1}\sum_{j=1}^{M}\sum_{j'=1}^{M} \left\lceil \frac{D_i(t)}{B_i^{\text{intra}}} \right\rceil \gamma_{fi}^{\text{intra}} d_{uu'k} X_{srijuk}(t)\, X_{\substack{s+1,rij'u'k'\\ k=k'}}(t) \tag{1.2}$$

$$+\sum_{t=1}^{T}\sum_{k=1}^{C}\sum_{k'=1}^{C}\sum_{u'=1}^{U_k}\sum_{u=u'+1}^{U_k}\sum_{i=1}^{P}\sum_{r=1}^{R_i}\sum_{s=1}^{S_{ri}-1}\sum_{j=1}^{M}\sum_{j'=1}^{M} \left\lceil \frac{D_i(t)}{B_i^{\text{intra}}} \right\rceil \gamma_{bi}^{\text{intra}} d_{uu'k} X_{srijuk}(t)\, X_{\substack{s+1,rij'u'k'\\ k=k'}}(t) \tag{1.3}$$

$$+\sum_{t=1}^{T}\sum_{k=1}^{C}\sum_{j=1}^{M}\sum_{u=1}^{U_k} \alpha_j Z_{juk}(t) \tag{1.4}$$

$$+\sum_{t=1}^{T}\sum_{j=1}^{M} \gamma_j N_j^{P}(t) \tag{1.5}$$

$$+\sum_{k=1}^{C}\sum_{u=1}^{U_k}\sum_{j=1}^{M} \delta_j Z_{juk}(1) + \frac{1}{2}\times\sum_{t=2}^{T}\sum_{k=1}^{C}\sum_{u=1}^{U_k}\sum_{j=1}^{M} \delta_j \left| Z_{juk}(t) - Z_{juk}(t-1) \right| \tag{1.6}$$

$$+\sum_{t=1}^{T}\sum_{k=1}^{C}\sum_{u=1}^{U_k}\sum_{r=1}^{R_i}\sum_{i=1}^{P}\sum_{s=1}^{S_{ri}}\sum_{j=1}^{M} \beta_j \lambda_{sirj} X_{srijuk}(t) D_i(t) \tag{1.7}$$

$$+\sum_{t=1}^{T}\sum_{r=1}^{R_i}\sum_{i=1}^{P} \phi_{ri} R_{ir}(t) \tag{1.8}$$

Constraints:

$$D_i(t) \leq A \times \sum_{r=1}^{R_i} R_{ir}(t) \qquad \forall i,t \tag{2}$$

$$\sum_{r=1}^{R_i} R_{ir}(t) \leq 1 \qquad \forall i,t \tag{3}$$

$$X_{srijuk}(t) \leq Z_{juk}(t) \qquad \forall s,r,i,j,u,k,t \tag{4}$$

$$\sum_{k=1}^{C}\sum_{j=1}^{M}\sum_{u=1}^{U_k} X_{srijuk}(t) = R_{ir}(t) \qquad \forall s,r,i,t \tag{5}$$

$$X_{srijuk}(t) \leq a_{srij} \qquad \forall s,r,i,j,u,k,t \tag{6}$$

$$\sum_{k=1}^{C}\sum_{u=1}^{U_k} Z_{juk}(t) = \sum_{k=1}^{C}\sum_{u=1}^{U_k} Z_{juk}(t-1) + N_j^{P}(t) - N_j^{-}(t) + N_j^{+}(t) \qquad \forall j,t \tag{7}$$

$$N_j^{+}(t) \leq \sum_{t=2}^{t-1} N_j^{-}(t) - \sum_{t=3}^{t-1} N_j^{+}(t) \qquad \forall j, t=3,..,T \tag{8}$$

$$\sum_{j=1}^{M} Z_{juk}(t) \leq 1 \qquad \forall u,k,t \tag{9}$$

$$\sum_{j=1}^{M}\sum_{u=1}^{U_k} Z_{juk}(t) \geq L_k \qquad \forall k,t \qquad (10)$$

$$\sum_{r=1}^{R_i}\sum_{i=1}^{P}\sum_{s=1}^{S_{ri}} \lambda_{sirj} X_{srijuk}(t) D_i(t) \leq T_j \qquad \forall j,u,k,t \qquad (11)$$

$$N_j^P(t), N_j^+(t), N_j^-(t) \geq 0 \text{ and integer} \qquad \forall j,t \qquad (12)$$

$$X_{srijuk}(t) \in \{0,1\} \qquad \forall s,r,i,j,u,k,t \qquad (13)$$

$$Z_{juk}(t) \in \{0,1\} \qquad \forall u,j,k,t \qquad (14)$$

$$R_{ir}(t) \in \{0,1\} \qquad \forall i,r,t \qquad (15)$$

The objective function consists of eight cost ingredients. The first term denotes the intercellular material handling cost. This cost is incurred whenever consecutive operations of the same part type are transferred between different cells. The product $X_{srijuk}(t) X_{s+1,rij'u'k'}(t)$ in term (1.1) is to verify whether two consecutive operations *s* and *s+1* of part *i* is processed on machines of types *j* and *j'* assigned to locations *u* and *u'* of cells *k* and *k'*, respectively. If the product reflects 1 as the result, then those machine are in different cells and the material flow between them impose intercellular material handling cost. The second term of the objective function represents the forward intracellular material handling cost. This cost is sustained whenever consecutive operations of the same part type are processed in a same cell but on machine types *j* and *j'* assigned to different locations *u* and *u'* where these two locations are arranged in forward direction in a straight line type layout. The third term of the objective function represents the backward intracellular material handling cost. This cost is sustained whenever consecutive operations of the same part type are processed in the same cell but on machine types *j* and *j'* assigned to different locations *u* and *u'*, where these two locations are arranged in backward direction in a straight line type layout. Term (1.4) denotes the maintenance and overhead costs of the machines utilized in all cells over the planning horizon. Term (1.5) is the purchase cost of new machines to be added to the available machines to eliminate capacity shortage arising due to high level of parts demand. Purchasing new machines results in increasing of the number of available machines which can be utilized to produce higher volume of part demands. Term (1.6) represents the cost of reconfiguration of cells occurring in these cases: (1) installing a new purchased machine or an old machine to be returned in a location of the system, (2) uninstalling a machine to be removed from the system and (3) swapping two existing machines between two locations, called machine relocation. The component $\left|Z_{juk}(t) - Z_{juk}(t-1)\right|$ in Term (1.6) quests whether machine type *j* assigned to location *u* at cell *k* in period (*t-1*) remains in that same location of same cell for subsequent period, (*t*), or not. Equaling term $\left|Z_{juk}(t) - Z_{juk}(t-1)\right|$ to 1 results a relocation cost. Terms (1.7) and (1.8) represent the machine operating cost and route setup cost, respectively.

Equations (2) and (3) ensure that one part type is produced in one period if a route is established in order to produce that part type and only one route can be established for each part type in each period, respectively. Inequality (4) guarantees that if a machine type *j* is located in location *u* of cell *k* , then the operation *s* of part type *i* along the chosen route *r* can be processed on the machine type *j* existing in that location. Equations (5) and (6) ensure that if route *r* is established in order to produce the part type *i*, then the operation *s* of the part type *i* along the chosen route *r* should be assigned to only one machine type *j* enable to process that operation. Equation (7) describes that the number of machine type *j* utilized in the period *t* is equal to number of utilized machines of the same type in the previous period plus the number of new machines of the same type purchased at the beginning of the current period, plus the number of machines of the same type returned to the system or minus the number of machines of the same type removed from the system at the beginning of the current period. Inequality (8) ensures that the number of machine type *j* returned at the beginning of period *t* not exceed from the number of machine type *j* available in order to return to the system.. Inequality (9) ensures that each location in each cell can receive only one machine. Lower bound on the cell size specified by designer is enforced with inequality (10). Inequality (11) ensures that capacity limitation of each machine is satisfied.

B. Linearization

The proposed model is a nonlinear mixed-integer programming model because of the existence of multiple variables in Equations (1.1) - (1.3) and the absolute term in the Equation (1.6) in the objective function.

To linearize this term $X_{srijuk}(t) X_{s+1,rij'u'k'}(t)$ in the objective function, we need to introduce one auxiliary variable to replace this nonlinear term with additional constraints. The required variable can be defined by the following equations:

$$P_{srijj'uu'kk'}(t) = X_{srijuk}(t) X_{s+1,rij'u'k'}(t)$$

By considering the above equation, following constraints should be added to the mathematical model:

$$P_{srijj'uu'kk'}(t) \geq X_{srijuk}(t) + X_{s+1,rij'u'k'}(t) - 1$$
$$\forall s = 1..S_{ri-1}, r, i, j, j', u, u', k, k', t \qquad (16)$$

$$P_{srijj'uu'kk'}(t) \in \{0,1\} \qquad \forall s = 1..S_{ri-1}, r, i, j, j', u, u', k, k', t \quad (17)$$

The nonlinear term of the equation (1.6) can be linearized by considering bellow equation, where the following constraints must be added to the original model.

$$\left|Z_{juk}(t) - Z_{juk}(t-1)\right| = ZB_{juk}(t) + ZD_{juk}(t-1)$$

$$Z_{juk}(t) - Z_{juk}(t-1) = ZB_{juk}(t) - ZD_{juk}(t-1)$$

ISBN : 978-602-97809-0-1

$$\forall\ j,u,k,t \quad (18)$$

$$ZB_{juk}(t), ZD_{juk}(t) \in \{0,1\} \qquad \forall\ j,u,k,t \quad (19)$$

III. Comprehensive Numerical Example

To verify the proposed model and illustrate its various features, one small-sized example inspired from the literature data are solved by branch and bound (B&B) method under Lingo 8.0 software on an Intel® Core™2 GHz Personal Computer with 2 GB RAM.

The information related to the example is given in Tables 1, 2 and 3. This example consists of five part types, five machine types and three periods in which each part type is assumed to have two alternative processing routes. In each route, there are three operations to be processed sequentially. Table 1 contains the information related to machine time capacity, operating cost, overhead cost, machine relocation cost and purchasing machine cost. Table 2 shows the operation sequence in each route of a part, route setup cost, intercell and intracell batch size, part demand in each period and material handling cost (forward/backward intracell and intercell). The machines are to be grouped into two cells with lower size of 1. The distance between the locations of a cell is shown in Table 3. Also, the distance between two cells is assumed equal to 40 distance units.

TABLE I. MACHINE INFORMATION FOR THE FIRST EXAMPLE

Machine type	α_j	β_j	δ_j	γ_j	T_j
1	300	8	90	30000	700
2	500	7	110	32000	700
3	400	5	100	34000	700
4	300	6	80	35000	700
5	500	7	120	35000	700

The optimal cell configuration of the example for three periods based on the proposed model and the related objective function value are shown in Fig 1 and Table 4, respectively. The parts assigned to the cells, the routings selected for the parts and the machines located in the cells can be seen in Fig. 1.

TABLE II. PART INFORMATION FOR THE FIRST EXAMPLE

Part	Route	Operation sequence	ϕ_{ri}	B_i^{inter}	B_i^{intra}	$D_i(1)$	$D_i(2)$	$D_i(3)$	γ_i^{inter}	γ_{fi}^{intra}	γ_{bi}^{intra}
1	1	1(3,0.73),2(2,0.49),3(4,0.46)	1100	35	7	300	400	200	35	5	9
	2	1(5,0.54),2(4,0.63),3(3,0.44)	1100								
2	1	1(1,0.76),2(1,0.65),3(1,0.39)	1800	25	5	350	150	0	20	4	9
	2	1(4,0.8),2(1,0.65),3(5,0.93)	1890								
3	1	1(2,0.99),2(3,0.57),3(1,0.46)	1200	20	4	200	250	300	25	5	11
	2	1(4,0.14),2(3,0.57),3(2,0.33)	1300								
4	1	1(1,0.49),2(3,0.67),3(2,0.74)	1200	24	3	0	250	200	30	7	13
	2	1(4,0.45),2(5,0.67),3(5,0.62)	1000								
5	1	1(2,0.4),2(4,0.26),3(3,0.59)	1300	28	6	400	350	150	27	10	15
	2	1(5,0.12),2(2,0.4),3(3,0.59)	1500								

TABLE III. THE LOCATION DISTANCE IN A CELL FOR THE FIRST EXAMPLE

Location	1	2	3	4
1	-	2	4	6
2	2	-	2	4
3	4	2	-	2
4	6	4	2	-

By investigating the optimal cell configurations, we can see that in the fist period one quantity of machine types 1, 2, 3 and 4 should be purchased. To increase machine capacity and satisfy extra part demands, one quantity of machine type 5 is purchased at the beginning of the second period. In the third period, machine type 1 is removed from the system to decrease maintenance cost and provide empty location accommodating new machine. The route selected by a part is also presented in the cell configuration in each period. No route is set up to produce part type 2 in the period 3 because of there is no demand for that part type. Adding machine type 5 in location 2 of cell 1 and removing machine type 1 from location 1 of cell 1 result in relocation cost. In the first period, processing all operations of part type 2 on machine type 1 located in location 1 of cell 1 incurs no material handling cost, because of there is no movement between machines. In the first period, processing the operations 1 and 2 of part type 5 on machine types 2 and 4 located in locations 1 and 2 of cell 2 results in a forward intracell movement. Similarly, in the second period, processing the operations 2 and 3 of part type 3 on machine types 3 and 2 located in locations 3 and 1 of cell 2 respectively, results in a backward intracell movement. In the third period, processing the operations 1 and 2 of part type 4 on machine types 4 and 5 located in cells 2 and 1 respectively, results in a intercell movement.

			C1	C2		
			P2(R_1)	P1(R_1)	P3(R_2)	P5(R_1)
C1	U1	M1	1,2,3			
	U1	M2		2	3	1
C2	U2	M4		3	1	2
	U3	M3		1	2	3

a. Period one

			C1		C2			
			P2(R_1)	P4(R_1)	P1(R_1)	P3(R_2)	P4(R_2)	P5(R_1)
C1	U1	M1	1,2,3					
	U2	M5		2,3				
	U1	M2			2	3		1
C2	U2	M4			3	1	1	2
	U3	M3			1	2		3

b. Period two

			C1	C2			
			P4(R_1)	P1(R_1)	P3(R_2)	P4(R_2)	P5(R_1)
C1	U2	M5	2,3				
	U1	M2		2	3		1
C2	U2	M4		3	1	1	2
	U3	M3		1	2		3

c. Period three

Figure 1. Optimal cell configurations for the first example

TABLE. IV. OBJECTIVE FUNCTION VALUE AND RELATED CONSTITUENTS FOR THE FIRST EXAMPLE

Total costs	**Machine overhead**	**Purchasing machine**	**Machine operating**	**Machine relocation**	**Inter-cell movements**	**Forward intra-cell movements**	**Backward intra-cell movements**	**Route setup**
263580	5200	166000	31318	590	21600	9220	12952	16700

IV. CONCLUSIONS AND FURTHER RESEARCH

This paper presents a novel integer non-linear programming model for the layout design of dynamic cellular manufacturing systems in the presence of alternative process routings. The excellent advantages of the proposed model are as follows: (1) reconfiguration cost is calculated in terms of machine relocation and this cost is happened even if a machine is relocated between two different locations of a cell, (2) calculation of intracell and intercell material handling cost is done based on the distance between the locations assigned to machines, (3) intracell movement can occur between two machines of a same type on different locations of a cell, (4) the concept of removing and returning machines is introduced by considering a machine depot where idle machines are placed and can be returned to the system whenever it's necessary to increase the machine capacity, (5) overhead cost is paid only for utilized machines in a period and the idle machines placed in the machine depot don't impose that cost. The proposed model is still open for incorporating other features such as holding inventory between periods, partial or total subcontracting, workload balancing among the cells, cell profit, machine utilization, machine closeness, unequal area facilities and like that suggested for future research. Moreover, it is necessary to develop a heuristic or metaheuristic approach to solve the proposed model for large-sized problems.

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

The Development of Computer Simulation and Modeling Approach for Sustainable Energy System: A Critical Study of National Electricity Sector

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***Abstract* – Energy Systems modeling is a major area in the Global Sustainable Energy policy studies. Systems Modeling and Computer Simulation has become one the common approaches used in energy systems planning and evaluation in many condition. On the other hand, the national energy system in Indonesia, particularly in electricity sector, is not achieves the ideal conditions yet this present time. This paper aims to explain the development of shared modeling approaches and computer simulation techniques in Energy Systems studies. In addition, this paper also described the typical characteristics of energy and electricity systems in Indonesia and the recommendations of the ideal type of modeling approach for the Indonesian national electricity system.**

***Keywords* – Energy System Modeling, Computer Simulation, Electricity Sector, Indonesia**

I. INTRODUCTION

As has been widely recognized, the problem of planning and evaluating sustainable energy systems is very important issue and become the focus in the international communities. Indonesia, as a big archipelago and large populated country should be able to design a sustainable energy policy. Electricity/Power sector is one of the important national energy sectors in Indonesia, which still requires special attention in order to achieve ideal conditions.

Meanwhile, to analyze the complex behavior and characteristic of energy and electricity systems required a model that can be representatively modeled the behavior and interaction of each system elements.

This paper consist of five sections various descriptions which aims to enrich knowledge about the development of various modeling approaches and applications of computer simulation in the global energy system studies, especially the electricity system in Indonesia.

This paper is started with **section one** which is general introduction and explanation of the purpose of the paper. Next, **section two** provides background on the condition of the global energy system and electricity sector in Indonesia. This section also gives an overview of various energy systems modeling approach that is currently used and some of its weaknesses. In addition, this section also presents the development of the system modeling and Computer Simulation scope in the field in Industrial Engineering science, After that, **section three** describes the development of various research and studies have been conducted both in the field of Global Energy Systems and in the electricity sector in Indonesia. Meanwhile, **section four** describes theoretical framework of the ideal model for energy systems, especially in the electricity sector in Indonesia and followed by whole paper conclusions in **section five**.

II. ENVIRONMENTAL BACKGROUND

As being widely recognized, the current world is facing serious problems of global energy, particularly in electrical sector. McCoy [21] reported at the meeting of the world's electrical energy producers in Evian France in 2006, the biggest problem today of the world's electricity sector is the imbalance between the level of electrical energy production and the level of world electricity consumption. Economic developments that occurred in a large part of the world's countries have made electricity consumption rose sharply and began cannot be met by a large part of electricity producers which are still rely on energy sources from fossil fuels.

Another problem faced by the world's electricity sector is the energy supply sources. More than 70% of the world electrical energy generated from the transformation comes from Fossil Fuels and other mining or oil materials (oil, gas, coal, etc.) which its production rates has been decreased in the last several decades[18].

Meanwhile, Cimino et al [2] suggested, another main problems in the electricity sector is in the distribution side. The imbalance between the distribution capacity, production capacity, and the level of demand, coupled with problems of reliability and distribution mechanisms ultimately lead to the blackout and the uneven condition of electricity distribution in certain area / country.

A. Electricity System Condition in Indonesia

Several studies of Indonesian Electricity System obtained a preliminary conclusion that the conditions of the National Electricity also was having problems as complex as

ISBN : 978-602-97809-0-1

that exist in the world today. Power shortage in some areas was significantly felt by many communities. Since 2001, there were at least 24 regions spread across all provinces experiencing power shortage. From about 66.200 villages in Indonesia, it turns out that getting 79% of new electricity supply from National Electricity Producers/PLN [32]. On the other hand, Kusdiana [13] reported that up to now electrification ratio - average in Indonesia still in the range of 65%, which means there are about 35% of the families who have not had access to electric energy directly.

Furthermore, until the year 2008/2009, as happened in the world, the national energy supply is still very dependent on fossil fuels. Ministry of Energy and Mineral Resources [4], in the blueprint document of The Development of New and Renewable Energy and Energy Conservation, elaborates that till now the Provision and Utilization System of National Energy (SIPPENNAS) are still very dependent on fossil fuels (95.9%), consisting of: oil (48.4%), gas (28.6%) and coal (18 8%) which is a source of greenhouse gases. On the other hand the energy consumption continued to increase up to 7% each year, but in other hands, Indonesian fossil fuel resources and oil reserves experience a significant decline since the era of the 80s [17].

Figure 1 below provides an illustration that the existing energy mix currently not ideal while in the year 2025 are expected to use fuel oil (BBM) as a source of energy is much reduced, while new and renewable energy sources / EBT is expected to keep rising.

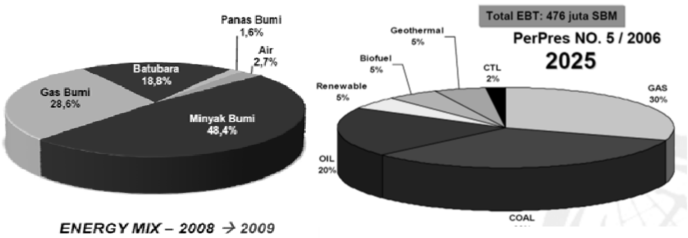

Fig. 1 Comparison of the energy mix in 2008/2009 (Left) and targets of the national energy mix is expected in the year 2025 (Right) Adopted from [4] and [3].

The third problem is the high electricity subsidy [3]. In 2006 government spending Rp. 32.2 trillion on subsidies and continue to increase, much improved compared to previous years which are Rp. 8.85 trillion in 2005, Rp. 3.3 trillion in 2004 and Rp 3.36 trillion in 2003. National Research Council [6], said that electricity prices are subsidized cause electricity price will lie below the economic value / market price, thus balancing supply and demand will experience a change in the value of equilibrium that causes the demand for electricity continues to increase significantly, which, if not followed by growth in energy supply will cause any significant power shortage.

Another problem which is also the main problems in the electricity sector in Indonesia is a problem in the electrical distribution on the user side. Energy loses that reached 11.5% and low network reliability have made the transformation efficiency of primary energy to final energy is only about 65% which means 35% of electrical energy in Indonesia is lost in the distribution phase of the plant to the users [4].

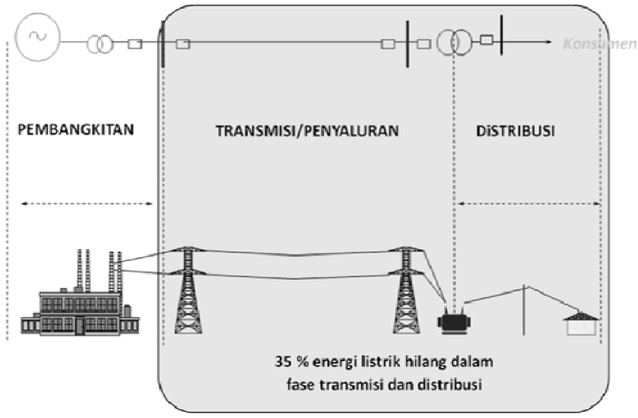

Fig. 2. Illustration of the problem of electricity transmission and distribution efficiency [37].

In addition to the problem above, the National Energy Board [5], has submitted the other major issues in national energy systems are as follows:

1) Foreign exchange earnings from the energy sector to energy sector development are still low.
2) Protection / preservation of the environment are still not a priority.
3) The existence of long-term plan of national energy policy as stated in:
   - National Act No. 20 / 2002 on Electricity
   - Decree of the Minister of Energy and Mineral Resources No. 2270 K/31/MEM/2006 on the National Electricity General Plan 2006-2026
   - Regulation of the President of the Republic of Indonesia No. 5 / 2006 on National Energy Policy.

From the description above, we can conclude it is still a lot of crucial issues in the national energy system, especially in the Electricity sector, which has not been completed despite many efforts and policies have been made by the stakeholders. On the other hand, it cannot be denied that the electrical energy sector is a complex system with many variables that will provide a high level of difficulty to be able to observe and perform *what-if analysis* of the policies made.

On many occasions, as will be explained later in this paper, the presence of an energy system model, including electric power system model has long been used by stakeholders in the field of energy and electricity to assist the process of decision making and planning of energy systems. They hope these are representative to model the complexities of energy and electricity systems.

B. Limitation of the existing Energy Planning Model.

Energy planning *models* have been developed since last 3 decades with different approaches. Nevertheless, most of these models are the energy planning model based on supply and demand forecasting on energy. Here are some of the energy planning models based on those projections on the principles of energy forecasting demand and supply:

1) BERR (British Energy Review Report) is an energy planning model in the UK based on the medium-term energy demand forecasting [35].
2) Model for Analysis of Energy Demand (MAED) is a forecasting model based on energy requirements of socio-economic aspects and demographics of a country [10].
3) WASP Model (Package Wien Automatic System Planning), is a model to forecast the needs of energy supply in the country - a developing country [10].
4) MARKAL Model (Market allocation) is a model of energy demand projections made by market with the concept of Linear Programming. This model is often compared with the macro model (macroeconomics) that predicted economic growth and the DEMO model (Demographic) to represent the population growth. The development of the three models which are based on linear programming is then a known as DEMI Model (Energy Demand Models for Indonesia). DEMI model is trying to compute the final energy needs with consideration of market factors, population growth, and economic growth, [30].
5) LEAP model (Long-range Energy Alternative Planning) is a model that projected energy supply based on those needs and Econometric Analysis [31].

All models above are based on projections or forecasts of the need for electricity supply, only the LEAP model that tried to simultaneously model demand-side factors and supply side of energy, while the rest is a model which are only considers one-sided forecasting modeling of supply or demand side, where BERR, MAED, and DEMI is a demand side forecasting model and WASP is a supply side forecasting model.

Another model often used as tools in energy planning is Econometrics. Harjono, [8] and Wahyuni, [36] suggested that Econometrics is energy forecasting model based on the development of regression and correlation methods. The main limitation of this model is more assumption required and less sensitive to existing assumptions changes. Gujarati [7] even requires at least there are eight assumptions required to establish an econometric model. In addition, because of regression methods based, the econometric model has not been able to describe interactions among the factors that affect the energy systems of the forecast.

Furthermore, Hendradata, [9] tried to simultaneously model several energy systems factor using a developed econometrics method, known as MIOTRINA. MIOTRINA is a hybrid model that combines the output adjustment approach (Marshallian adjustment) and the price adjustment (Walrasian adjustment) in reaching the point of balance. The interactions between factors have started to be modeled in this method; despite such feedback in the system behavior cannot be described clearly.

Next, the Leontief Input-Output Models have also frequently used for energy modeling because the ability of the model of showing a relationship among feedback and multiplier effect of each factor and sub-systems of the observed system. This model was created by Wassily Leontief [14] who drove him get nobel prize in 1973. Njoku, [22] extended that Input - Output model can be used to evaluate the energy sector in the certain country and also has been describe the links between energy sector, however the analysis tends to be static where it is good for evaluation, but not representative to perform prediction.

C. The Development of Energy System modeling in the Industrial Engineering Studies area.

System Modeling has become a specific part in industrial engineering science studies. Model is required when the system too complex to be observed directly. For that, a model is developed to describe the observed system with the simpler form and structure, but has a sufficient level of representation on the scope of the area that became the observation focus. [27].

On the other hand, Turner, et al [34] defines the scope of basic industrial engineering as follows:

> *"...Industrial Engineering is concerned with the **design, improvement**, and installation of **integrated systems** of people, **materials, information**, equipment, and **energy**. It draws upon specialized knowledge and skill in the mathematical, **physical, and social sciences** together with the principles and methods of engineering analysis and design to specify**, predict, and evaluate** the results to be obtained from such systems...".*

From the description above, it can be concluded that: The design and modeling aspects of an integrated system of materials, people, information, and energy that require knowledge on mathematical, physical, and social science to make projections and evaluation of the related system, is part of the Industrial Engineering Science Focus of study.

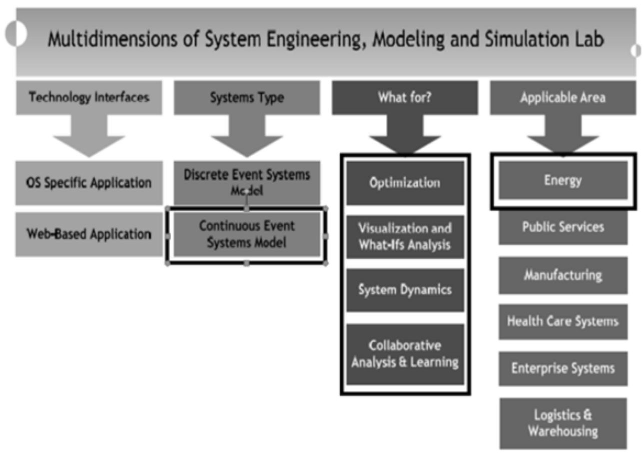

Figure 3.Portfolio Dimensional System Modeling and Simulation Studies [26].

SEMS Lab [26], explained that the study of systems modeling and simulation is consisting of multidimensional aspects. Each dimension consists of several conditions and different areas. At least there are the four dimensions considered in a study of modeling and simulation systems, namely: Aspects of Technology, System type observed objective observation system, and application area (Figure 3).

As seen in the image above, the energy sector, is a system with continuous event characteristics, is one of the main area of modeling and simulation studies application. The purpose of the system studies in this area usually include Optimization, Visualization and What if analysis (policy), dynamics system representation, and analysis and learning. Thus, a conclusion can be drawn that the Modeling and Simulation of Energy Systems in order to perform visualization of system dynamics, policy analysis, and scenario development in order to achieve better energy system is an important part and absolutely within the scope of Industrial Engineering Sciences.

The development of simulation modeling also suggested by Zuhdi, [38] which stated that the use of system dynamics modeling for energy planning has also been developed in last 2 decades which are focused on policy evaluation and strategic planning (Figure 4).

Effects of regulatory policy on utility performance	Geraghty and Lyneis (1983)
Effects of external agents on utility performance	Geraghty and Lyneis (1985)
Financial performance of utilities	Lyneis (1985)
Effects of energy conservation practices on utility performance	Ford, Bull and Naill (1989); Ford and Bull (1989); Aslam and Saeed (1995)
Regional strategic electricity/energy planning	Dyner et al. (1990)
National strategic electricity/energy planning	Coyle and Rego (1983); Naill (1977, 1992); Sterman (1981)
Deregulation in the US electric power industry	Lyneis, Bespolka and Tucker (1994)
River use and its impact on hydroelectric power	Ford (1996a)

Figure 4.Several studies on systems dynamics modeling of the energy in the United States, [38]

III. EMPIRICAL REVIEW OF THE DEVELOPMENT ON ENERGY MODELING RESEARCH

As described in section - the previous section. Model MARKAL - MACRO is one approach that is often used in the modeling of energy projection. One example is research conducted by Bozic, [1] who use the method MARKAL - MACRO to do the modeling of energy demand in sweden. While in Indonesia MARKAL model has been applied to optimize the national energy supply [30].

Turan, et al [33] have classified and clustered factors that influence the energy system in the Turkish nation. Using a system thinking approach, energy systems are grouped into three components, which are endogenous, exogenous, and Environment (Excluded) as shown in Figure 5 below.

Marriott [20], has conducted research on modeling the projected needs of the national energy supply in the United States. Aspects of the energy distribution have also been modeled in these studies. From this research, it can be proved that the Input-Output model can be used to model electricity demand projection and the cluster distribution. Nevertheless, the resulted model still cannot properly describe the internal mechanism (behavior) of energy systems elements of the related research.

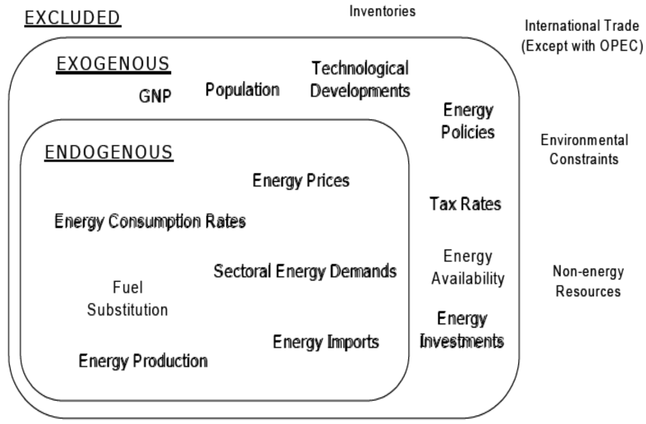

Figure 5.Basic elements and system boundary and energy systems [33].

Meanwhile, Longbin [16] attempted to use System Dynamics approach to designing energy efficiency policy that is consumed by the steel industry sector in China. This model simultaneously incorporates the supply side and demand side of energy derived from fuel oil and electricity. This model has demonstrated the system dynamics method to describe the mechanism of interdependence of energy systems for the steel industry sector in China. The limitation of this model is that the model is only focus on energy sector and not accommodates other interrelated aspects such as economics and the environment.

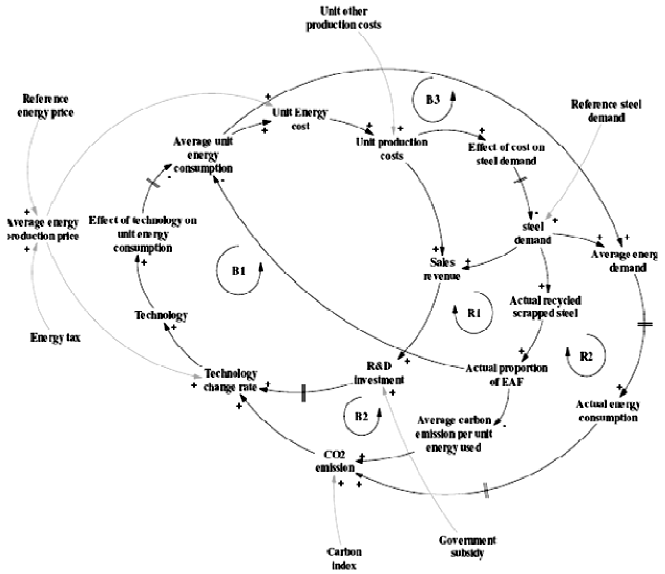

Figure 6.Examples of Dynamic Causal Loop Model of energy consumption sector in China's Steel Industry [16]

In addition, System Dynamics model has also been used to model the system policy in the industrial energy supply and electricity market and their effects on macroeconomic and environment sector in Germany [12].From this research can be concluded that the policy mix of energy supply can significantly affect the sector and macro-economic environment

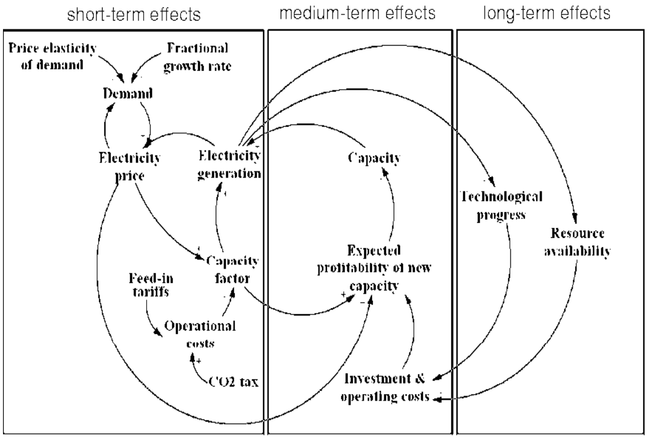

Figure 7.System Dynamics Model policies on the influence of electrical energy supply to the economic and environmental sector in Germany [12]

On the other hand, a decade earlier, Marnay et al [19] have used a computer simulation approach to analyze the policy of restructuring the development of renewable energy and its effect on demand and energy markets in the state of California, United States.

After that, Njoku [22] proved that the mathematical models, Multivariate Regression methods can be used to model projections of energy demand for the electricity sector in a developing country, Nigeria.

In Indonesia, Smajgl and Carlin [28] developed a model named as the agent based model. This model was built to study the relationship / impact of energy pricing policy and poverty in East Kalimantan. The model was built with the basic concept of computer simulation scenarios. Several policies on energy prices are successfully simulated and as the result, the relationship / impact between energy price and poverty level also can be concluded. One of the limitations of this model is that one sub energy system modeled in this research which is economic that represent with energy price factor. Meanwhile, as will be described in the next section in this text, that the ideal energy system model should be able to simulate aspects of 3E (energy-economy-environmental).
Energy supply chain has also become one of the topics within the scope of the energy system modeling research study, as has been done by Liu and Nagurney [15] that uses mathematical and econometric models to analyze the link between distribution channels and price of energy (fuel and electricity) in the state of New England, United States. As is generally a mathematical model, many initial assumptions that must be formed by the modeler which can reduce model robustness because it is not sensitive to assumptions changes.

Finally, Harjono [8] have also developed a quantitative analysis of the projected energy needs of the Indonesian National electricity using a modified Econometrics model. This research reinforce the fact that the national electrical energy consumption pattern is still not efficient and is dominated by the industrial sector, which means that if the electricity subsidy is applied, then the industrial sector (factories and entrepreneur) will earn the most benefits.

IV. THEORITICAL REVIEW OF IDEAL MODEL FOR NATIONAL ENERGY / ELECTRICITY SYSTEM

As mentioned previously, one of the purpose of modeling in the field of energy and electricity despite of making predictions also to assist stakeholders in making decisions of any measures taken. Therefore, a good model of the energy system must be able to also serve as a representation of the macro energy system that can describe the behavior of the system to changes that occur in every sector. The International Energy Agency / IEA earlier in the year 2009 have been suggested by a manuscript, entitled World Energy Model: Methodology and Assumption, the good energy system model is a model that meets the following characteristics:
1) Assumptions change sensitive
2) Ability to represent the behavior and dynamics of the system and changes in each sub-system as a whole energy of the system which means the integration between the demand side, supply side, as well as other aspects.
3) Able to accommodate aspects of 3E (Energy-Economics-Environmental) or Techno-economic and environmental.
4) Can be used as decision support tools (policies) in the field of energy in a precise and fast.
5) Having the ability to perform *what-if analysis*.
6) Easy to use by the targeted users (policy makers and analysts in the energy sector).
7) Having an adequate level of validity.

In another aspect, the IEA [11] also stated that energy and electricity model should be able to analyze the projection of demand and supply of energy, the impact of a policy and technological change on the energy sector, environmental impacts of energy use, as well as links with macroeconomic conditions. This is reinforced by Schrattenholzer [25], adding that the energy model can be classified into 5 types based on its main functions are: Model balance / energy balance, energy projection model, evaluation model of energy, Model 3E, and Decision Making model / simulation.

Another important aspect to note in the energy system modeling is the aspect of uncertainty and risk. Oliveira and Antunes [23], suggested that the ideal energy system model must consider several aspects of uncertainty and risk in energy systems that can that can be identified include:
1) Genesis extremes: weather, sabotage, and a big disaster.
2) The operational performance risk: Failure in Transmission / distribution of energy
3) Technological Risk: The technology that has not been established, regulatory costs, public acceptability.
4) Supply and Demand Uncertainty in energy.
5) The uncertainty condition of energy sources availability
6) Market risks and uncertainties: energy prices, subsidies, exchange rates, world oil prices

Typical conditions in the Indonesian energy system Indonesia, as one large developing country by the archipelago geographical circumstances, the multi-ethnic and wide socio-economic strata range and good Economy growth has distinct characteristics in the energy system. National Research Council [6], explain a few special characteristics and condition of Indonesia energy systems, such as:

1) The final energy consumption pattern (mainly fuel and electricity) is different from developed countries.
2) Low Reliability of Energy / Electricity Transmission and Distribution Line.
3) The existence of energy subsidies that made energy prices does not reach the level of its economic (market price).
4) Low electrification ratio and uneven energy distribution.
5) High uncertainty on both the supply and demand side energy.
6) Certain region concentrated Economic activities.
7) Most of the GDP (Gross National Product) is contributed by small number of Indonesian Society.
8) The energy supply still relies on fossil fuel.

V. CONCLUSIONS

From the description above, it can be concluded that the problem of policy planning and analysis of energy systems, particularly the electricity sector is a major area in the sustainable global energy management.

Furthermore, it can also be concluded that although still require various development, system modeling and computer simulations have contributed significantly in designing the global energy system model.

On the other hand, the complexity of the electricity sector in Indonesia to the relevant stakeholders in the field need to design an ideal model to perform analysis, design, and policy studies of the Indonesian electricity system toward sustainable energy systems.

The ideal approach of energy systems modeling must be able to clearly describe the behavior of the energy system as well as the interdependent relationships of each element. The ability to perform *what-if analysis* is also an important variable in the energy systems modeling.

Finally, energy system models which is based on computer simulations and integration with 3E (energy-economy-environment) concept has a significant potential for improved to be a good alternative model for energy systems especially for electricity or power sector in Indonesia, so that expected able to assist stakeholders to develop and evaluate various strategic policy in the circumstances.

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

Implementation of process modelling and simulation techniques in Malaysian industries – A case study

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***Abstract* - The potential industrial development across the world has enhanced the manufacturing research and development sector including in Malaysia. Challenging demands and competition necessitates the development and utilization of efficient manufacturing processes and systems, quality tools, process modeling techniques, etc. Process modeling and simulation (PMS) is one of the most important tasks which is commonly outsourced by most of the Malaysian automotive supplier companies. The PMS services rendered by the external companies have several drawbacks such as poor conceptualization of the manufacturing process, miscommunication, high costs, etc. This paper attempts to explore the critical factors (CFs) and challenges which govern the implementation of process modeling and simulation (PMS) technique in Malaysian automotive parts supplier industries. A process model has been created using iGrafx process for six sigma and simulated for a case study. It is evident that this attempt is the first time in Malaysia which has identified CFs of PMS implementation and developed an IDEF0 model to analyse and evaluate the same.**

***Keywords* - Process modeling and simulation, implementation, critical aspects and challenges**

I. INTRODUCTION

The medium and small scale industries (SMEs) in most of the industrially developing countries including Malaysia come across many uncertainties when venturing into the competitive global platform [1]. Manufacturing in automotive industry remains a distinctive challenge to meet the demands of local and international markets. In Malaysia the automotive industry can be considered as one of the most important and strategic industries in the manufacturing sector. Initially, the assembly plants were mainly joint venture projects between European automobile manufacturers and local partners were previously their local distributors. The implementation of the national car projects was a step towards to the development of an integrated motor vehicle industry [2, 3]. As manufactured vehicles have become more global, the competitive pressures from multi-national companies have increased substantially [4]. It is important to be acquainted with some of the problems faced by these supplier companies in various operations which consequently affect their performance [5]. It is because they play vital role in stimulating the economic growth of the country. These companies have their own unique characteristics that differentiate them from larger companies. It was outlined in few studies that there are several specific problems in medium scale industries, such as lack of human resources skills, shortage of training facilities and inadequate time in sending employees to the training and development program in another place to intensify their skills and knowledge. SMEs also tend to emphasize profit in short period without having a vision or systematic planning. Consequently, they also lack interaction with non-engineering unit such as marketing, purchasing and inventory site.

Focus on reduced work in progress (WIP) inventories as well as allowing rapid response to product or product changes has added structural and operational complexity to the manufacturing systems. This complexity combined with the high cost of setting up and maintaining such a system necessitates the use of formal models of the system [6, 7] for process improvement. Implementation of advanced techniques in all the domains of the industry should be the right step to meet the competitors [8]. Advanced manufacturing systems aid in the exploration of alternative production line scenarios, making assembly lines more efficient with the aim of reduced lead time to product launch, shorter product times. The predominant factor which determines the success of any industry is manufacturing process planning using modeling and simulation [9]. Many SMEs outsource such an important task and hence it is imperative to investigate the critical factors which determine the successful implementation of the same.

Therefore this paper focuses on the critical factors and challenges in implementation of PMS techniques in Malaysian automotive part manufacturing companies. The research is based on a comprehensive case study of one of the largest automotive parts supplier industry. In this study, the responses of top management and middle level management were recorded using questionnaires and extensive interviews during tours of company facilities. A process model was created using iGrafx IDEF0 and simulated for the case study. The results were verified accordingly and found to be precise. The attempt to implement PMS experienced several confrontations from various domains of the industry. The potential factors were identified, categorized and studied.

II. CASE STUDY

As an experimentation field we selected the car door frame production process at an automobile-part manufacturing company. The description of the plant is appended in sub section-A.

A. *Plant description*

The plant operations began in the early 1990 to manufacture automotive components for the growing number of carmakers in Malaysia and the ASEAN region. Rolled steel sheet is the primary raw material and employs continuous roll-forming for the production of car door parts sections and diverse complexity. Therefore it offers the possibility of achieving lower cost and high strength products. The plant produces car door parts on-demand from national car makers and also others. The original product-mix of the plant included door sash for sedan, mini-van and saloon cars. According to the factory sources, the plant purchases most of its raw materials (steel sheets) from vendors. The plant operates on a 5 day/week schedule and has around 300 total employees.

There are four major tasks in the manufacturing plant namely daily meeting, planning, production and pre-delivery process. The production task encompasses the assembly section, having four lines including a final assembly point of all the parts. The assembly line begins with the roll forming and after the completion of the same, is subjected to in-process inspection. The different forms are then cut, notched, pierced, crimped and coupled together at other appropriate sections by welding. The finished coupled sections are then sprayed with anti-rust oil spray. The pre-delivery inspection ensures product conformation with technical specification, minimize reject and complain from customers.

III. PROCESS MODEL AND ITS VERIFICATION

The case study of the car door manufacturing plant was modeled in IDEF0. A top-down approach was employed in modeling the process. Primary and secondary data obtained from the factory was jointly verified by the author and Plant manager. All the sub-assemblies were modeled separately using iGrafx IDEF0 2007. Other than the static presentation of nearly the whole process, it was easy to ascertain the level of process similarity that will enable exchange of information between and within processes to avoid information duplication within the production system using IDEF0. For instance, in IDEF0, if an aspect or task is skipped how it would be communicated to the whole system and promptly rectified, whose omission could largely be due to human.

Even if it is communicated at the lower level of production, this information does not go 'up'. In the various lines of production, in-process inspection was recognized as a practice to minimize rejects and identify bottle neck. Even though the top-down approach enhances understanding of the process operation, rejects, bottle neck and product assembling presented a difficult task to model.

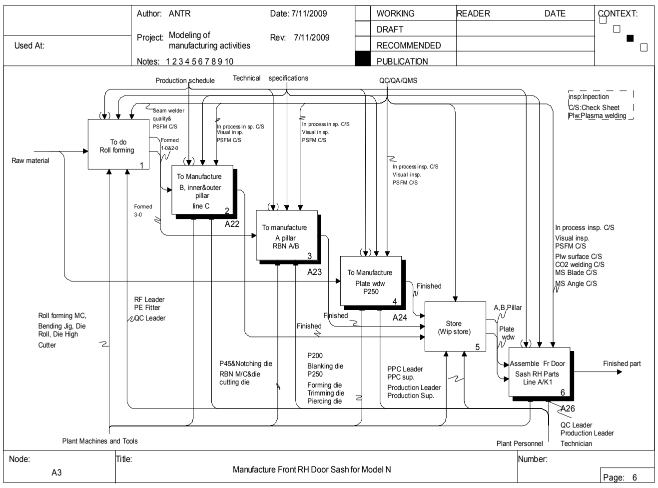

Fig. 1. IDEF0 level A2 representation of sub-assembly system of car door manufacturing process.

The modifications were carried out to address the above. Inclusion of a Manager level view in the existing IDEF0 to trace process delay was enabled with modification. Roll forming activities was observed for the production lines; though the operations are similar they are in parallel. It was important to differentiate these operations, which could not have easily been done outside IDEF0. The interaction of the data input made it possible to identify a series of bottle necks. For instance, the storage after in-process inspection was identified during simulation indicating a caution on the parameter allocated to it with respect to the whole manufacturing process. The attempted compression of the process to provide a seamless 'stream' from the manager view was successful.

Fig. 1 is the manager view in IDEF0 type model. We adopted specific notation in order to highlight these sub processes, identify bottle necks and point when delay could occur. The logical functions in model presented us several choices to have delay and error. These functions also were used as decision and coupling nodes. Parallel operations during manufacturing process were easily captured in the new model. The sequencing of the process was not allocated arbitrary function in process flow unlike in the IDEF0. Even though model of errors can be achieved by specific logical operators in trying to enhance the proposed model, time error was omitted. Due consideration was given to this due to the fact that a thorough verification exercise will be needed for this part so that the process flow model generates its own error in the process.

A. Verification

Verification is essential part of the model development process if models to be accepted and used to support decision making in a real world setting [10]. It is done to ensure that the experiment/model solves an important problem, meets a specified set of model requirements and correctly reflects the workings of a real world process. The criteria for judging the goodness of models is based on how accurately measures extracted from the model corresponding to the measures which would be obtained from the represented system. Besides, to increase the credibility of the model as cases are studied. Verification of the process simulation was very challenging because the parts produced require in-depth understanding. Furthermore, many of these batches were run based on order requirement which changed during the period of manufacturing. The personnel involved in the case study had to be trained on certain functions of the IDEF0 for output verification. Thus, the collection of data and verification of parameters relied more heavily on the personnel of the factory.

B. Simulation and experimental design alternatives

The formal description and construction of the steps taken to model the process for simulation in iGrafx® Process™ for Six Sigma is as follows;

1. Each process line consists of the various tasks such as stamping, welding assembly, inspection), and these tasks are described with their properties (input, output, start and decision, execution time) in the task view pane of the modeling programme (Fig 1).
2. Properties of a resource are described in the resource view for activities including cost, organization, role and scheduling rule.
3. Lastly the assignment function describes the task and mode of execution of the model. Each task is taken as an event and the process is executed scheduling events and changing states of the business process.

The modeling software allows a discrete event simulation of models, where information is exchanged between the sub-assemblies to ascertain the level of congruence of the operation model to the operation data collected between and within processes. However, it was difficult to tell if information duplication within the production system occurs. For instance, in the various line of production, in-process inspection was recognized as a practice to minimize rejects and identify bottle neck. This inclusion of this task in all the level of the model for simulation raised some issue that if this aspect is skipped, how it would be communicated to the whole system and promptly rectified. This omission could largely be human. Even if it is communicated at the lower level of production, this information does not go 'up'. Though the top-down approach enhances understanding of the process operation, rejects, bottle neck and product assembling presented a difficult task to model.

The following assumptions were made during the simulation model and the case data for study.

1. The production yield is constant.
2. Worker cost was at $10.00/ hour. Not equipment / machine cost was included.
3. Simulation period was limited to 1 cycle time.

The execution of the simulation runs and the process of analyzing the results step has two major phases as below:

1. Designing the simulation experiment to generate the output data, which would be sufficient for the subsequent system investigation, and
2. Determining the number of observations required for achieving the desired precision of the simulation results.

The simulation of the models was carried out for different cycle time for the discrete event simulation. The estimated and simulated measure of output was compared to the data collected. According to the production schedule, the car door part is produced according to an overall demand of respective customers. The production target however fluctuates, hence for the simulation, a production target of 500, 1000, 2000 were chosen for production activity and compared with the production records made available.

The top management personnel were able to agree on product flow, quality and personnel involved for the expected cycle times. A simulation period of 3 months to a full year was run to check the validity of the data used. As the simulation run-time is extended, the steady-state performance has a larger impact on the results. However, storage (WIP) added to the differentiated scenario. WIP increased and automatically reduced total process time and cost. The real world scenario may be inexhaustible but the reality of the result was confirmed by the personnel in-charge of the process. Several iterations were made until the simulation behavior closely resembled actual system performance.

ISBN : 978-602-97809-0-1

IV. FACTORS AFFECTING THE IMPLEMENTATION OF PROCESS MODELING AND SIMULATION (PMS)

A. Methodology:

The research is based on comprehensive case study of a large supplier industry of auto-parts. The details of the cases are described in the section II-*A*. Literature survey and empirical approaches have been followed where the responses of top management and middle level management were recorded using questionnaires and extensive interviews during tour to company facilities.

Rockart [11] describes that interviews to identify CFs is a unique opportunity to assist the managers in better understanding their information needs. ‘‘The CSF interview often presents the initial occasion to interact with the manager on the types of information support that might be useful to her’’ [12].

CFS interviews were conducted with various levels of factory personnel including general managers, plant managers, planning managers, section heads, engineers, production managers, quality and control department and many others involved in the manufacturing processes.

The potential factors that determine the successful implementation were identified, studied and categorized into three such as suitability of technique, technical and managerial factors. A graphical representation of the same is shown in the Fig. 2. These three aspects were evaluated further based on its level of significance in affecting the implementation of PMS. Thereafter it was found that the primary aspect is the suitability of the technique. Technical factors form the secondary basis and managerial aspects come in the final order.

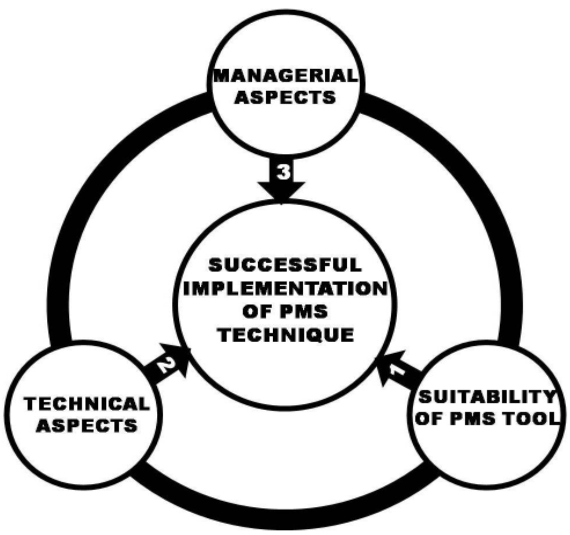

Fig. 2. Graphical representation of factors influencing the successful implementation of PMS techniques.

A. Suitability of technique

The suitability of the model, modeling and simulation technique is the primary aspect for the implementation of PMS in any industry. In some cases certain models cannot be imposed on actual industrial situations. Every technique has its own drawback which may also greatly influence the suitability for implementation such as,

- A PMS technique requires consistency between different levels of modeling which is sometimes difficult to maintain.
- The standards of the industry and software should be in match for smooth adaptation.
- Few techniques don’t support the interface between the factory systems and it greatly affects the data input for PMS.
- Getting input from the working scenario need the facilitator understand all the details of modeling and who applies the technique.

B. Technical Factors

Utilization of new technology in any industries at the early stage of their development is always uncomplicated than adapting in later periods. This case study attempts to adapt PMS while factory is already in operation for several years. Potential technical factors which affect the implementation process were identified such as,

- Current line study which involves the activities such as DPA (digital pre assembly), reduction of end item, similarity check with current facility, etc, may not be accommodated in the modules of PMS due to its diversity.
- In most cases the automatic productions systems encounter problems which needs a trouble shooting and may take long time. Drafting such technical factors in PMS could be intangible.
- PMS implementation involves a paradigm shift in the mindset of the entire organization as the technical contribution is required from all levels of employees. This can be achieved through systematic and strategic training of all the employees. The firm may not have the required technical expertise to train the staff and may look for external consultants for training.

C. Managerial Factors

Though a small number of major industries were successful in implementation of process modeling and simulation, there are many industries who have failed to harvest the benefits of the same due to their different focus in its implementation process. While applying such techniques to their organizations it is mandatory to have a clear understanding of the principles of PMS. Therefore, the first major barrier for the application of PMS is the misinterpretation of PMS philosophy and the lack of understanding the processes. This could be due to the following,

- Deficient in the necessary knowledge about PMS and its implementation procedure.
- PMS should be embraced as a strategy by the top management and they should get visibly and explicitly committed to its philosophy. The pivotal role played by middle managers in spearheading the impetus for quality improvement may not be understood clearly.
- Another major barrier in most of the industries in implementing PMS is lack of proper leadership. Leaders should be able to set viable corporate vision and be willing to initiate change and provide the resources needed for team efforts directed towards achieving the vision. Senior management may want the results, which PMS can bring but may not be backing it wholeheartedly.
- There could be another barrier, the fear whether PMS really works and is worth the effort. Due to this notion, middle managers may not let employees take responsibility.
- Employees may resist to new changes since it is known fact that PMS adds of bureaucracy which is not a preferred domain amongst academic professionals.
- In most cases the employees are trained and deployed for a specific task. Additional tasks make them uncomfortable and drive through poor efficiency in adapting a process modeling technique.

D. IDEF0 model for analysis & evaluation of critical factors

An IDEF0 model (figure not shown) was created with an objective of PMS implementation in an industry based on the enumerated critical factors. The main activity has several controls and a proposed PMS technique as an input. The PMS technique which is intended to be implemented will be evaluated with the critical factors. The critical factors which are categorized into three main categories are made as child activities under the main activity of the model.

When the check for suitability of technique is done and if found to be suitable then the input goes for technical factors check and finally to managerial factors if found to be technically satisfied. When all the three critical factors are found to be positive with the input (proposed PMS technique) then it is recommended for implementation commencement. In other case, when the input is found to be unsatisfactory with the factors then either the input is changed or the critical factor is evaluated accordingly.

V. CONCLUSIONS

The research explored significant factors which are hindrance in the implementation of PMS techniques in an automobile supplier industry of Malaysia. The factors that were discovered during study are suitability of the technique, technical aspects and managerial aspects. This was demonstrated with the help of a comprehensive case study. The process of a car door manufacturing industry was modeled and simulated with a modified IDEF0 approach. The results obtained after simulation with the current factory data was verified and found to be appreciable.

During the implementation of such successful technique into the industry posed several problems. The factors which influence the implementation of PMS in the current case was categorized based on the impact it incurs. An IDEF0 approach has been introduced to evaluate and analyse the CFs. The author believes that this is the first study which has attempted to outline the key factors and challenges faced by Malaysian automotive parts supplier companies in PMS implementation.

VI. ACKNOWLEDGMENT

The first author of this paper is grateful to Engr. Nabeel Adeyemi, Department of Mechanical Engineering, IIUM for his support during this study.

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ISBN : 978-602-97809-0-1

Create Randomization in Simulation Models

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Abstract **– In today's rapid changing world, systems are more complex than those in the past and to analyze them different techniques such as simulation must be used. Due to random situations in systems, the random aspects in simulation are necessary. Thus randomization can be created in simulation models by random numbers and random variates. The aim of this paper is generating random values for using in simulation. The classification of algorithms for generation of random number variates, is another contribution of this paper.**

Keywords **– Random Numbers Generator, Random Variates, Modelling, Simulation.**

I. Introduction

At first This article, briefly reviews the field of random numbers and random values and the relationships between two discussions, then it will present random values generation algorithm in the model of classified form and eventually one of the best of these methods along with the various applications. Non-uniform Random variates generation is common area between computer science, statistics, operations research and mathematics. The knowledge started about mid-century ago. During World War II, when feasibility of Monte Carlo experiments had been studying, the random values generation from different distribution was considered as an important area of research.

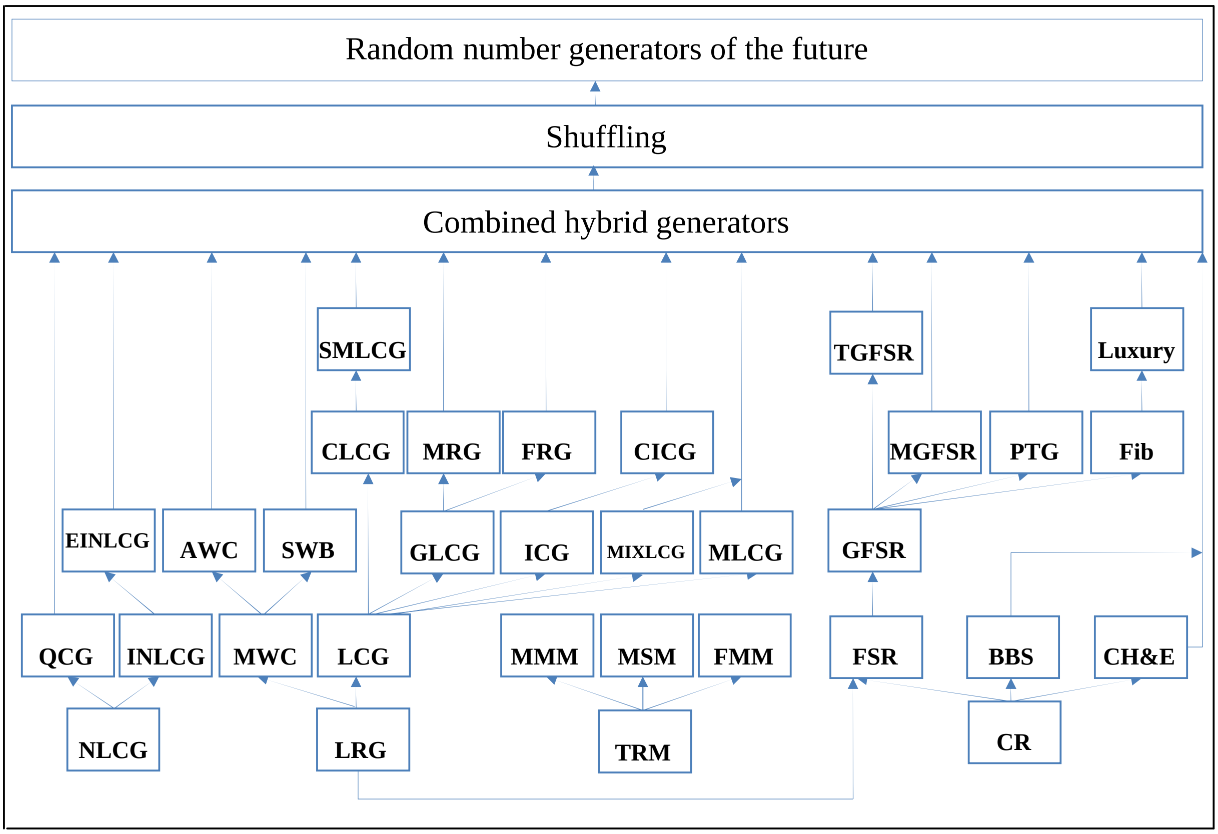

Fig. 1 Taxonomy of (pseudo) random number generators

The application of this field is very various, for example for solving various problems in Monte Carlo methods such as random optimization, Monte Carlo integration, solving linear equations, etc. (Banks et al., 2005). Random number generators are required for generating random values from different distributions. Random number generators are required for generating random values from different distributions. So, assumed random number generators with desired characteristics are available. Random numbers are the nuts and bolts of simulation machine (Banks, 1998). In simulation of a system or process which there is substantial random component, need to produce a model for numbers that have been random.

II. RANDOM NUMBER GENERATORS

Various generators to generate random numbers are available. In this paper, with regard to mathematical relations between generators, the classification model for generators is presented as follow. A desirable computational generator must have features such as uniformity, independence, high speed generation random numbers, capability to generate previous sequence, the ability to easy implement, long-length sequence, unpredictable, portability and ability to jump on the sequence. Tang (2007) has presented three important features of generators: long-length sequence, randomness and computational efficiency.

III. THE GENERAL ALGORITHMS TO GENERATE RANDOM VALUES

It is supposed that random numbers generators with desired characteristics are available. Various algorithms to generate random values are presented and for classification of these algorithms different criteria are used that a sample is presented in the following table (Law and Kelton, 2000). For selecting the method of generation random values for a particular distribution, different criteria should be considered. Examples of these measures include: speed of algorithm, accuracy, simplicity and ability to understand, the range of parameters, the amount of random numbers, required memory, speed of setup and performance, setup time, length of compiler codes, being independent of the machine, etc. General methods to generate random values are: inverse transformation, convolution, composition and acceptance-rejection. Inverse transformation method is used when the distribution function is available. This method is simple and exact and requires only a random number to generate random values. Also this method is applicable to variance reduction techniques. This method can be used for truncated distribution and quasi Monte Carlo methods. In copula, this method is necessary for transforming uniform marginal distribution to main marginal distribution (Derflinger et al., 2009). In addition, this method is used for generating order statistics.

TABLE I
INTRODUCTION OF DIFFERENT GENERATORS IN FIGURE 1

Traditional Methods (Banks et al., 2005)	TRM
Mid multiplicative Method	MMM
Mid Square Method	MSM
Fixed Multiple Method	FMM
Linear Recursive Generator (L'Ecuyer,2001)	LRG
Multiple With Carry	MWC
Linear Congruential Generator (L'Ecuyer, 1994)	LCG
Generalized Linear Congruential Generator	GLCG
Inverse Congruential Generator (Weigl and Anheier, 2006)	ICG
Mixed Linear Congruential Generator (Klimasauskas, 2003)	MIXLCG
Multiplicative Linear Congruential Generator	MLCG
Combined Linear Congruential Generator (Tsang et al., 2006)	CLCG
Multiplicative Recursive Generator	MRG
Fibonacci Recursive Generator (Marsaglia and Tsang, 2002)	FRG
Combined Inverse Congruential Generator	CICG
Shuffled Multiple Linear Congruential Generator	SMLCG
Cryptography Method (Panneton and L'Ecuyer, 2010)	CRM
Feedback Shift Register (Tang, 2002)	FSR
Blumb-Blumb-Shub	BBS
Crypto hardware & Entropy	CH&E
Generalized Feedback Shift Register (Tang, 2006)	GFSR
Multiple Generalized Feedback Shift Register	MGFSR
Primitive Trinomial Generator (Carr, 2003)	PTG
Fibonacci Generator (Kung and Tang, 2007)	Fib
Twisted Generalized Feedback Shift Register (Tang, 2005)	TGFSR
Sub-sampled Fibonacci Generators	Luxury
Non linear Congruential Generator (Chen and Tang, 2008)	NLCG
Quadratic Congruential Generator	QCG
Inverse Nonlinear Congruential Generator (Zeeb and Burns, 1997)	INLCG
Explicit Inverse Nonlinear Congruential Generator	EINLCG

TABLE IIIII
CLASSIFICATION OF RANDOM VALUE GENERATION ALGORITHMS

Number	Classification in Term of…	Description
1	Accuracy	Approximate algorithm such as Uniform Fractional Part-Exact algorithm such as inverse transformation method
2	Number of used random numbers	Some algorithms require a certain number of random numbers, but some algorithms the number of random numbers is random (Tang, 2007)
3	Number of Input to output random numbers	One by one such as composition-several by one like acceptance-rejection-one by several-several by several
4	Ability to generating random values	Facilitator like composition-generator like inverse transformation
5	Method of generating random value	Inverse transformation, convolution, composition, acceptance-rejection
6	flexibility	Applicable for all distribution (black box) such as TDR-applicable for specific distribution such as polar for normal distribution

One of disadvantages of the method is availability to closed form of F for some given distributions. However it may use numerical methods (such as bisection, Secant and Newton-Raphson Interaction) and can apply Inverse transformation method for generating random values from functions with complex F .

Composition method can be used when the distribution function F can be replaced by a convex combination of other distribution F , F , ... This method is applicable to discrete and continuous distribution (Devroye, 1986).

$$F(x) = \quad PF\ (x) \qquad (1)$$

Convolution method is used for distribution in which x can be calculated as summation of y ‘y ‘…‘y , so random values generation from these parameters is easier than direct calculation of x (Hörmann and Leydold, 2002). When the other methods are not usable, the acceptance-rejection method is used. In this method, a hat function for the main function is considered in such a way that the production values of this hat function is easier than main function (Korn, 2007). Algorithm of this method schematically is as follow.

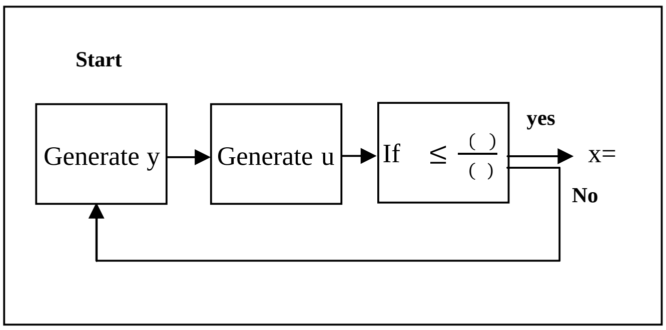

Fig. 2 Graphical presentation of acceptance-rejection algorithm

Most of random values generating methods are sub-category of acceptance-rejection method. Squeeze method is among these methods. In this method two function h and h are used in such a way that the following relation is satisfied.

$$h\ (\ ) \leq\ (\ ) \leq h\ (\ ) \qquad (2)$$

In this relation, h is hat function $(t(x))$ and h_2 is squeeze function $(s(x))$. One may facilitate acceptance condition stage in acceptance and rejection algorithm by considering squeeze function (Fishman, 1998).

IV. OTHER ALGORITHMS TO PRODUCE RANDOM VALUES

Until now general methods for generating random values have been evaluated that are presented graphically in the following diagram along with the classifications of algorithms derived from them.

For generating random values from discrete and continuous distributions there are specific algorithms that are graphically presented in the following Figure. Due to specific structures, some of the algorithms cannot be categorized in a special category (Fishman, 2006). These algorithms include ratio of uniform, series method, Forsythe-vonne Neumann method and almost exact approximation method.

V. THE ALGORITHMS TO PRODUCE RANDOM VALUES OF DISCRETE AND CONTINUOUS DISTRIBUTION

Continuous distributions with different methods for generating random values from them are presented in Table 4. Also discrete distributions with different methods for generating random values from them are presented in Table 5.

VI. CONCLUSION

This paper introduced random values and random numbers as well as different methods for generating random values and a new method based on statistical principles with applications. Due to expanding the use of computer simulation, more attention has been paid to different methods for generating random values that are compatible with the computer methods.

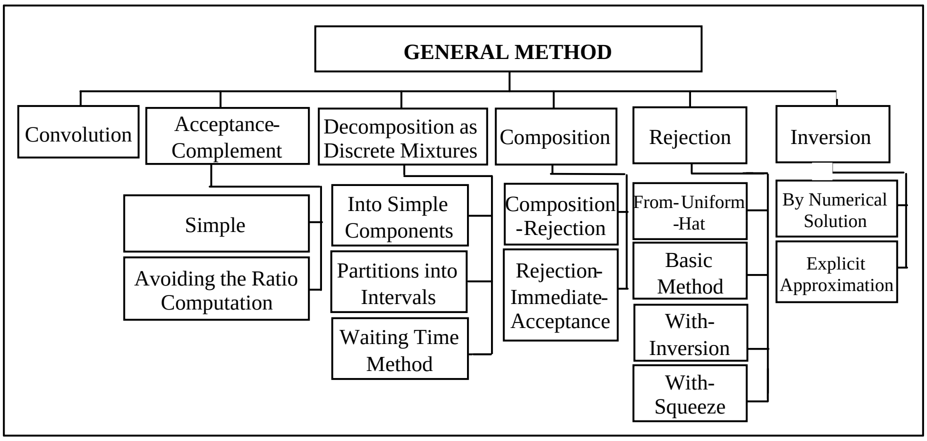

Fig. 3 Classification of different algorithms

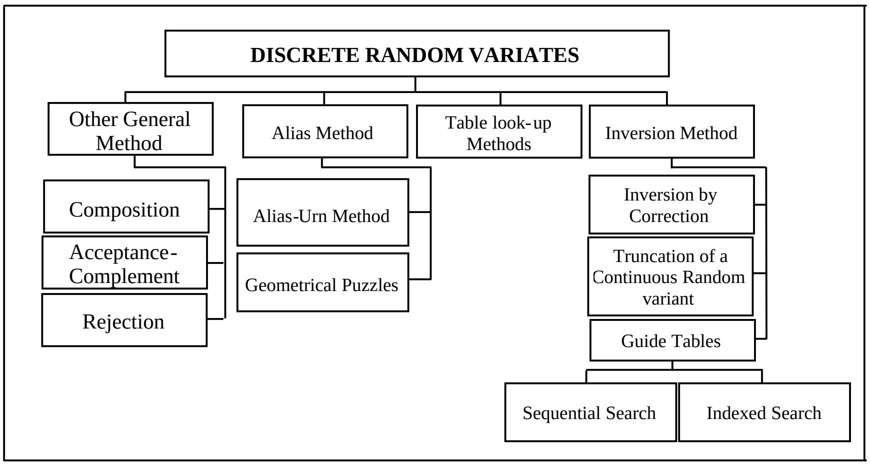

Fig. 4 Classification of random value generation algorithms for continuous distributions

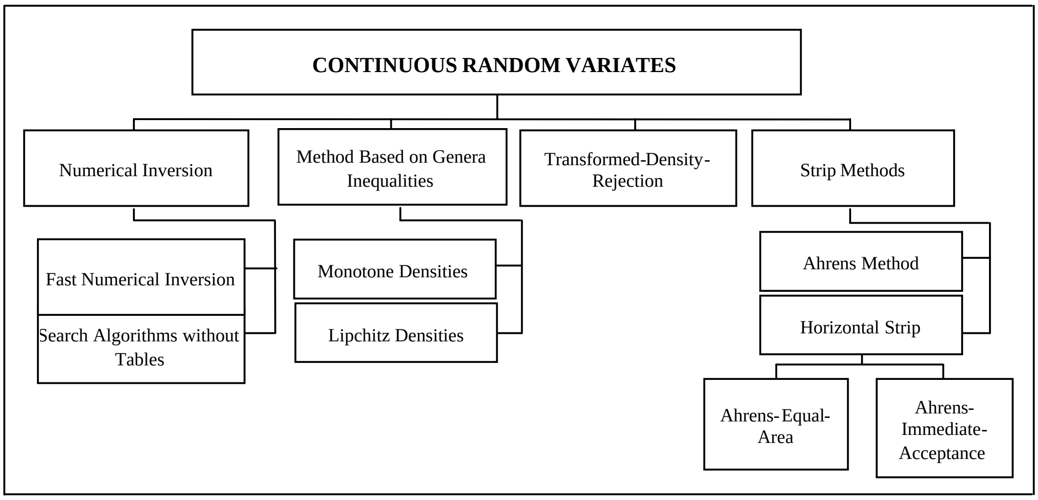

Fig. 5 Classification of random value generation algorithms for discrete distributions

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TABLE IVVVI
UTILIZED METHODS FOR GENERATING VALUE FROM CONTINUES DISTRIBUTION

Distribution	Applicable Methods for Distribution
Uniform	Inverse transformation
Exponential	The uniform spacing method (Knuth, 1998) - von Neumann's method Marsaglia's exponential generator, or Its modifications The ratio-of-uniforms method - The series method Table methods - Method presented by Peng et al. (2002) using vertical strips.
Erlang type m	Convolution-the use of gamma random value generation methods.
Gamma	Acceptance-rejection by Ahrens and Dieter with $0 < \ < 1$ - Acceptance-rejection by Cheng with $1 <$ - Acceptance-rejection by Fishman with $1 <$ - rejection from a combination of normal and exponential densities by Ahrens and Dieter (1974) (GO) - rejection from the Cauchy density by Ahrens and Dieter in 1974 (GC) - rejection from the Burr XI distribution by Cheng (1977) (GB) - rejection from the t distribution with 2 degrees of freedom by Best (1978) (SG) - rejection from the Laplace density by Tadilcamalla (1978) (TAD_2) - exact approximation method by Carlos (2004) - Uniform Fractional Part method by Izadi (2005) - Acceptance-rejection by Kunda (2007) - Numerical inversion method by Hormann (2007) - the Ratio of uniform method by Tanizaki (2008).
Weibull	Inverse transformation.
Normal	Acceptance/Rejection from Laplace density (Ridley, 1997), from Cauchy density (Ross, 2006) - Polar method by Box and Muller (1958), Bell (1968) - Iversion by Muller (1959) - Rejection method by Von Neumann (1951), Sibuya (1962) - Ration of Uniform by kinderman and Monahan (1977) - Composition/Rejection Marsaglia (1963) and Bray (1964), Aherens and Dieter (1972), Kinderman and Ramage (1976) - Series Method by Devroye (1998) - Almost exact inversion by Wallace (1976) - Table method by Marsaglia et al. (1964) - Forsythe's method by Forsythe (1972), Aherence and Dieter (1973), Brent (1974)- Vertical Strip method by Pang (2002) - Uniform Fractional Part method - improved Ziggurat Method by Jurgen (2006).
Beta	Johnk's method (1964) and Its modifications - Rejection from the normal density by Ahrens and Dieter (1974) - Rejection from polynomial densities by Atkinson and Whittaker (1976) - Forsythe's method by Atkinson and Pearce (1976) - Rejection from the Burr XI1 density by Cheng (1978) - Rejection and composition with triangles, rectangles, and exponential curves by Schmeiser and Babu (1980) - Strip method by Hormann et al. (2003) - Approximation method by Hormann and Leydold (2003) - Exact method by Carlos (2004) - Uniform Fractional Part method by Abuyi (2005) - Numerical inversion by Hormann (2007) - GING Method by Grilo and Coelho (2007) - Univrsal method (2008).
Chi-square with k degree of freedom	The use of gamma random value - if K is even then consider its relation with Erlang distribution - if K is small then use from normal random values (Josef and Hormann, 2006).
t with ν degree of freedom	Inverse transformation-table methods - The ratio of uniforms method - Transformation of gamma varlates - Transformation of a symmetric beta random variate- Transformation of an F random variate - The ordinary rejection method - The composition/rejection method by Kinderman et al. (1977) - The acceptance-complement method by Stadlober (1981).

TABLE IV
UTILIZED METHODS FOR GENERATING VALUE FROM DISCRETE DISTRIBUTION

Distribution	Applicable Methods for Distribution
Bernoulli	Table look up method.
uniform	Inverse transformation.
Binomial	Convolution - Alias - if n is large from Anukul, Kachitvichy and Schmieser's Methods - Fishman's method based upon rejection from the Poisson - Table methods - Generators based upon recursion by Relles (1972), Ahrens and Dieter (1974) - rejection method by Fishman (1979), Ahrens and Dieter (1980), Kachitvichyanukul (1982), Devroye and Naderisamani (1980).
Geometric	Inversion transformation - Inversion by sequential search.
Negative polynomial	Convolution - if n is large then use from fishman method.
Polynomial	Numerical inversion method (bisection or Newton - Raphson Interaction).
Poisson	Generators based upon the connection with homogeneous Poisson processes by Knuth (1969) - Generators based upon recursive properties of the distribution by Ahrens and Dieter (1974) - The acceptance-complement method with the normal distribution as startling Distribution by Ahrens and Dieter (1982) - Rejection methods by Atkinson (1979), Ahrens and Dieter (1980), Devroye (1981), Schmeiser and achitvichyanukul (1981).

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MP4 Player QTTEC QT-102 Re-designing with User-Centered Design Method

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Abstract – **Popularity of MP4 Player is growing fast nowadays. Various types of MP4 Player are preferred particularly by teenagers. They tend to be attracted by the sophisticated technology and practicality of the MP4 Player. A lot of producers of MP4 Player put their efforts to provide some variations in the MP4 Player. However, these variations are not always suitable with the needs of users. In the end, the users feel uncomfortable using the MP4 Player. MP4 Player Qttec QT-102 is chosen as the object research since preliminary evaluation from the users show that it is quite difficult to operate the MP4 without reading the manuals.**

To get a design of MP4 Player which is useable and suitable with the needs of users, it is needed to re-design MP4 Player QT-102 with User-Centered Design (UCD) Method. The advantage of UCD Method is it can investigate the difficulties of users in operating MP4 Player Qttect QT-102 through usability test. By using UCD Method, it can overcome the difficulties as expected by the users.

MP4 Player Qttec QT-102 re-designing is focused on the design and position of buttons, screen or menu display, and mode display. In the re-design of screen display, it is focused on color contrast, position and design of letters on Menu Display, and Mode Display: Music, Record, Voice and FM Mode.

According to result of usability test and interview with respondents, it is proposed two alternatives of MP4 Player design. After the re-designed, the two alternative designs of MP4 Player are evaluated again by respondents using the final questionnaire to determine whether it has been comfortable and suitable with the expectancy of users or not. From the result of final questionnaire, it is found that the first alternative is the best design. Based on result of the evaluation, it can be concluded that the MP4 Player Qttec QT-102 after re-designing is easier to be operated, have higher usability rate, and more appropriate with expectancy of users than the preliminary design.

Keywords : user-centered design, usability test, MP4 player.

I. Introduction

A. *Background of Problem and Problem Statement*

Popularity of MP4 Player is growing more and more each day because of fast and continuous changing of technology. Various producers of MP4 Player compete to give the best features. However, the offered features and models of MP4 are not always necessarily suitable with the needs and expectancy of users. As the result, the users of MP4 Player can feel uncomfortable in using the MP4 Player. The common problem is the difficulty to understand the function of a button without reading the manuals.

The object of this research is MP4 Player Qttec QT-102 made in China, as shown in Fig. 1. It is chosen as the object research since preliminary evaluation from the users show that it is quite difficult to operate the MP4. The difficulties are as result of bad design of buttons, mismatched button information, and bad menu design. The dual functionality buttons add more difficulty as well in operating the MP4 Player.

Fig. 1 MP4 Player Qttec QT-102

To overcome the problem, it is required a good design of MP4 Player which is user-friendly. Therefore, it is required re-design the MP4 Player. Since the design should be focus on the needs [1] and the expectancy of MP4 Player users, the User-Centered Design (UCD) Method [2, 3, 4, 5, 6] is applied in the research.

Fidgeon [2] explained that User-Centered Design (UCD) Method is a human factor approach which put users of a product as the focus in product design and development. As the result, the design can be suitable with the needs and the expectancy of users.

The purpose of the research is to create a design of MP4 Player QT-102 which is usable, user-friendly, and suitable with needs of the user.

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B. Scopes of the Problem and the Assumptions

Scopes of the problem are:

1) MP4 Player QT-102 re-designing is focused on the buttons design (size, button information on the MP4 Player, type and function of the buttons), buttons position, Menu and Mode Display, and button operations.

2) Menu and Mode design is focused on color contrast, position and design of letters on Menu display, and mode display: Music, Record, Voice, dan FM Mode.

3) Respondent of the research is the users MP4 or MP3 Player of any brand, except the MP4 Player QT-102, who have already used the player at least 3 months and the data collection was conducted in Bandung, Indonesia.

4) MP4 Player Qttec QT-102 re-designing is developed until the phase of designing three dimensional product figure.

The assumptions of the research are:

1) There is no changing happened in the preliminary design of MP4 Player QT-102 within the research .

2) The re-design of MP4 Player QT-102 does not consider of certain aspects, such as: the effect of production cost, type of material, and the weight of designed product.

C. Research Methodology

The research methodology of this research shown in Fig. 2.

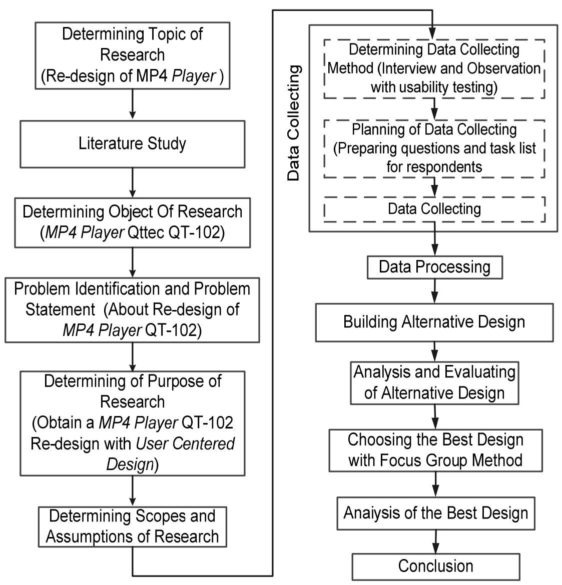

Fig. 2 Research Methodology

II. Collecting and Processing Data

To obtain qualify data; it is required good data collecting instruments as follow:

1) *Questionnaire*: Questionnaire is given to the respondents before and after observation of usability test. In the preliminary questionnaire, the given questions are focused on the profile of respondents and their experiments of using MP4 Player. While in the final questionnaire, the respondents are given statements related with the observed the MP4 Player Qttec QT-102.

2) *Observation (in usability test)*: After the preliminary questionnaire, the respondents are asked to do a set of tasks in usability test [7, 8, 9]. The purpose of the observation is to identify of the respondents difficulty to operate the MP4 Player and to detect the readability of the MP4 Player Menu Display. The usability test uses the validation test, which applies Within-Subjects Design [9] and Think Aloud Method [2].

3) *Interview*: The interview is conducted after the observation. The questions are focused on the experience of respondents in operating the MP4 Player Qttec QT-102.

Purposive sampling [10] is used to choose the respondents. The chosen respondents are people who are able to operate the MP4 Player very well. The research requires 15 respondents [9, 11].

The data obtained from 15 respondents are profile of respondents, time to complete the given task (in the observation), difficulties in completing the given tasks, the result of interview and final questionnaire. According to the usability test, the usability of MP4 Player Qttec QT-102 is low since total of respondents who can complete the given tasks well is less than 50% from 15 respondents.

The result of interview after observation shows that there is 14 problems occurred during usability test. The problems are:

1) It is difficult to adjust the MP4 frequency.
2) It is difficult to find the information of the number of songs.
3) The Power Button is difficult to find.
4) The recording name is unseen.
5) The information of Hold Button is unseen.
6) It is difficult to save the recording.
7) To turn on or off the MP4 Player, it should be done by Power Switch.
8) Information of the recording progress is unseen.
9) It is difficult to find the return menu function.
10) The respondents do not know how to enter mode.
11) The respondents do not know the Voice Mode function.
12) The respondents do not know that Hold Button function is the same with lock function.
13) The position of microphone is unseen.
14) The respondents often push Record Button.

Each problem has its own critical rate, severity rate, and probability (frequency) to occur. Each problem is sorted from the highest to the lowest critical rate, shown in Table 1. The problem with the highest critical rate has the highest priority to be overcome in the re-designing process.

The result of final questionnaire shows that the positive responses from respondents to the usability rate of MP4 Player QT-102 reach 59.05%. According to all processing data, it can be concluded that the usability of MP4 Player QT-102 is still low. Therefore, it is require to re-design the MP4 Player to obtain MP4 Player QT-102 with better usability rate and more user-friendly.

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TABLE 1

PROBLEM PRIORITY OF RE-DESIGNING MP4 PLAYER QT-102

Problem No.	**Frequency Rate**	**Severity Rate**	**Critical Rate**
11	3	4	7
1	3	3	6
3	2	3	
7	2	3	
12	2	3	5
6	3	2	
14	3	2	
10	1	3	
2	2	2	
4	2	2	4
5	2	2	
13	2	2	
8	2	1	3
9	1	1	2

III. RE-DESIGNING PRODUCT

In the preliminary design, MP4 Player Qttec QT-102 has 58 mm length, 12 mm width, and 32 mm height. The preliminary design of three dimensional figure of the MP4 shown in Fig. 1.

After re-designing, it is solved the problem of button information position and design of information writing of the button. Power Switch is replaced with Power Button and placed on the top of MP4 Player. The function as power on Play Button (dual functionality button) was removed. The press system on frequency button is fixed. The three dimensional figure of MP4 Player QT-102 after re-designing shown in Fig. 3.

Fig. 3 MP4 Player Qttec QT-102 (After Re-designing)

MP4 Player QT-102 has eight type of control buttons, which are Menu, Record, Previous, Next, increase volume (+), Play/Stop, decrease volume (-), and Hold Button and a Power (On/Off) Switch. The position of the buttons and the switch in preliminary design shown in Fig. 4.

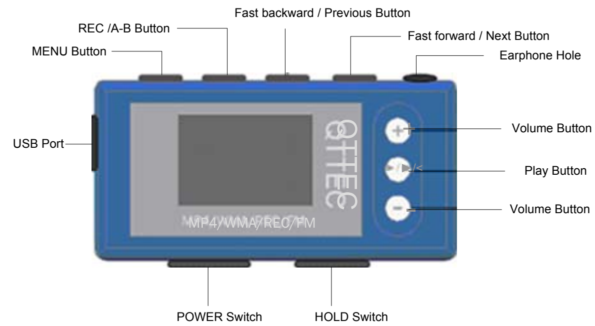


Fig. 4 Preliminary Design of Control Panel

After re-designing, the microphone is placed on the right bottom (shown in Fig. 5). The separated position of increase (+) and decrease (-) Volume Button is fixed into adjacent position. While shape of the Volume Button is changed into half sized bigger than the preliminary design.

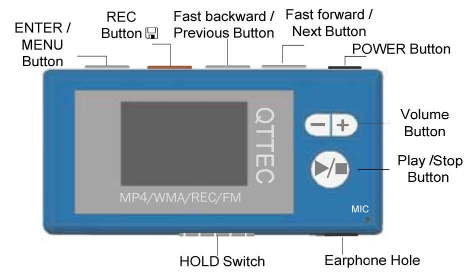


Fig. 5 Control Panel (After Re-designing)

On top of preliminary design of MP4 Player (shown in Fig. 6), there are MENU, record (REC), NEXT, and PREVIOUS button. The size of these buttons is the same, i.e. 17 mm x 3 mm. Besides the control buttons, there is a connector hole for headphones.

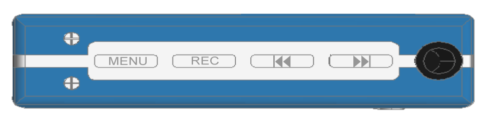


Fig. 6 Preliminary Design of Top View

On top of MP4 Player after re-designed (shown in Fig. 7), it is placed Power (On/Off) Button. Record (Rec) Button is given red color since it should be differentiated from other buttons. The new push and release system proposed in adjusting MP4 frequency. If the button is pushed, the frequency will increase or decrease. If the button is released, the frequency will stop on the last frequency. There is additional information of dual functionality function buttons, such as: on Menu and Record (REC) Button.

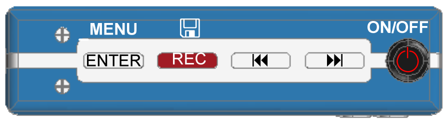


Fig. 7 Top View (After Re-designing)

On the bottom of MP4 Player in preliminary design (shown in Fig. 8), there is Power (On/Off) and Hold Button. Besides these buttons, there is microphone which is useful in voice recording. The design of button information in preliminary design uses capital letters. Its position is on the back of MP4 Player (shown in Fig. 9).

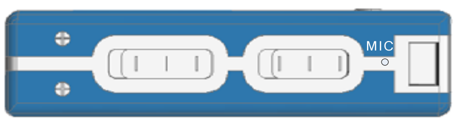


Fig. 8 Preliminary Design of Bottom View

Fig. 9 Preliminary Design of Back View

On the bottom of the MP4 Player after re-designing (shown in Fig. 10), there is Hold Switch and Connector Hole for headphone. Position of the connector is changed to the bottom of MP4 Player in order not to interrupt operating of other buttons.

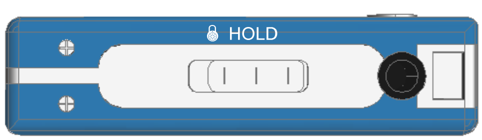
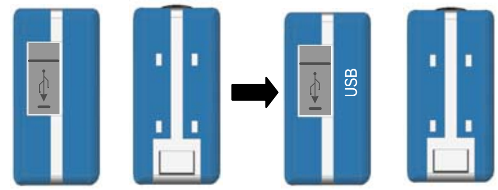


Fig. 10 Bottom View (After Re-designing)

On preliminary design of the MP4 Player side (shown in Fig 12a) , the button information is not clearly seen by the users. On the back (shown in Fig. 11) and side (shown in Fig. 12b) of the MP4 Player after re-designing, there is changing in buttons information position. The On/Off, Hold, and USB information is removed near the related buttons.

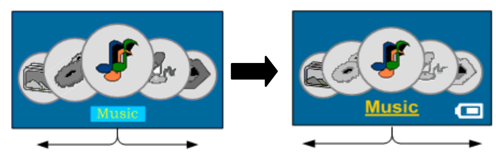
Fig. 11 Back View (After Re-designing)



a. b.

Fig. 12 Side View (Before and After Re-Designing)

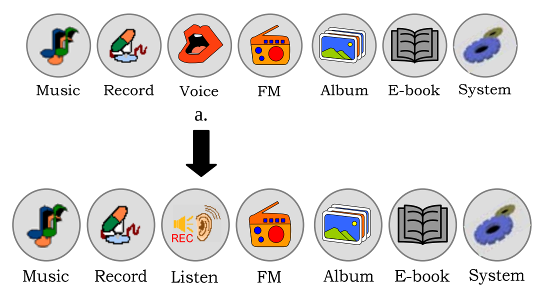
After re-designing, there is changing in Voice Mode picture of Menu Display, mode information, and additional battery indicator on the Menu Display. When MP4 Player is on ready condition, the mode position is still in the middle. However, the blue highlight on preliminary design (shown in Fig. 13a) is removed. The name of mode is written in Italic and Bold style to direct the sight of user to the chosen mode. Menu Display after re-designing shown in Fig. 13b).



a. b.

Fig. 13 Menu Display of (Before and After Re-designing)

Related with the mode picture of preliminary design (shown in Fig 14a), the respondents often confuse between Record and Voice Mode. To overcome the problem, information of Voice Mode is changed into “Listen”, while the picture of the Voice Mode is changed to the picture of ear. The picture of mode after re-designing shown in Fig. 14b.



b.

Fig. 14 Picture Mode (Before and After Re-designing)

The Music Mode display in the preliminary design (shown in Fig. 15a) has the weakness in communicating several Music Mode to the user. Information of number of songs is similar to date. Therefore, in the re-designing information of number of song, it is changed into amount of total songs, given border to it, and moved its position to the top screen. The Music Mode display after re-designing shown in Fig. 15b.

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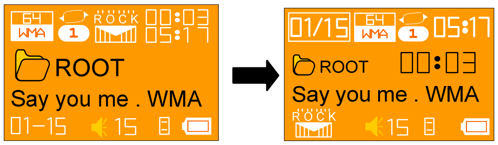
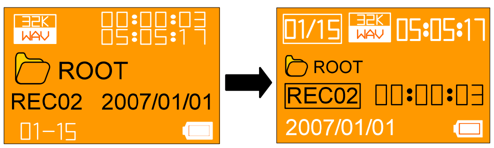


a. b.

Fig. 15 Music Mode Display (Before and After Re-designing)

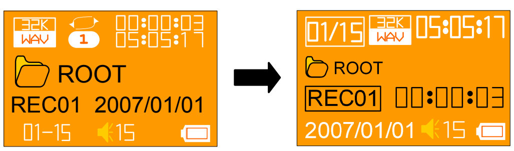
The preliminary design of Record Mode (shown in Fig. 16a) is fixed on its letter size and the position of several information. After re-designing, on the top of Record Mode display there is changing in position of recording number, size of letter, and maximal duration of recording. In the middle of screen, information of the date recording is moved to bottom screen, while in the middle it is shown the information of recording progress. Along with date of recording, in the bottom screen is placed information of battery indicator and recording time. The Record Mode display after re-designing shown in Fig. 16b.



a. b.

Fig. 16 Record Mode Display (Before and After Re-designing)

The size and position of information on Voice Mode display of the preliminary design (shown in Fig. 17a) is also fixed according to the needs of users. The Voice Mode display after re-designing shown in Fig. 17b.



a. b.

Fig. 17 Voice Mode Display(Before and After Re-designing)

According to respondents, FM Mode display of the preliminary design is easy to be understood by the users. Therefore, the FM Mode is not changed at all. The preliminary design of FM Mode shown in Fig. 18.

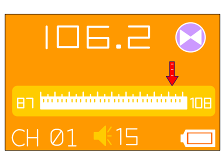


Fig. 18 FM Mode Display

IV. Analysis of the Design

After two alternatives proposed, the next phase is to identify strong and weak points of each design which is shown in Table 2. Although each design has the strong and weak points itself, it should be chosen the best design as the result of this research. The chosen best design based on the result of discusion using focus group method and the consideration criteria of good MP4 Player display.

The criteria of good MP4 Player display are as follow:

1) display simplicity, such as button information, the shape and the color of buttons;

2) minimize area needed in placing the buttons and the button information,

3) flow movement consistency from the users in operating the buttons to minimize movement complexity,

4) placing buttons information consistency, and

5) minimize movement and time operation needed by the users with the chosen button shape.

According to the result of focus group and the criteria of good display of MP4 Player, the first alternative is the best design. The result of focus group shown that 72.22% from the total of 18 respondents choose the first alternative.

TABLE 2

Analysis of Strong and Weak Points of the First And Second Alternative of Re-Designing MP4 QT-102

Analysis	**Alternative 1 of MP4 Player QT-102**	**Alternative 2 of MP4 Player QT-102**
Strong Points	The amount of information of button near the screen is unchanged.	There is no additional new button.
	The number of buttons in the bottom of MP4 Player is less than the preliminary design.	Power (ON/OFF) Switch lessen the press tendency.
	The movement of Hold Switch is not interrupt with the Headphone Connector.	The information of button can clearly be seen from the front of MP4 Player so that it can lessen the press error.
	Power (On/Off) Button is easier to be known and used.	
Weak Points	There is additional Power (On/Off) Button on the top of MP4 Player.	The information of button near the screen is increase.
	Power (On/Off) Button can be pressed unintentionally.	The number of buttons on the bottom of MP4 Player is unchanged.
	The information of buttons is unclearly seen from the front of MP4 Player so the press error can occur.	The movement of Hold Button is a little interrupt with the Headphone Connector.
		Power (On/Off) Switch is harder to be recognized and used.

According to the criteria of good MP4 Player display, the first alternative has these criteria:

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- The display and the button informations are simpler and neater, since there is no separated information from the buttons. It is suitable with the second criteria.
- The button information is placed consistently, which is on the top of the related buttons. It is suitable with the forth criteria.
- The shape of Power (On/Off) Button is easier to be used than the Power (On/Off) Switch of the second alternative. It can minimize the movement and time operations by users. It is suitable with the fifth criteria.

V. CONCLUSIONS

The preliminary evaluation of MP4 Player Qttec QT-102 design shows that MP4 Player Qttec QT-102 has low level of usability rate. It is measured from time to complete a set of tasks and the success percentage of operating the MP4.

After proposed two alternatives based on UCD Method, the first alternative is chosen as the best design. The evaluation result of final questionnaire shows that the usability rate of the first alternative design reaches 88.46 %. It is higher than the usability rate of preliminary design that only reaches 59.05%.

According to the result of this research, the future work suggested are as follow:

1. Producers of the MP4 Player should pay more attention to the problem occurred on the MP4 Player and apply the given solution for re-designing the MP4 Player.
2. Further research can be done for high technological product, such as: Ipod.
3. Further research should include various type of MP4 Player so that the re-designing result can be applied generally.

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ISBN : 978-602-97809-0-1

A Model of Product Performance Forecasting (Case study on Low End Segment Mobile Phone)

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Abstract - to reduce the risks associated with new product, forecasting becomes very important to estimate success rate of the product. Causal based forecasting model is developed based on price, technical superiority, time from launching, brand, and customer perception. A model of product performance forecasting is developed by Artificial Neural Network (ANN) and Regression. Linear regression and artificial neural network are applied and compared to the proposed model. The result shows that ANN gives better measure performance.

Keywords: product performance, success factors, regression, artificial neural network

I. INTRODUCTION

Some research showed that the development and introduction of a new product is an inherently risky venture. Crawford identified that 35 % to 45 % of new products failed to compete in market [1]. Stevens and Burley even identified that the failure rate of new products was somewhere between 40 % and 75% [2].

To reduce the risks associated with new products, forecasting becomes very important to estimate success rate of the product. Some sales forecasting has become an established practice within the marketing research industry. Despite many claims of high precision, sales forecasting of new products is risky and estimation can often be off the mark. Some forecasting techniques are available. Three broad categories of forecasting methods are Qualitative, Time Series, and Causal [3] however qualitative and time series are not quite appropriate to forecast new product performance because of limited historical data. Causal forecasting method is the most commonly used because it can find the correlation between demands and environmental factors and use them to develop forecasting model.

This researcher emphasizes on identifying and developing forecasting tools to evaluate product performance based on success factors. The model will be developed based on some needs and assumptions, namely, (1) Product success factors tend to be different among different type/level product so estimation model must be developed for each product segment. (2) This model also can be used to evaluate the existing product in market whether it is successful or not so the model is generated based on successful product data. (3) The model is developed based on regression and neural network.

II. LITERATURE REVIEW

Product performance factors

Product success rate is the percentage of products meeting the firms' objective (financial) criteria [4]. It is usually measured based on product performance. The term product performance is associated to product properties. Different definitions of performance are found in the literature. Ulrich and Eppinger define product performance as: "How well a product implements its intended function" [5]. The definitions imply that product performance is a measure of functional aspects of the product.

Many researchers identified some factors of success [6][7][8][9] and develop product performance measures [10][11][12][13]. Montoya-Weiss & Calentone underlined that many researches did have wide variation in result and they are non convergent [9]. Based on multivariate analysis, Cooper identified 11 dimensions (from 77 observed independent variables) of product success [14]. They were product uniqueness/superiority, market knowledge and marketing proficiency, technical synergy/proficiency, market dynamics, market need (growth and size), price, marketing and managerial synergy, marketing competitiveness and customer satisfaction, newest to firm, strength of marketing

ISBN : 978-602-97809-0-1

communication and launch effort and source of idea/investment magnitude.

Henard & Szymanski developed taxonomy of product success factors that consisted of 4 main factors [8]. They were product characteristics, firm strategies, firm process characteristics, and market characteristics. By using meta-analysis of 60 empirical studies, Henard & Szymanski also showed 8 important variables of product performance. They were product advantage, product innovativeness, marketing strategy, technological strategy, structured effort, market orientation, cross functional integration and competitive response intensity [8]. Cooper & Kleinschimidt, based on effect on profitability and impact, identified some critical factors which drive product success [6]. Top four of them were high quality product process, new product strategy, adequate resources, R & D spending.

Artificial Neural Network

An *Artificial Neural Network* (ANN) is information-processing systems that have certain performance characteristics in common with biological neural network [15]. They have been developed as generalization of mathematical models of human cognition or neural biology. ANN is based on architecture that models data sets and it can represent any continuous functional mapping between the input and output variables (Figure 1).

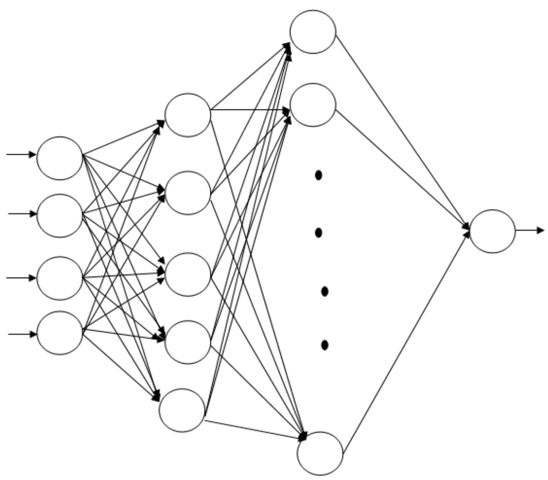

Figure 1.The architecture of a three-layer neural network

Back-Propagation Neural Network (BPN), based on supervised learning, is one kind of popular neural network as the black box that can set up the nonlinear map between the inputs and outputs for the prediction. Standard back propagation (feed forward) is a gradient descent algorithm, in which the network weights are moved along the negative of the gradient of the performance function [16]. The term back propagation refers to the manner in which the gradient is computed for non linear multi layer networks. It applies supervised learning to monitor the difference between the true data and the prediction, and then does a sequent revision on the weighting along the branches of BPN so that the difference between true data and the prediction (e^2) will converge gradually within finite steps. This method requires the inputs and outputs of a neural network were limited within the ranges from 0 to 1

Properly trained back propagation networks tend to give reasonable answers when presented with inputs that they have never seen. Typically, a new input leads to an output similar to the correct outputs for input vectors used in training. This generalization property makes it possible to train a network on a representative set of input/target pairs and get good results without training the network on all possible input/output pairs [17]. The training of a BPN includes three stages: (1) feed-forwarding of the input training pattern, (2) associated error calculation and back-propagation, and (3) weight and bias adjustments.

ANN has been successfully applied in some areas of forecasting. Binner, et.al. applied ANN to model Taiwan's inflation rate resulting in particularly accurate forecasts when divisia monetary measures were used [18]. ANN successfully has also been applied in some intelligent manufacturing cases [19] and design [20][21].

III. CONCEPTUAL FRAMEWORK

The conceptual framework of the model is developed based fives important factors of product success, namely, price, product superiority, timing, company superiority, and product images. Price sensitivity is important variable for customer to buy a product because it can limit someone to buy a product [22]. A significant variables of product advantage are technical superiority [8][9][23]. Launching timing is very important variable to product success [24][25]. Brand equity is important variable for customers to buy a product [22] [26]. Aesthetic and symbolic have important role of product appearance. Consumer goods carry and communicate symbolic meaning [27].

The literature reviews indicate some variables influence performance product success. They are launching, technical superiority, pricing, brand and customer perception. By considering the identified variables, estimation model is designed (Figure 2).

IV. METHODOLOGY

Besides literature reviews, an empirical study was done. A survey was run to identify customer behavior in buying mobile phone. The result showed that customers considered quality, simplicity, price, and product image as significant variables to buy a mobile phone. Quality and simplicity referred to technical superiority. This result supported the model developed

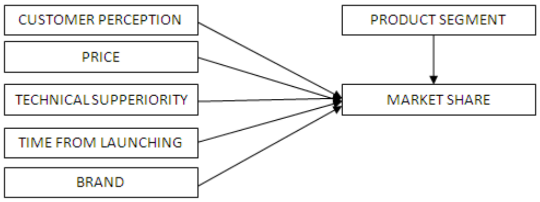

Figure 2. Conceptual diagram of the model

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Two steps research are performed namely success variables identification and product success forecasting model development**.** Success variables identification is applied by analyzing variables regression/correlation. Based on the variables identified, a model is developed for each product segment. Some variables that significantly correlated to sales are involved in estimation model. Two estimation techniques, namely linear regression and back propagation ANN, are applied to develop the model.

Market share is identified based on sample consists of 135 mobile phone shops in Yogyakarta and Southern of Central Java in period of January until September 2008. The product is classified as low end product if its price is less than $ 150.

Some data ware involved in this analysis, they were launching date, technical specification, price, and brand value and customer perception. Launching dates were used to determine both launching duration and innovation (with technical specification). Technical superiority values were determined by calculating the average of some technical specification such as screen resolution, data transfer speed, and features. Likert scoring was used to quantify the features rate. The technical superiority norm was performed in Table 1.

Table 1. Technical Superiority Norm

Value	Screen	Camera	Data transfer/ OS	Features
1	MONOCROM	-	-	-
2	CSTN 65.536	VGA	GPRS 10	RADIO/
3	TFT 65.536	1.3 MP - 2 MP	SYMBIAN 9.	RADIO/MP3
4	TFT 262.144	3.12 MP (2 MP & VGA)	SYMBIAN S60	RADIO/MP3/GPS
5	TFT 16.000.000	5 MP & VGA	SYMBIAN S60, WIFI, GPRS 32, HSDPA	RADIO/MP3/GPS, OFFICE APPL

This paper uses mobile phone brand value analysis done by SWA and MARS 2008 and % sales were taken from Yogyakarta Nokia Representative. Brand values were determined based on brand share, brand awareness, advertisement awareness, customer satisfaction, and gain index. They were analyzed from survey that involved 2648 respondents collected from 7 big cities of Indonesia [28].

Customer perception was based on shape, price, easy to use, image and quality. Shape consisted of 7 attributes, price, easy to use, image and quality had 2, 4, 5, 7 attributes.

V. RESULTS AND DISCUSSION

Nokia has highest %sales by 73 %, followed by Sony-Ericsson (10%), and Motorola (4%). The rest is for LG, Samsung, and other brand. The low-end product has highest market by 58 %. The medium and high products have 16% and 2%. The phenomenon that low-end product has very high shared correlates to the Indonesian income that is still low (less than $1600 per annum).

Linear regression and back propagation ANN are run to estimate product performance. To minimize computation and reduce collinearity, regression backward analysis is applied. The initial model consists of 27 variables (24 variables are from customer perception and 3 variables are from tangible product performance). Based on the backward analysis, the variables can be reduces become 6 variables. The final regression models is

$$y= 9.726 - 0.339\,KH1 - 0.711\,KM4 - 0.003\,PR - 0.06\,WK - 1{,}246\,TCH + 0.061\,BR \quad \text{.....................................(1)}$$

Where:

KH1 = customer perception on product price
KM4 = customer perception on product luxury
PR = product price
WK = time duration from launching
TCH = technology superiority
BR = brand index

The regression model fits because R of the equation is 0.956 and value R^2 is 0.912.

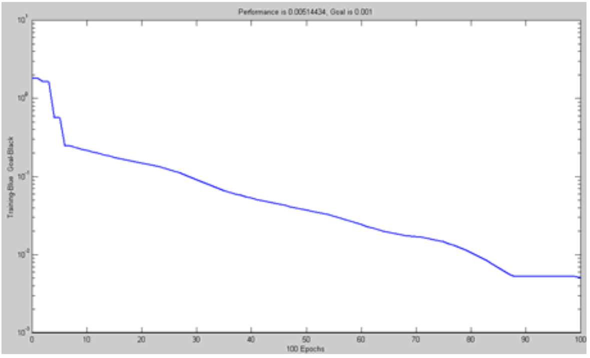
ANN is applied and compared to regression results. After simulating some architecture, three layers back propagation ANN with the number neurons are 5, 10, and 1 are applied. Activation function of first, second and third layers are pure linear, binary sigmoid and pure linear. The best value for learning rate is 0.3.

Model validation is run by analyzing training and testing errors for the architecture MSE based training error analysis indicate that ANN gives better result compared to linear regression. The comparative study between the methods performed in Table 2.

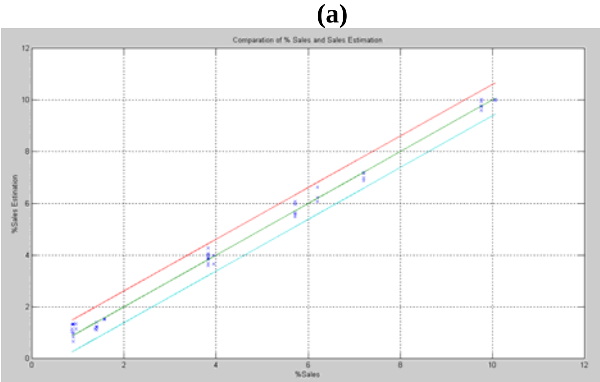
Table 2. The performance comparative study among forecasting methods

Characteristics	Regression	ANN
R	0.956	
MSE	0.9704	0.2046

The deviation of forecasted ANN result and actual value is relative small. It is less than 3 sigma (Figure: 3).



(a)



(b)

Figure 3: (a) ANN performance (b)ANN % sales estimation performance VS % sales for Low-end product

The testing errors show the model can perform well because there are no significant different between the forecasting results and the real value (α= 0.05). The complete result performs in Table 5. Small error average of training and test error show that ANN model can fit to the cases.

VI. CONCLUSION

1. The ANN model gives better result compared to linear regression
2. The best ANN architecture is three layers back propagation ANN with the number neurons are 5, 10, and 1. Activation function of first, second and third layers are pure linear, binary sigmoid and pure linear.

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Table 3. Performance Analysis of The model

DATA								TESTING ERROR	
KH1	KM4	KM5	HARGA	WAKTU	TECH	BRAND	MS	REGRESSION	ANN
4	2	2	385	12	1.25	82.1	10.0581	0.494996	-0.1175
3	3	3	400	12	1.5	82.1	9.760845	0.885745	-0.19296
3	2	2	800	49	1.5	82.1	5.720435	-1.52566	-0.08026
3	3	3	800	49	1.5	82.1	5.720435	-0.81466	0.151435
4	3	2	550	18	1.75	82.1	6.198441	-1.62116	-0.36696
4	4	4	850	12	2.5	82.1	7.204006	0.759906	0.210206
3	3	4	850	12	2.5	82.1	7.204006	-0.29009	0.079306
3	3	3	835	27	3	11	1.40093	-0.23757	0.21613
4	4	4	835	27	3	11	1.40093	0.81243	-0.25097
3	3	3	835	27	3	11	1.40093	-0.23757	0.14433
3	3	4	1000	22	3.25	11	0.86739	-0.71011	0.24169
4	3	4	1050	17	3	82.1	3.830336	-2.34176	-0.15226
3	3	3	1050	17	3	82.1	3.830336	-2.68076	-0.01866
2	4	3	750	27	2	11	0.896735	-1.64127	0.099535
3	3	3	650	12	2.25	11	1.575104	-1.9534	-0.0391
MEAN								-0.74006	-0.00507
STANDARD DEVIATION								1.181775	0.186906
T TEST								-2.72967	-0.11823

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

Implementation of FMEA to Design Actions Plan

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Abstract. **In a highly competitive, every company must maintain product quality to get customer satisfaction. One method to maintain or improve product quality is called Failure Mode and Effect Analysis (FMEA). This method can contribute to improve design for product or process at manufacturing or service industries. This paper develop FMEA to design actions plan in the textile industry that is PT CS. Production process of PT CS has achieved an International Standard for quality management system, except The Second Weaving Department that still produce some defective products. Observation of this research is focused on this department to reduced product defect. There are 11 types of defects in Grey, product of The Second Weaving Department. Among the 11 types of defectives, there are two main types of defects that affect quality of products, namely double warp and broken warp. Analyze by using cause-effect diagram, can resulted many causes of the both main types of defects - that is called failure mode - as much as 7 items. Process FMEA begins from analyzing the effect of each failure mode, the frequency of occurrence, and likelihood of occurrence, and followed by determining the Severity Number, Occurence Number, Detecting Number and Risk Priority Number (RPN). The failure modes with highest RPN should be the highest priority to correct. In this case, the recomended actions to reduce product defects are create SOP for operating machine correctly, communicate the SOP to operator by training, inspect yarn and improve the previous process in Warping Department, and periodically inspect and controll all parts of the machine.**

Keywords: **FMEA, maintain product quality, RPN.**

I. INTRODUCTION

The failure in production process can produce many defective products that can received by costumer. It will affect the company's growth. In another hand, customer satisfaction become a necessity that must be met in a highly competitive.. Therefore, how does improve or maintain a product quality become a very important thing.

There are many methods to improve or maintain product quality. One kind of them is Failure Mode and Effect Analysis (FMEA).

A failure mode and effect analysis (FMEA), is a procedure in product development and operations management for analysis of potential failure modes within a system for classification by the severity and likelihood of the failures. *Failure modes* are any errors or defects in a process, design, or item, especially those that affect the customer. *Effects analysis* refers to studying the consequences of those failures [1].

The FMEA method can contribute to improved designs for products and processes, to have higher reliability, better quality, increased safety, enhanced customer satisfaction and reduced costs [2]. It provides a knowledge base of failure mode and corrective action information that can be used as a resource in future troubleshooting efforts. In addition, an FMEA is often required to comply with safety and quality requirements, such as ISO 9001, QS 9000, ISO/TS 16949, Six Sigma, FDA Good Manufacturing Practices (GMPs), Process Safety Management Act (PSM), etc. [3]

It is widely used in manufacturing industries in various phases of the product life cycle and now increasing is used in the service industry. This paper will study FMEAs implementation steps that is used in manufacturing industry – in the textile industry as a case – to improve actions plan.

II. BOOKS REVIEW

According to Breyfogle [4], Failure Mode and Effects Analysis (FMEA) is one method or methodology that provides a facility in process improvement efforts. By using FMEA, an organization can identify and reduce the problems that occurred in the early stages of the development process or product design stage. Applying FMEA appropriately will improve customer satisfaction for both customers internal and external customers.

The FMEA systematically considers each component of a system, identifying, analyzing, and documenting the possible failure modes within a system and the effects of each failure on the system. It is a bottom up analysis beginning at the lowest level of detail to which the system is designed and works upward [2]

The FMEA is divided into two parts, namely Design FMEA and Process FMEA. Design FMEA is a procedure for identifying whether the materials used are appropriate, in connection with customer specifications and to ensure that government regulation has been applied, before finishing the product design. Conversely, the Process FMEA associated with manufacturing and assembly processes. The Process FMEA begins when the already available reports from the Design FMEA. The Process FMEA to identify potential failures that may result from the processes of manufacture / assembly, engine, features and methods of production [5].

Foster [2] explained that there are five basic areas where FMEA can be applied. These are concept, process, design, service, and equipment. In the concept area, FMEA is used to analyze a system or its subsiystems in the conception of the

ISBN : 978-602-97809-0-1

design. As [5] told, Fosters [2] had a similar opinion about using of FMEA in the design and process area. With service area, [2] state that FMEA is used to test industry processes for failure prior to the their release to customers. A company also can use FMEA to analyze equipment before the final purchase.

The outcome of an FMEA development is actions to prevent or reduce the severity or likelihood of failures, starting with the highest-priority ones [6].

FMEAs are developed in three distinct phases where actions can be determined. It is also imperative to do pre-work ahead of the FMEA to assure that the Robustness and past history are included in the analysis [7].

- **Step 1** is to determine all failure modes based on the functional requirements and their effects. If the severity of the effect is a 9 or 10 (meaning safety or regulatory in nature) actions are considered to change the design or process by eliminating the Failure Mode if possible or protecting the customer from the effect [6,7].
- **Step 2** adds causes and Occurrences to each Failure Mode. This is the detailed development section of the FMEA process. Reviewing the probability or occurrence number in order of the highest severity and working downwards, actions are determined if the occurrence is high (> 4 for non safety and regardless of occurrence >1 when the severity is 9 or 10)
- **Step 3** considers testing, design verification and inspection methods. Each combination from steps 1 and 2 which are considered at risk requires the detection number to be selected. The detection number represents the ability of planned tests and inspections at removing defects or excite failure modes to fail [6,7].

After these three basic steps, Risk Priority Numbers (RPN) are calculated, by multiplying these three numbers: RPN = S × O × D.

The failure modes that have the highest RPN should be given the highest priority for corrective action. This means it is not always the failure modes with the highest severity numbers that should be treated first. There could be less severe failures, but which occur more often and are less detectable [8].

After these values are allocated, recommended actions with targets, responsibility and dates of implementation are noted. These actions can include specific inspection, testing or quality procedures, redesign (such as selection of new components), adding more redundancy and limiting environmental stresses or operating range. Once the actions have been implemented in the design/process, the new RPN should be checked, to confirm the improvements. These tests are often put in graphs, for easy visualization. Whenever a design or a process changes, an FMEA should be updated [1].

Figure 1 shows the cycle of FMEA implementation steps.

III. METHODOLOGY

Based on explanation above, FMEA implementation steps are divided into two parts [7], namely:

Part 1 : pre-work ahead of the FMEA to assure that the Robustness and past history are included in the analysis, which include:

1. Collecting data of types and number of defects
2. Determining Priority Issues
3. Finding Causes Problems

Part 2 : the Process FMEA, which include :

1. Ranking of the Severity, Occurence and Detecting Number,
2. Calculating RPN,

Improving actions plan

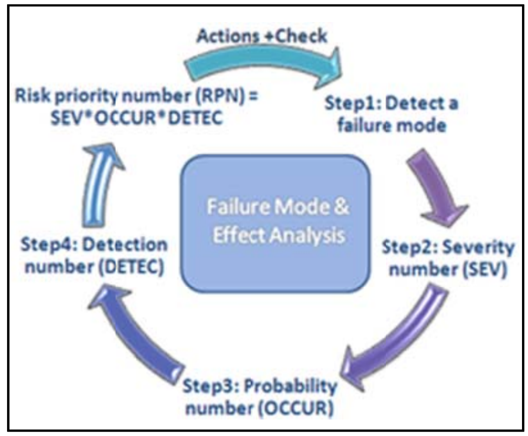

Fig. 1 The FMEAs cycle adapted from : [1]

IV. CASE STUDY

This paper will take a case of implementing FMEA in PT CS to improve actionsplan.

PT. CS is one of textile manufacturing industries that produce interior fabrics. In the production process, PT. CS has dicided to concern the quality objectives in the international standard for quality management systems and has measured the quality objectives. Based on the result of measurement, there is still one department that have not achieved the quality objectives, that is Second Weaving Departments. Production activities in the Second Weaving Department begin from the process of forming yarn into cloth, the semi-finished fabric called Grey. The problem in this department is still producing many defective product. It causes the target of quality have not achieved very well. This problem will be reduced by improving actions plan using FMEA method.

Implementation of FMEA divided into 2 parts, there are : pre-work ahead of FMEA to analyze existing condition and followed by process FMEA which include measuring of Severity Number, Occurence Number, Detecting Number and Risk Priority Number (RPN).

A. Part 1 : Pre-work ahead of FMEA

Analyzing of excisting condition follows include steps :

1) Collecting data of types and number of defects

ISBN : 978-602-97809-0-1

These datas had been collected by direct tally from sample products for 1 month. Stratification of types of defects and number of every types shown on Tabel 1.

2) Determining Priority Issues

Type of defects in tabel 1 are sorted from the highest to the lowest for frequencies of appearance. The result of sorting shown into Pareto Diagram in Figure 2.

TABEL 1

STRATIFICATION OF TYPE OF DEFECT

No	Type 0f Defect	Code	Frequencies
1	Broken warp	F	19
2	Back off weft	A	3
3	Wad weft	S	4
4	Broken weft	M	6
5	Jump warp	E	4
6	Misfeeds comb	U	2
7	Empty warp	K	2
8	Stripe weft	L	2
9	Double warp	C	27
10	Dirty oil	R	3
11	Slack weft	B	7

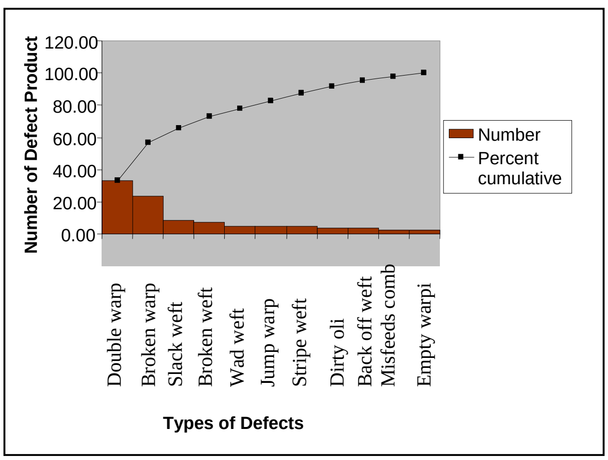

Fig. 2 The Pareto Diagram for many types of defects

3) Finding Causes Problems

In Pareto Diagram, it can be seen that there are two main types of defects that causing product defects, namely double warp and broken warp. These two main problems will identified its causes by using cause-effect diagram.

The cause-effect diagram devide causes into 5 parts, that are method, machine, environment, material and man. By means of direct observation, it's found many causes in every part. Figure 3 shows the cause-effect diagram for two main problems that cause product defects.

Every cause that affect product defect is called failure mode. In this case, there are 7 failure modes that will causes double warp and broken warp. At the end, it will produce many defective products.

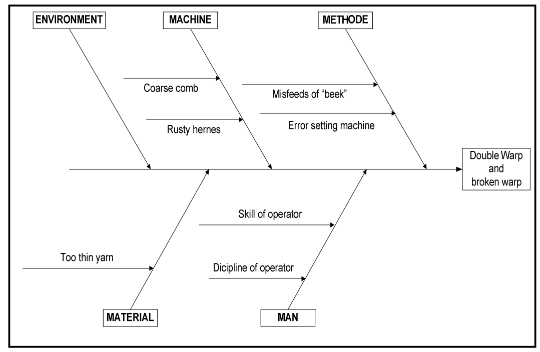

Fig. 3 The Cause – effect Diagram for main problems

After analyzing many problems in the production area of Second Weaving Department, the next step is process FMEA.

B. Part 2 : The Process FMEA

Part 2 begins from determining effect of each failure mode that have been identified. This effect is ranked by Severity Number, from 1 to 10. If the failure mode will be a dangerous effect , the Serevity Number is 1, while if will not effected, the Serevity Number is 10 [1].

Frequency of each failure mode is ranked by Occurence Number, from 1 to 10. If the failure mode almost be sure will occur, the Occurence Number is 10, while if imposible will occur, the Occurence Mumber is 1 [2].

The probability of occurence that is caused by each failure mode is ranked by the Detection Number, from 1 to 10. If the probablity is high, the Detection Number is 10, while if it is low, the Detection Number is 1 [2].

The result of each number for every failure mode shown in Tabel 2. In the last column, RPN are calculated by multiplying these three numbers.

V. ANALYSIS

The failure modes that have the highest RPN should be given the highest priority for corrective action.

In this case, the error setting machine and misfeeds of "beek" are failure modes that have the first and second highest RPN. Both of failure modes are "method" of the cause - effect diagram. If it's traced, the operationalization method of machine is affected by the presence or absence of Standard Operational Procedures (SOP) about how to operate machine correctly. In our observation, PT CS does not have SOP for operating machine correctly.

In addition to the SOP, the operator also influences the occurrence of both highest of the failure modes. Without SOP, operator will construct their own experiences become skills. It resulted skill of every operator unequal.

TABEL 2

RECAPITULATION OF SEVERITY NUMBER, OCCURENCE NUMBER AND DETECTING NUMBER

No.	Failure Mode	Severity Number		Occurrence Number		Detection Number		RPN
		description	rank	Description	rank	Description	rank	
1.	dicipline of operator	It will less affect production process	5	There are 3 defects among 1,278 Roll of fabric, (1 in 20,000)	2	Probability of occurence becuase of the failure mode is low	2	20
2.	skill of operator	It will affect the production process	6	There are 6 defects among 1,278 Roll of fabric (1 in 4,000)	3	Probability of occurence becuase of the failure mode is low	3	54
3.	misfeeds of “beek”	it will cause defects in the product	7	There are 9 defects among 1,278 Roll of fabric (1 in 1,000)	4	Probability of occurence becuase of the failure mode is moderate	4	112
4.	Error machine setting	It will cause defects during production	8	There are 11 defects among 1,278 Roll of fabric (1 in 1,000)	4	Probability of occurence becuase of the failure mode is moderate	4	128
5.	Rusty Hernes	It will affect on product quality	6	There are 5 defects among 1,278 Roll of fabric (1 in 4,000)	3	Probability of occurence becuase of the failure mode is low	3	54
6.	Coarse comb	It will affect the results of fabrics	6	There are 3 defects among 1,278 Roll of fabric (1 in 20,000)	2	Probability of occurence becuase of the failure mode is low	2	24
7.	Too thin yarn	It will cause a broken warp	7	There are 9 defects among 1,278 Roll of fabric (1 in 1,000)	4	Probability of occurence becuase of the failure mode is moderate	4	112

In this case, it is proposed to create SOP for operating machine correctly, start from setting, feeding, operating until unloading product. The SOP that has been prepared must be communicated to the operator by training to know well about it.

The third highest RPN is material part. It’s proposed to inspect the raw material before processed, and suggested to improve the previous process in Warping Department.

The fourth highest RPN are parts of the machine condition, that is comb and hernes. We find that these parts have not been maintained periodically. PT CS will substitute these parts if they have been broken. It’s suggested to inspect and controll periodically all parts of machine.

All suggestion are resumed in the FMEA worksheet that shown in Tabel 3, and are arranged the priority-highest for corrective action.

VI. CONCLUSIONS

By using FMEA, it can be created improvement plan, based on the failure analysis. Implementation of improvement plan is expected to reduce failures.

This paper obtained 11 types of defects in Grey, the product of Second Weaving Department. Among the 11 types of defectives, there are two main types of defects that affect the quality of products, namely double warp and broken warp. By using cause-effect diagram, the causes of both main types of defects that is called failure mode can analyzed. There are 7 failure modes.

Process FMEA begins from analyzing the effect of each failure mode, the frequency of occurrence, and likelihood of occurrence, and then determining the Severity Number, Occurence Number, Detecting Number and Risk Priority Number.

Based on the calculation of the RPN, it has found the priorities for process improvement. The failure mode and the recommendation actions of the highest-priority shown in Table4.

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TABEL 3

SUGGESTED ACTIONS PLAN BY USING FMEA

Item/ Function	Potential Failure Modes	Potential Effect Of Failure	Seve-rity (S)	Potential Cause/ Mechanism Of Failure	Occur-rance (O)	Current Process Control	Detec-tion (D)	Risk Priority Number (RPN)	Recommended Actions	Respon-sibility
Double warp and/or broken warp	error setting machine	All product s to be defective	8	Operator didn't know how to operate machine correctly	4	controlled by the chief	4	128	Creating SOP how to setting machine correctly	Work Station of Second Weaving Depart-ment
	misfeeds of "beek"	Many products to be defective	7	Operator didn't know ho to operate machine correctly	4	controlled by the chief	4	112	Conducting training to operators about installation process of warp correctly	
	too thin yarn	warp will broken	7	Yarn is processed directly without inspection	4	controlled by the chief	4	112	Inspecting yarn and improving the previous processes in Warping Department	
	skill of operator	Production process will be affected	6	There's no SOP for operating machine	3	controlled by the chief	3	54	Conducting training to operators about operating machine correctly	
	rusty hernes	Hampered process	6	Part is substituted if it is damaged	3	controlled by the chief	3	54	Periodic inspection and substitution the rusty hernes	
	coarse comb	Hampered process	6	Part is substituted if it is damaged	2	controlled by the chief	2	24	Periodic inspection and substitution the coarse comb	
	dicipline of operator	little influencial	5	Operator works lack of dicipline	2	controlled by the chief	2	20	Conducting training to operators about self-discipline	

Source : [2]

==

TABEL 4

RECOMMENDED ACTIONS

No.	Failure Mode	Recommended Actions
1	error setting machine	Creating SOP how to setting machine correctly
2	misfeeds of "beek"	conduct training to operators about installation process of warp correctly
3	too thin yarn	Inspect yarn and improve the previous processes in Warping Department
4	skill of operator	conduct training to operators about operating machine correctly
5	rusty hernes	Periodic inspection and replacement rusty hernes
6	coarse comb	Periodic inspection and replacement of coarse comb
7	dicipline of operator	conduct training to operators about self-discipline

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ISBN : 978-602-97809-0-1

Cooperative Multi-person Decision on Product Development

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Abstract **- Decisions for multi-person on product development are very complicated since many parties involved. Where a number of stakeholders are involved in choosing single alternative from a set of alternatives, there are different concern caused by differing preferences, experiences, and background. Therefore, a support system is required to enable each stakeholder to evaluate and rank the solution alternatives before engaging into negotiation. Function and cost as value criteria is one of the most important key success factors. Cooperative decision is presented in a coalition formation in form of a mathematical model. It consists of the process of identifying agreement options, analysis and coalition formation. The objective is attained by model of satisfying game as a basis for two main preferences of value which are function and cost. This model provides a set of analysis on cooperative game theory to get an algorithm of coalition for agreement option. The results demonstrate a process to select priorities of product development in a business process.**

Keywords **- Cooperative, decision, product, value.**

I. Introduction

In the context of strategic management, competitive advantage of a business depends on the value of product business. For a product business, low price by cutting cost is not the best strategy. The survival of the fittest for the business is value. Product development display an increasing awareness of sustainability but invariability assumed a level of technical sustainability and concentrate on economic and social sustainability. Therefore value should be the main consideration when choosing a solution

How product will be designed, produced, and marketed is based on how business can identify unnecessary cost and basic function of the product. This concept is called Value Management (VM). It is a structured and analytical process that seeks to achieve value by identifying all necessary functions at the lowest cost, while maintaining with the required levels of quality and performance [1]. VM will also drive business strategy in two ways which are resource based view by target costing and competition by lower cost in appropriate function of product. It also means that VM identifies and eliminates unnecessary cost based on function analysis [2]. Unnecessary cost is the nature in a product development. VM has been adopted in many countries as a very effective tool to meet the increasing demands for value enhancement by clients [3]. Value-based decision is an effort of VM process. It improves the value of a product through identifying opportunities to remove unnecessary costs.

As a process involving multi disciplines and teamwork [6], negotiation becomes an important role in the value-based decision process of a component or an element of a product. Many researchers suggested applying Game Theory in negotiation support system (NSS) [4], [5]. However, NSS model for VM processes has not been developed. This research applies the satisfying game method where function and cost of solution techniques as value criteria can be formulated on coalition algorithms for cooperative decision.

II. Theoretical Background

A. Value-based Decision

Real-time decisions are reached using value-based methods in a team setting: function analysis, quality modeling, group creativity/innovation techniques, life-cycle costing, design/cost simulation modeling, and choosing by advantages [7]. Crow [8] argued that the meaning of value may be open to interpretation but generally the value of product will judged on some factor such as a high level of performance, capability, emotional appeal, style, etc. relative to its cost. This can be expressed as: Value= Function/Cost.

Many researchers [9] believe that value analysis is a powerful problem solving tool that can reduce cost while maintaining or improving performance requirements. Value analysis is not concerned with simply minimizing cost. It is possible to increase the value of a product by increasing its function even when this results in greater cost, provided that added function increases more than additional cost. This leads to the concept of functional worth, which is defined as the lowest cost to provide a given function [10].Value-based decision allows an understanding of the relationship between functions of a product and purpose of their existence to be developed.

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B. Cooperative Games

Cooperative game theory concepts have been used. The concepts are suited to decentralized multitask environment [11]. Cooperative games are often defined in terms of a characteristic function which specifies the outcomes that each coalition can achieve for itself. A cooperative game consists of two elements which are first, a set of player N = {1,2,…, *n*}. Members of *N* run from 1 to *n*. The second is a characteristic function specifying the value created by different subsets of the player in a game. The characteristic function is a function denoted *v* that associates with every subset *S* of *N*, denoted *v*(*S*). In a cooperative game, it is a pair (*N*,*v*), where *N* is a finite set and v is a function that maps subsets of *N* to members.

C. Coalition and Characteristic Function

Decision makers may choose to cooperate by forming coalitions. Coalition is formed in order to benefit every member of the coalition so that all might receive more than they could individually on their own. Coalition has been used in many researches in negotiation [12] and cooperative games such as transmission planning in power system [13], cooperative information agent-based systems [14], and COTS selection [15]. Soh and Tsatsouls [16] proposed a coalition approach that identifies and builds sub optimal yet satisfying coalitions.

Since there are 2^n possible subsets of *N*, there are 2^n possible coalitions. If *N*= {1, 2} or coalitions with two members, the possible coalition are 2^n = {0, 1, 2, 1-2}. In every coalition there is empty coalition that is a coalition made up of no members (the null set ϕ) and a grand coalition *N* consisting of all the players [17]. The benefit of a coalition can be quantified by characteristic function. The characteristic function of a coalition $C \subset N$ is the largest guaranteed payoff to the coalition. A coalition structure is a means of describing how the players divide themselves into mutually exclusive coalitions. It can be described by a set $S = \{S1, S2, ..., S_m\}$ of the m coalition that is formed.

III. Support for Cooperative Decision

Li, Woodhead and Ball [18] say that "In many of the areas to which value analysis has previously been applied the evaluation of alternative solutions has been relatively straightforward". Therefore, in addition to each process that may offer an alternative solution, there are several possible implementations for each of these modelling and evaluating [19]. A hierarchical approach to evaluation is needed, and it is important to eliminate unsuitable solutions at the highest level of abstraction as possible. Many study in value-based design decision use decision tools [20]. A paired comparison is held to determine the weighing to be given to each attribute. Weighting and scoring technique are relevant in value-based decision analysis exercise [21] where a decision needs to be made in selecting an option from a number of competing options and the best option is not immediately identifiable.

A. Negotiation Support

Negotiation is the interactive communication among parties to facilitate a distributed search process [12]. Kraus et al. [22] argue that two approaches use to the development of theorems relating to the negotiation process. The first is informal theory, which attempt to identify possible strategies for a negotiator and to assist a negotiator in achieving optimal results. The other approach is the formal theory of bargaining originating with the work of John Nash, who attempted to construct formal models of negotiation environments. Morge and Beaune [4] propose that a NSS provides three kinds of functionality. Firstly, it facilitates the exchange of information among users. Secondly, it provides decision modelling or group-decision techniques to reduce the noise and uncertainty that occur in the process. Finally, it provides negotiation support. The field of Artificial Intelligence in particular multi-agent methods can be useful for negotiation support [23].

Negotiation consist an exchange of proposals between stakeholders. The agent *i* propose its alternative to agent *j*. This alternative should be the most preferred alternative for agent *j* (with the highest priorities with respect to the goal) to be immediately accepted. If not, agent *j* tries to change the preference order of alternatives by adjusting judgments in pair-wise comparison matrixes. If the proposal is not accepted, it will send a counter-proposal. The negotiation will be stopped, when an alternative is approved unanimously.

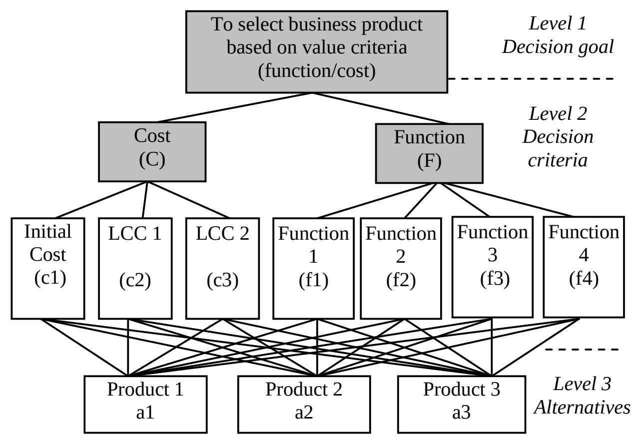

Fig. 1 Decision Hierarchy Based on Satisfying

B. Satisfying Model

Stirling [24] has written and demonstrated satisfying games on multi-criteria decision making. He writes that 'a natural procedure of satisfying options is to separate the attributes into two categories, one to involve the attribute that represents functions of an option and the other to involve attributes that represents losses'. To compare function and cost representing the value of a product solution, they must be represented on the same scale. This may be done creating selectability (Ps) and rejectability (Pr) functions and normalizing the problem [24] so that the decision-maker has a unit of function utility and a unit of cost utility to apportion among the options. Fig. 1

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shows the decision hierarchy based on satisfying and the TABLE I and II presents it calculation to 'cost' and 'function'. The result of normalization from TABLE I and II is presented on TABLE III. It shows the value of each alternative project based on utility of cost and function.

TABLE I
Process of Satisfying Analysis (COST and LOSS)

	Cost				
	c1	c2	c3	COST	LOSS
a1	0.002	0.029	0.064	0.095	0.026
a2	0.016	0.005	0.005	0.026	0.095
a3	0.009	0.015	0.019	0.043	0.078
					0.200

TABLE II
PROCESS OF SATISFYING ANALYSIS (FUNCTION)

	FUNCTION				
	f1	f2	f3	f4	Function
a1	0.250	0.014	0.050	0.034	0.347
a2	0.047	0.050	0.020	0.014	0.132
a3	0.089	0.022	0.121	0.126	0.356
					0.835

TABLE III
NORMALIZATION

Alternatives	NORMALIZATION			Ranking
	Loss (Pr)	Gain (Ps)	V=F/C	
a1	0.133	0.415	3.130	1st
a2	0.476	0.158	0.333	3rd
a3	0.392	0.427	1.089	2nd

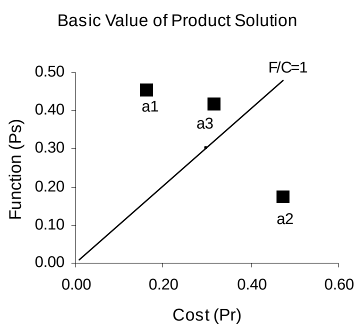

Fig. 2 Cross-plot of Function and Cost

Based on the results presented in Table III, Fig.2 provides a cross plot of function and cost, with *Pr* (rejectability) the abscissa and *Ps* (selectability) the ordinate. The caution index *F/C=1* is taken as unity where the alternatives will be "select" or "reject" if the value (*F/C*) is >1 or <1 respectively. Observe that a2 has the lowest function, it also has the highest cost, and a rational decision maker can legitimately come to conclusion that this is eliminated. Options a1 is easily selected by the cost-function test. Options a3 here gives high benefit but also have higher cost comparing to a1.

C. Negotiation Strategy

The rationality of negotiating agents is implemented with a utility function given by Analytical Hierarchy Process (AHP) [25]. Within the limits of this decision, the enumeration of alternatives and the development of decision hierarchy help the group to debate the problem [4]. All stakeholders share the same goal (G = c0) but each of them has its own set of alternatives (A*i*) or criteria (C*i*). Wanyama and Far [23] wrote that sets of activities could move, expand and, retract during negotiation. When a user takes into account a new alternative or/and criterion, she/he proposes this alternative and or criterion to all users.

D. Best Option on Cooperative Decision.

Three steps are conducted for this stage which are analyze agreement options and coalition, determine payoff optimum, and determine the best options for group stakeholders.

Stage One: Agreement Options and Coalition

Agreement options are determined by identifying the potential stakeholders followed by determining the optimal solution for each sub-group. First step is determining the weighting factor of each criterion for each stakeholder based on the pair-wise comparison. Second step is grading alternative for each evaluation criteria and third step is scoring every alternative for every stakeholder.

Stage Two: Determining Payoff Optimum

The determination of the optimal solution for each stakeholder in a coalition is based on a cooperative multi-person games with complete information in which coalition-formation among sub-group members are allowed [3], [4]. In the context of Game Theory, the formation of coalitions among subsets of negotiating entities (stakeholders) provides a means for achieving Pareto optimality, since every member in a coalition acts in such a way to benefit the entire coalition. The payoff optimum for every stakeholder and every alternative on each coalition was determined tabulated on TABLE IV for Cost and Function.

TABLE IV
PAYOFF OPTIMUM FOR EACH COALITION

FUNCTION						
Coalition		Alternatives			Payoff Optimum	
SH1+2+3		a1	a2	a3	Max-min	Optimum
	SH1	0.495	0.239	0.267	0.256	0.388
	SH2	0.352	0.436	0.212	0.224	0.436
	SH3	0.366	0.246	0.389	0.143	0.389
		1.212	0.920	0.867		
SH1+2		a1	a2	a3	Max-min	Optimum
	SH1	0.495	0.239	0.267	0.256	0.411
	SH2	0.352	0.436	0.212	0.224	0.436
		0.847	0.674	0.479		
SH1+3		a1	a2	a3	Max-min	Optimum
	SH1	0.495	0.239	0.267	0.256	0.471
	SH3	0.366	0.246	0.389	0.143	0.389
		0.860	0.484	0.655		

SH2+3	a1	a2	a3	Max-min	Optimum
SH2	0.352	0.436	0.212	0.224	0.436
SH3	0.366	0.246	0.389	0.143	0.282
	0.718	0.681	0.601		

The payoff optimum refers to each stakeholder in each coalition. The value of (max-min) payoff for a stakeholder is used to determine the payoff optimum by applying the coordinating scenario. This means that no one stakeholder has higher importance than others. This scenario can be changed depending on situation of negotiation in a process of product development.

Stage Three: Analysing Best Fit Options

On this paper the process is applied to both value criteria namely function and cost. There are two categorize of best options which are best for function and best for cost. Based on the two categorize, a best option for all stakeholders can be determined by value equation which is function/cost. For both value criteria, the best selectable option is the one with the least negative value. However, if two alternatives have the same negative value, then the one with higher positive value of is better. The rationale is that if the negative value is close to zero, then most stakeholders earn a payoff close to their Pareto optimum. A high negative value means that some stakeholders earn higher than their Pareto optimum.

TABLE V
BEST-FIT OPTIONS FOR EACH ALTERNATIVE IN EACH COALITION

	χ_{ij} (+)				χ_{ij} (-)			
a1	SH1	SH2	SH3	ψ_j^+	SH1	SH2	SH3	ψ_j^-
SH1+2+3	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	5.20
SH1+2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SH1+3	0.00	0.00	0.00	0.00	0.00	0.00	-0.05	32.53
SH2+3	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	14.85
a2	SH1	SH2	SH3	ψ_j^+	SH1	SH2	SH3	ψ_j^-
SH1+2+3	0.00	0.00	0.01	8.08	-0.08	-0.13	0.00	87.91
SH1+2	0.00	0.00	0.00	0.00	-0.08	-0.13	0.00	107.67
SH1+3	0.00	0.00	0.00	0.00	-0.08	0.00	-0.02	61.58
SH2+3	0.00	0.00	0.00	0.71	0.00	-0.13	0.00	89.80
a3	SH1	SH2	SH3	ψ_j^+	SH1	SH2	SH3	ψ_j^-
SH1+2+3	0.00	0.00	0.00	0.00	0.00	-0.55	-0.01	319.91
SH1+2	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	5.10
SH1+3	0.00	0.00	0.00	0.00	0.00	0.00	-0.05	32.65
SH2+3	0.00	0.00	0.00	0.00	0.00	-0.01	-0.02	16.12

In the context of negotiation during the selection process for a product of business, the negative value of the grand coalition represents the amount of risk [15] associated with the corresponding alternative product. The process is presented in TABLE V. The results from the process and calculation for the best-fit solution of each coalition in the first round of negotiation are presented in TABLE VI. In this case, product 1 is the best alternative to be developed.

Firstly, individually all stakeholders have their own best solution. Finally, as shown on TABLE VI, a1 is found to be the 'best fit' solution for all stakeholders after coalition. As the 'best fit' solution, a1 is contrary to the best option selected by SH1, who chose a3. On the process of trade off in the next negotiation round, SH1 can propose a new preference if he or she did not accept a1 as the best option.

TABLE VI
ALTERNATIVE RANKING FROM POSSIBILITY OF COALITION

Alternatives ranking for each stakeholder and coalition	Product Alternatives		
	a1	a2	a3
SH1	2nd	3rd	1st
SH2	1st	3rd	2nd
SH3	1st	2nd	3rd
Coalition SH1 and SH2	1st	3rd	2nd
Coalition SH1 and SH3	2nd	3rd	1st
Coalition SH2 and SH3	2nd	3rd	1st
Grand Coalition (SH1, SH2, SH3)	1st	3rd	2nd
Result	1st	3rd	2nd

IV. CONCLUSIONS

A Value in Function/Cost is the basis for decision criteria presented on this paper. On the value-based process, function and life cycle cost are analysed. On multi-criteria decision-making, a satisfying option is used by correlating the function and cost to get the value of a technical solution option. On cooperative multi-person process, the payoff optimum and best fit options are based on the criterion of value, which are function and cost.

The implementation results demonstrate a process to select priorities of product. It further emphasizes the importance of performance evaluation in business process. Using a protocol based on a cooperative environment, a NSS can be developed.

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

Development of Medical Devices, a Data Acquisition Tool for Workflow Analysis

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***Abstract* – Workflow analysis is a powerful tool to describe processes or the "flow" of work within a system. In medical applications workflow analysis is frequently used for the optimization of the patient flow, the equipment utilization and human resources. But Workflow analysis can be used as a tool for the development of medical devices as well, e.g. for the generation of optimized requirement lists.**
Advancement and technical innovations within the medical range are driven by the ideas and desires of physicians involved. Medical or interventional processes are very complex and specific. Therefore the communication between physician und product developers is difficult. In fact, it is necessary that the developing engineer deals with the medical field of activity and the procedures and expirations in order to understand the task. To simplify the cooperation of engineers and physicians workflow analysis can be used as tool for task definition, requirement formation or optimization. In a first trial these method was tested using data acquisition sheets. In this publication the generation of computer based data acquisition tool especially for minimal invasive interventions is presented and demonstrated.

Keywords **- engineering process, medical devices, workflow**

I. Introduction

For the development of successful medical devices an overall technical and medical knowledge is necessary. Therefore global players in industry operate large development departments employing special staff with medical and engineering background. For small and medium companies, a cost intensive structure like this is not feasible. But right these companies are searching for new innovations far away from the main businesses of the global players. Especially for these small businesses a methodical approach during the product development reduces the development time and the development cycles substantially. Workflow analysis could be a very effective part of this methodical approach. Observation and documentation of a work system gives a time structured experience of the process taking part. Out of these observations a complex procedure can be separated into defined parts for detailed analysis. Time consuming activities and deficits of tools and handling can be realized. Out of this information's requirements for better devices corresponding to the needs of the physician can be captured.

In [1] a first trial of this method is described. A data acquisition sheet was used to capture the process of a catheter intervention. As a result an optimized requirements list where the specifications of the product to be developed are categorized and described was compiled. As a next step, now a computer based data acquisition tool for this intervention is designed. By application of this tool, the complexity of this method will increase. A rising accuracy and a higher level of details will be the advantages. Also the effort for multiple observation of the same process will decrease. Using this new tool for the same application will make the results comparable and advantages and disadvantages can be described.

II. Background

In 2002, medicine-technical goods having a value of € 72.9 billion were produced in the US, followed by Japan with € 15.3 billion and Germany with € 12.6 billion. Hence, the structural composition of the medical technology industry is very similar in the US, Europe and Asia. Several very intensively researching and globally acting enterprises, in particular from the range of electrical medical devices and instruments, are confronted with a multiplicity of small manufacturers. Small enterprises which offer new technologies and products have usually a narrow product spectrum and produce predominantly for the respective national market or act primarily on niche markets. They depend on the conditions of the national market access and the restrictions of health systems. Decisive factors for the potentials of these producers are the constellation of interests of the national healthcare sector, the financing by the health system and the international adjustment of standards of medical technology products. However, for technological pioneers in the medical sector even the acceptance on the home market and the implementation of innovations in application is of importance for economic survivability [2].

The market access of small businesses is based strongly on personal contacts into the medical community and positive experiences in the co-operation of a physician and the developing enterprise. Long and frequent development cycles for products are not accepted. The expectation is high. While global players can rely on a stable workforce of physicians who cooperate actively in the forming of an opinion and evaluation of new product ideas, small and medium-sized companies are dependent on a fast and successful transfer of innovations. Applying a workflow analysis can contribute to reaching this goal.

Workflow analysis within the medical division is not a new issue. The method is frequently used for the optimization of the intervention times and the patient flow or the staff requirements. Here, the economic value is the most important figure for hospitals, like for instance better equipment utilization, higher patient throughput, savings regarding personnel and non-personnel costs [3],[4]. In addition, quality increase can be a motivation for the use of workflow analysis. In that way operational sequences can be compared, in order to determine the potential of improvement. Also the comparison of workflows of analog operations can lead to improving work methods [5].

In the range of engineering of medical technology the procedure was used in a first trial described in [1]. The developer often tried to set up a list of describing requirements by discussing and explaining the problem to the physician. For specifying the requirements the engineer frequently has to rely on him/herself, since the temporal integration of the active physician does not permit to deal intensively with the problem. A high level of time and hidden costs on search and systematization must be invested. As a result the developer receives a requirement list that describes the problem in a way that he or she finds it logical but the conceptions of the physician does not correspond necessarily. The practice of the workflow analysis helps the developer to better understand the approach of the physician and to determine and document difficulties, e.g. with the handling of assigned tools. Furthermore, problems become not only visible but also quantifiable by means of an analysis of expenditure of time or accuracy. From here on, not only precise requirements can be derived, but also a definite improvement by using new equipment. A measurable medical use or time saving leads to a higher acceptance and thus to a more successful product introduction.

III. METHOD

A. Engineering in the context of INKA research projects

In the research project „INKA - intelligent catheters“, components and overall systems for minimal invasive operation techniques are developed. In these medical interventions, not allowing a direct optical control of the application area and only to be accomplished under a medical imaging, x-ray with 3D functionality is most frequently applied. A new, but still rare method is the execution of minimal invasive operations controlled by magnet resonant imaging (MRI).

For both procedures guidance and/or basis catheters, diagnostic and therapy options on the catheter tip will be developed in the INKA project. These must be compatible with the imaging systems, so that navigation, detection, therapy and control of the catheters are made possible.

Fig. 1 Catheter test on INKA x-ray lab

The INKA team defines problems regarding minimal invasive operations in medical applications, and analyzes and improves them by means of technical developments. Thus interventions supported by magnet resonance represent an apparent challenge for the product development. For this application only a few tools and devices exist that are compatible with the MRI. Frequently the MR compatibility leads to restrictions with the usefulness of the equipment [6].

Also, within the range of the therapy of neurovascular illnesses a high demand for suitable functional and - above all - very small tools exists to conduct fast and successful interventions. The INKA team compiles solutions for these proposals, which are converted from the technical bases to prototypes. The results are then taken up and marketed by regional small and medium-sized companies. The experience in INKA’s commitment to engineering medical devices has led to the necessity of optimizing the process of information reception. In the following, the first steps of the production development process using workflow analysis are demonstrated by introducing an example.

B. First steps of engineering process of a steering of a micro catheter applying workflow analysiss

Due to the brain-supplying arteries the region of the artery cerebri media is most frequently (approx. 80% of the arising cases) affected of lack of blood circulation. Blood clots replaced by the bloodstream settle there and cause an apoplexy, which may then cause the impairment of the movement apparatus or disturbances of the apprehension [7]. Several studies revealed that each minute of the blood

ISBN : 978-602-97809-0-1

circulation of the brain being impaired is harmful and therefore a treatment must taking place as early and fast as possible [8]. In order to treat the neurological losses the physician inserts a catheter into the vessel system to the place of illness and conducts an appropriate therapy. The treatment takes place with the support of a rotation x-ray system that points the x-ray-close catheter and the vessel tree visualized by an additional injection of contrast agent.

For moving the catheter into the correct vessel branching, the tip is preformed defined and navigated by manual rotation and careful forward pushing. Additionally, the use of a guide wire is necessary, which is pushed through the catheter and affects its form (Fig. 1).

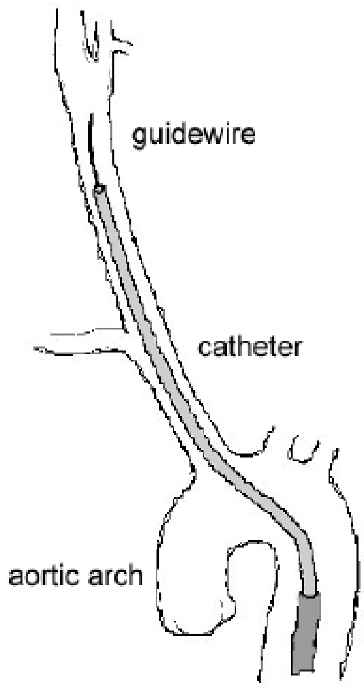

Fig. 2 Selective catheterization technique

For very small vessels and complex branching this approach becomes very complicated and time-consuming, since the guide wire or catheter must be changed frequently and/or readjusted. As a consequence, the operation time and concomitantly the risk of irreversible damage rises. To avoid this, a possibility for the external controlling of the catheter tip is to be developed. Fig. 2 shows configurations of guide wires for catheter steering as the actual state of the art.

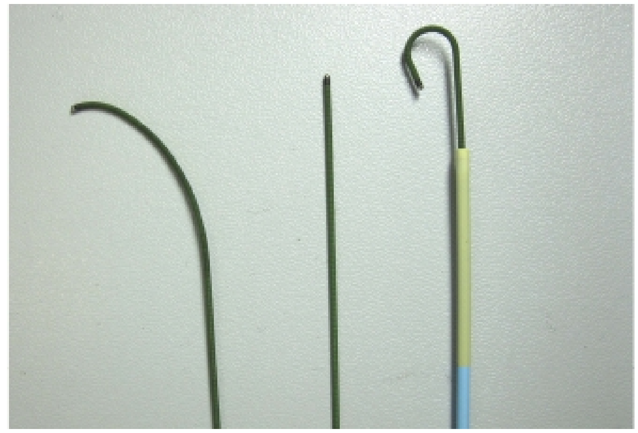

Fig. 3 Guide wires and catheter for vascular intervention

In a first step the engineering process was accomplished in the classical methodical way: discussions with the operating physician, searching the approach in principle, investigating the assigned devices and tools. In a next step, the workflow analysis using a data acquisition sheet as mentioned in [1] applied. Based on the documentation the actual state of art was archived for the purpose of comparison. Using the dataset made it is possible to generate optimization scenarios and in such a way to find a “better“solution. But the expenditure of time for the observation of several interventions was high. Also the level of detail in the description of the process was low. Therefore a computer based system is used now.

In the “Innovation Center Computer Assisted Surgery (ICCAS)” Leipzig, Germany a tool for the acquisition of the workflows of surgical operations was created [5]. For the modelling of surgical procedures, data must be acquired at an adequate level of granularity. Different strategies can be used, sensor or video systems or human observation or a combination of both. For effective recording of the process the observer uses a tablet pc with pre generated activity charts. All activities are categorized and personalized. The operation tools are also preselected. Therefore a fast acquisition in a standard language is possible.

Fig. 4 Computer based data acquisition for workflow analysis

This method now is used for minimal invasive interventions like catheter angiographies. These interventions differ to a surgical operation, so the language and the pre generated information must be adjusted. A catheter intervention always takes part under image guidance. The image system and operating staff must be integrated into the acquisition software. Also the used tools are selected online by the physician depending on the actual vessel situation of the patient. A fast selection pool of possible catheters and guide wires is necessary. Basing on the first experiences with workflow analysis a theoretical plot of the intervention was integrated into the system. Afterwards some workflows are captured to adjust the technique. Thus a useful acquisition tool was created.

C. Results

The workflow analysis during the engineering process is a simple and a helpful tool. The documentation of complex procedures and the processing is made possible in order to purposefully create a requirements list or archive the actual state of art. In comparison with the first trial data collecting sheet discussed in [1] the complexity is higher using a pc based data acquisition tool. This means also rising costs for the method. Extra equipment has to be bought. A user has to be trained on the system and software. The advantage is a faster acquisition with a higher level of detail (granularity). Also, the post processing simplifies. All necessary data is already stored on the pc and can be evaluated. Workflows taken at different times are easy to compare. The collection structure is the same at any workflow acquisition. A comparison of advantages and disadvantages of the data acquisition tool will be the next step.

IV. Conclusions

The application of the workflow analysis during the engineering process of a medical device is helpful for documenting complex procedures. The understanding for not self executed procedures is improved. It was shown that a documentation using data acquisition tool can bring some important advantages in time and accuracy. Depending upon complexity of the interesting procedure and the temporal resolution of the expiration the method can be extended by using documentation tools. As a next step the results of a workflow analysis taken up with data collection sheet and with data acquisition tool will be compared directly. Also the effort and costs will be discussed. These possibilities and their pro and cons are subject to a continued examination in the context of the product development processes within the INKA project.

Acknowledgment

The authors would like to thank their colleagues at the Otto-von-Guericke-University of Magdeburg. This research was financially supported by the Federal Ministry of Education and Research (BMBF) in context of the 'INKA' project.

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ISBN : 978-602-97809-0-1

Designing Electric Guitar Using Integrated QFD and Kano Model

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***Abstract* – This research discusses the design of an electric guitar, using QFD as the basis of the design process. Quality Function Deployment (QFD) is a well-known product design method, which is able to identify costumer needs. Nevertheless, not all needs can be fully satisfied. Thus, Kano Model is integrated to the QFD such that certain needs may be selected and prioritized to be fulfilled in order to elevate customer satisfaction to the utmost. The research starts with collecting customer needs via questionnaire, then the collected needs are categorized based on Kano model. The result is integrated into the House of Quality (HOQ) to obtain the output of prioritized metrics and specification targets. Some product concepts are then developed, selected, and tested. The final results are the design, final specification, and the prototype of the electric guitar.**

***Keywords* – product design, QFD, Kano, HOQ**

I. INTRODUCTION

Music instrument industry has received the positive impact of the rapid development of Indonesian music industry in general. Many people become interested at playing music instruments, either simply for hobby or for the purpose of being a professional musician. One of the most popular music instruments is electric guitar, which experiences a surge in demand.

In Indonesia, the major portion of electric guitar market still belongs to major brands like Fender, Ibanez, Gibson, Epiphone, Washburn, and Cort. Those brands may be considered as the pioneers in world's guitar industry, so consequently their products are relatively expensive. In order to respond the need for good quality electric guitar with lower price, some local brands have emerged recently.

PT. Asia Guitar Labs (AGL) started the business by repairing guitar, and later it started to produce customized guitar with the specification wanted by its customers. It was triggered by the success of local brands, Extreme and Marlique, to compete with the existing brands. Now it intends to produce guitar under its own brand, i.e. AGL Series-1, in a massive number.

AGL need to carefully design its first mass product, such that it may be competitive with other existing brands. The initial step of designing a product is identifying customer needs. Afterwards, they need to be translated into technical specifications. A well-known method able doing so is Quality Function Deployment (QFD). Not only translating needs, QFD also sets the target for each specification. The targets become the basis for developing product concepts.

In reality, customer needs are greatly varied and at times not all needs can be fulfilled. Kano model may be used to select and prioritize needs to be fulfilled, in order to elevate customer satisfaction to the utmost.

In this research, Kano model is integrated into QFD by appending the division of needs (based on Kano model) into the House of Quality (HOQ). Thus, the HOQ has additional information that may be used to determine the target for each specification.

Therefore, the objectives of this research are:

1) identifying customer needs for electric guitar,
2) classifying customer needs based on Kano model,
3) determining final specifications and final design of AGL Series-1.

II. QUALITY FUNCTION DEPLOYMENT

Quality Function Deployment (QFD) was developed by Yoji Akao and Shigeru Mizuno in early 1960's [2]. It is a method to develop and deign a product systematically. It allows product designers to clearly specify what customer wants and needs, such that each product concept developed may be analyzed in order to obtain the best one [5].

QFD involves several matrices. The first matrix is called House of Quality (HOQ). The other matrices are Subsystem Design Matrix, Piece Part Design Matrix, and Process Design Matrix [5]. The template for the HOQ is shown on Figure 1.

III. KANO MODEL

Kano model was developed by Noriaki Kano in 1984. The model classifies customer needs based on how it impacts customer satisfaction when fulfilled, i.e.:

1) Must-be requirements (Dissatisfiers): the needs which are mandatory to be fulfilled. Otherwise, the product has no ability to perform its fundamental functions. As the result, customers would not interested at all to buy the product.

ISBN : 978-602-97809-0-1

On the other hand, when these needs are fulfilled, customer satisfaction would not increase significantly.

2) One-dimensional requirements (Satisfiers): the needs which increase customer satisfaction proportionally when fulfilled. It means, the more these needs are fulfilled, the higher customer satisfaction as well.
3) Attractive requirements (Delighters): the needs which increase customer satisfaction very significantly when fulfilled. It is so because the fulfillment of these needs is way beyond customers' expectations.

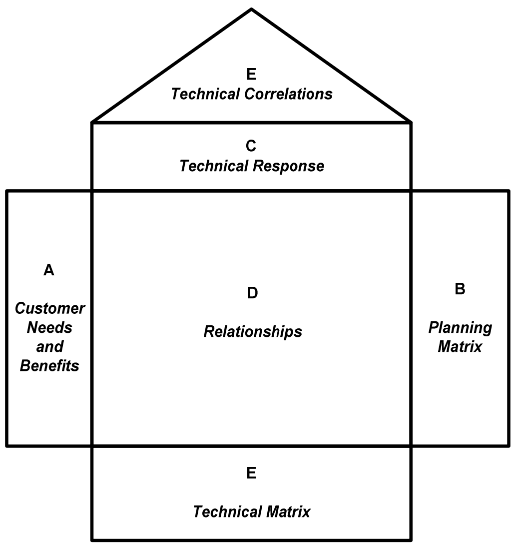

Fig. 1 Template for HOQ [5]

The needs classification based on Kano model may be depicted by the next figure.

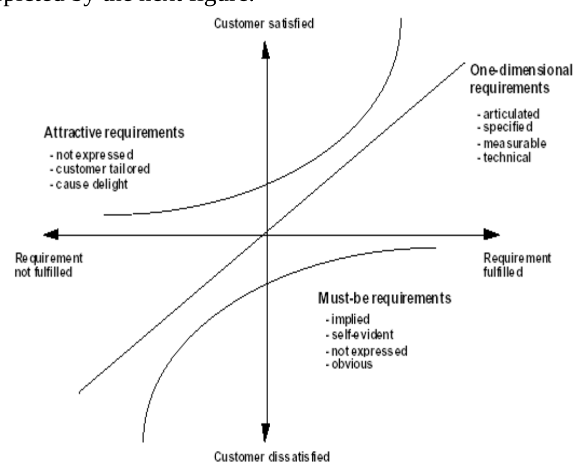

Fig. 2 Classification of needs based on Kano model [1]

IV. Kano Integration into QFD

Kano model is integrated into QFD by adding a column into the planning matrix of HOQ [3]. The value in the column is obtained by converting each category of need in Kano's classification into a quantitative value, i.e.:

Attractive = 4
One-dimensional = 2
Must-be = 1
Indifferent, Questionable, Reverse = 0

To obtain the categorization of needs, each need is arranged into positive (functional) form and negative (dysfunctional) form. After being asked to a respondent, the respond for both forms are matched into the table below.

TABLE I
Kano Categorization for Each Need

	Dysfunctional				
Functional	1	2	3	4	5
1	Q	A	A	A	O
2	R	I	I	I	M
3	R	I	I	I	M
4	R	I	I	I	M
5	R	R	R	R	Q

The value given for each type of respond:

1 = I want it (*like*)
2 = I think it should be like that (*must be*)
3 = I am neutral (*neutral*)
4 = I can hardly accept it (*live with*)
5 = I do not want it (*dislike*)

The type of Kano category based on the matching:

Q = *Questionable* I = *Indifferent*
R = *Reverse* O = *One-Dimensional*
A = *Attractive* M = *Must Be*

V. Electric Guitar Design

The design starts with making the mission statement, followed by collecting customer needs, determining the importance of each need, developing HOQ, developing product concepts, selecting and testing concepts [4].

The mission statement is shown on the next table.

TABLE II
Mission Statement

Mission Statement* : *AGL Series-1	
Product Description	"AGL Series-1" is an electric guitar having a modern design, reflecting the image of AGL as a high-quality guitar manufacturer.
Key Business Goals	1.Constructing image as a high-quality guitar manufacturer with reasonable price 2.Penetrating the electric guitar market of Indonesia, ASEAN, and Middle-East 3.Selling more than 100 units of product in the first 6 months

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Primary Market	Professional and semi-professional guitarists
Secondary Markets	People who likes either playing guitar or collecting guitars
Assumptions and Constrains	Assumptions: no new competitors emerging in Indonesia Constraint : initial capital investment for production machines
Stakeholders	1. User 2. Distributor 3. Marketing 4. Production 5. Service 6. Product Designer

The customer needs collected are shown below. The needs have also been categorized into Kano categorization.

TABLE III
CUSTOMER NEEDS AND THE KANO CATEGORIZATION

Category	No	Need	Kano Category
Sound	1	Guitar has a good quality of sound.	M
	2	Guitar has low level of noise.	A
Material & Hardware	3	Guitar is made by the proper material.	M
	4	Guitar uses good quality components.	O
Usability	5	Guitar is easy to set.	M
	6	Guitar is comfortable to play.	M
Design	7	Guitar has a unique model.	O/M
	8	Guitar has various available colors.	A
	9	Guitar is also designed for left-handed ones.	I
Price	10	Guitar has reasonable price.	M
Feature	11	Guitar is easy to be connected with a computer's CPU.	A
Service	12	Guitar is widely available in markets.	O
	13	Guitar has official service center.	A
	14	Guitar uses components whose replacements are easy to find when broken.	O
	15	Guitar has official guarantee period.	O

A list of metrics is created in order to accommodate all customer needs. For each need, one (or more) corresponding metric(s) is found to fulfil it in a quantitative or measurable way.

TABLE IV
METRIC LIST

Metric No.	Need No.	Metric	Units
1	1,3,10	Body material	List
2	3,6,10	Neck material	List
3	3,6	Fingerboard material	List
4	1,2,4,10,14	Pickup type	List
5	1,4,5,10,14	Bridge type	List
6	1,6,7	Guitar construction	List
7	1,2,5,10	Pickup construction	List
8	6	Guitar's weight	kg
9	7,8	Color variety	List
10	6	Neck's thickness	mm
11	1,6	Scalloped Neck	Binary
12	6	Number of frets	unit
13	5	Number of control knobs	unit
14	11	USB connector	Binary
15	10	Price	10^6 Rupiah
16	15	Guarantee	Year
17	9	Left-handed availability	Binary
18	12,14	Online shop	Binary
19	13	Service centre	Binary

It is also important to collect information related to the competitors, such that benchmarking may be done. Two brands chosen for benchmarking are Fender Stratocaster and Gibson Les Paul.

TABLE V
METRIC COMPARISON ON BENCHMARKING

No.	Metric	Fender Stratocaster	Gibson Les Paul
1	Body material	Alder	Maple & Mahogany
2	Neck material	Maple	Mahogany
3	Fingerboard material	Rosewood/Maple	Rosewood
4	Pickup type	3 Standard Single Coil Strat Pickups	Humbucker Pro with Alnico V magnets
5	Bridge type	Vintage Style Synchronized Tremolo	Tune O Matic
6	Guitar construction	Solid Body	Topped Solid body
7	Pickup construction	3 Single Coil	2 Humbucker
8	Guitar's weight	5 - 5.5	6
9	Color variety	Black	Heritage Cherry Sunburst
		Sage Green Metallic	Latte Crème
		Blue Agave, etc	Root Beer, etc

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No.	Metric	Fender Stratocaster	Gibson Les Paul
11	Scalloped Neck	No	No
12	Number of frets	21	22
13	Number of control knobs	3	4
14	USB connector	Not Available	Not Available
15	Price	8	9
16	Guarantee	1	1
17	Left-handed availability	Yes, add $100	Yes, add $100
18	Online shop	Available	Available
19	Service centre	N/A in Indonesia	N/A in Indonesia

Based on the benchmarking, the marginal and ideal values for each metric may be determined. The next table also shows the importance value of each metric, which was obtained from the questionnaire distributed to the respondents.

TABLE VI
IMPORTANCE, MARGINAL, AND IDEAL VALUES OF EACH METRIC

No.	Metric	Importance value	Marginal value	Ideal value
1	Body material	4,2	Mahogany	Maple
2	Neck material	3,8	Mahogany	Maple
3	Fingerboard material	3,8	Maple	Rosewood
4	Pickup type	4,2	Single coil	Humbucker
5	Bridge type	4,2	Tune O Matic	Tremolo
6	Guitar construction	4,2	Solid body	Solid body
7	Pickup construction	4,2	3 Single Coil	2 Humbucker
8	Guitar's weight	3,8	< 5	4
9	Color variety	3,7	Optional	Optional
10	Neck's thickness	3,8	20	19
11	Scalloped Neck	4,2	N/A	Available
12	Number of frets	3,8	21	22
13	Number of control knobs	2,9	4	2
14	USB connector	2,3	N/A	Available
15	Price	3,5	< 10	5
16	Guarantee	3,1	1	>1
17	Left-handed availability	1,9	N/A	Available

No.	Metric	Importance value	Marginal value	Ideal value
18	Online shop	3,4	N/A	Available
19	Service centre	3	N/A	Available

The product concepts developed are shown below. The metrics are sorted from the highest priority –which is obtained from the calculation in HOQ.

TABLE VII
DEVELOPED CONCEPTS (A-E)

No	Concept A	Concept B	Concept C	Concept D	Concept E
4	Humbucker	Single Coil	Single Coil, Humbucker	Humbucker	Humbucker
7	2 H	3 S	H-S-H	2 H	2 H
5	Tremolo bridge	Tremolo bridge	Tune O Matic	Tune O Matic	Tune O Matic
9	Natural, Solid, Burst	Natural, Solid, Burst	Natural, Solid, Burst	Natural, Solid, Burst	Natural, Solid
6	Solid body	Solid body	Topped Solid body	Topped Solid body	Hollow body
19	Available	Available	Available	Available	Available
1	Mahogany	Alder	Mahogany, Maple	Mahogany, Maple	Swamp ash
18	Available	Available	Available	Available	Available
14	Available	N/A	N/A	N/A	N/A
2	Mapple	Maple	Mahogany	Mahogany	Mahogany
16	1	1	1	1	1
11	Available	N/A	N/A	N/A	N/A
3	Rosewood	Maple	Rosewood	Rosewood	Rosewood
10	19	19	19	20	20
15	5	6	7	7	8
13	2	3	5	4	4
12	21	21	22	22	24
8	4	4	6	6	5
17	Available	Available	Available	Available	Available

The reference for screening and scoring the concepts is Fender Stratocaster, as it is the world's highest-selling electric guitar. Both screening and scoring are done by inquiring the opinion from the experts. The concept screening is shown on the next table.

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TABLE VIII
CONCEPT SCREENING

Criterion	Concept					
	Ref	A	B	C	D	E
Sound	0	+	0	+	0	0
Material & Hardware	0	0	0	+	0	+
Usability	0	0	0	0	0	+
Design	0	+	+	+	+	+
Price	0	+	+	+	+	0
Feature	0	+	0	0	0	0
Service	0	+	+	0	+	+
Number of +	0	5	3	4	3	4
Number of 0	6	2	4	3	3	3
Number of -	0	0	0	0	0	0
Final Score	0	5	3	4	3	4
Rank	4	1	3	2	3	2
Continue?	No	Yes	No	Yes	No	Yes

The concept scoring are shown below.

TABLE VIII
CONCEPT SCORING

Criterion	W	Concept					
		A		C		E	
		S	WS	S	WS	S	WS
Sound	0.3	4	1.2	3	0.9	4	1.2
Material & Hardware	0.1	4	0.4	4	0.4	4	0.4
Usability	0.2	4	0.8	3	0.6	3	0.6
Design	0.15	4	0.6	4	0.6	4	0.6
Price	0.1	4	0.4	3	0.3	2	0.2
Feature	0.1	5	0.5	3	0.3	3	0.3
Service	0.05	3	0.15	3	0.15	3	0.15
Total Score		4.05		3.25		3.45	
Rank		1		2		2	
Continue?		Yes		No		No	

(Note: W = weight, S = score, WS = weighted-score)

The concept testing is done by interview. Based on the interview with the selected customer-to-be, these comments for Concept A guitar are collected as follows.

- Sound
  Sound character resulted by the guitar is excellent. The solid body construction which is built by maple, combined with the usage of humbucker pickup results in bright and thick sound. Humbucker pickup is able to minimize noise as well. The guitar's sound is still excellent when distortion is applied.
- Material
  The body and neck of the guitar made by maple are good enough to result in clear sound. The fingerboard made by rosewood results in warm sound as well. Rosewood also enhances the guitar esthetically.
- Hardware
  Tremolo bridge enables the guitar to produce tremolo effect quite easily. It makes users able to explore more sound effects.
- Usability
  The guitar is very comfortable to be played as it is designed as scalloped neck, which allows users not to press the neck too hard to produce good sound.
  The initial setup process might be quite difficult. However, once the proper setting is obtained, there is no need to re-set the guitar for a relatively long period as a lock system is provided on the nuts to keep the setting unchanged.
- Design
  The simple design makes the guitar look modern. The colorful choices enhance the attractiveness of the guitar. The left-handed-designed guitar might attract customers who are actually not left-handed, as it is offered with the same price with the right-handed-designed one.
- Price
  Although the price is relatively expensive, customers still perceive it reasonable, considering the features offered.
- Feature
  The main advantage of the guitar is the availability of USB slot allowing user to set a direct connection with a computer's CPU. It allows user to record the music played by the guitar directly into CPU. It has been the desire of many guitar players, and it is actually possible to be realized.

The final specification for the designed guitar is as follows.

TABLE IX
FINAL SPECIFICATION FOR AGL SERIES-1

No.	Metric	Value
1	Body material	Mahogany
2	Neck material	Mapple
3	Fingerboard material	Rosewood
4	Pickup type	Humbucker
5	Bridge type	Floyd Rose Licensed Tremolo
6	Guitar construction	Solid body

7	Pickup construction	2 Humbucker
8	Guitar's weight	4
9	Color variety	Natural, Solid, Burst
10	Neck's thickness	19
11	Scalloped Neck	Yes
12	Number of frets	21
13	Number of control knobs	2
14	USB connector	Yes
15	Price	5
16	Guarantee	1
17	Left-handed availability	Available
18	Online shop	Available
19	Service centre	Available

The final design for the AGL Series-1 is shown on the next figure.

Fig. 3 Final design of AGL Series-1

VI. Conclusions

Based on the research, it may be concluded that:

1. Customer needs for an electric guitar are shown on Table III.
2. Customer needs categorized based on Kano model are shown on Table III.
3. The final specification of the designed electric guitar AGL Series-1 is sown on Table IX, while the final design itself is shown on Figure 3.

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ISBN : 978-602-97809-0-1

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Proceedings

The International Conference on Industrial Engineering and Business Management 2010

CHAPTER 11 : Manufacturing and Production System (MPS)

editor :
Arya Wirabhuana, Muchammad Abrori, Kifayah Amar

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ISBN : 978-602-97809-0-1

Solving The "Dynamic Facility Layout Problem" in Cell Manufacturing Using Meta-Heuristic Algorithms

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Abstract **-Cost reducing is one of the main strategies for a manufacturing plant to able to survive in market competitions. Large amount of production operation costs refer to material handling costs which can be decreased with a suitable layout for the equipment. Under these conditions, dynamic facility layout problem (DFLP) for the finding of equipment site in manufacturing environment based on multi period planning horizon is raised. In this paper, DFLP for the case of cell manufacturing is investigated. Among machines (or departments) transportation costs and rearranging costs changes from one period to another one. The other new hypothesis which adds to the problem is considering time value of money. Regarding these conditions, a new mathematical model for the problem is suggested. Since the type of the problem is a NP-hard one, for solving it two meta-heuristic algorithms – a simulated annealing(SA) and a tabu search(TS) one – are suggested. At the end, comparison will be with SA and TS algorithms.**

Keywords **— dynamic facility layout problem, cell manufacturing, simulated annealing, tabu search, non linear mathematical model.**

I. INTRODUCTION AND LITERATURE SURVEY

Cost reduction is one of the major strategies for a manufacturing organization to adopt to stay in business under global market competition. It has been estimated that between 15% and 70% of total manufacturing operating expenses can be attributed to material handling, and that an effective facility layout can reduce these costs by at east 10%~30%[1].Material-handling costs are determined based on the amounts of materials that flow between the departments and the distances between the locations of the departments. When the flow of materials between the departments is fixed during the planning horizon, this problem is known as the static (single period) facility layout problem (SFLP), which can be formulated as a quadratic assignment problem(QAP). When the flow of materials between departments changes during the planning horizon, this problem is known as the dynamic (multiple period) facility layout problem (DFLP)[2]Some of the factors associated with changes in the flow between departments are as follows and were taken from Shore and Tompkins.

- Changes in the design of an existing product;
- the addition or deletion of a product;
- replacement of existing production equipment;
- shorter product life cycles and
- changes in the production quantities and associated production schedule.[3]

The DFLP is the problem of finding positions of departments on the plant floor for multiple periods such that departments do not overlap, and the sum of the material handling and rearrangement costs is minimized. In other words, for each period in the planning horizon, the layout is determined such that the sum of the material handling cost for each layout and the cost of rearranging departments between each pair of consecutive layouts is minimized[4]. A layout plan for the DFLP is a series of layouts, and each layout is associated with a period. Therefore, the total cost of a layout plan consists of the sum of the material handling costs for all periods and the sum of the rearrangement costs. Rearrangement costs are incurred when the departments are rearranged in order to minimize material handling costs. In a manufacturing environment, rearrangement cost is incurred when moving machines (or departments) from one location to another. Also, the rearrangement of departments may cause production loss, and it may also require specialized labor and equipment. Thus, rearrangement cost consists of labor cost, equipment cost, and the cost of production loss. It is important to reiterate that the DFLP is not just a series of SFLPs/quadratic assignment problems (QAPs). Consider the two extreme cases below:

(1) If material handling costs are much larger than rearrangement costs, then the DFLP could be solved sequentially as a series of SFLPs (QAPs). In other words, the layout for the first period could be obtained by solving the SFLP (QAP) using data only for the first period, and then the layout for the second period could be obtained by solving the SFLP (QAP) using data only for the second period and so on.

(2) If rearrangement costs are much larger than material handling costs, then the DFLP could be solved as a series of SFLPs (QAPs). The layout obtained for the first period could be assigned to all the periods, and the total material handling

ISBN : 978-602-97809-0-1

cost could be obtained. Furthermore, the layout obtained for the second period could be assigned to all the periods, and the total material handling cost could be obtained. Continuing in this fashion, the layout plan that gives the minimum total material handling cost is selected.[5]

Rosenblatt [6] presented a dynamic programming algorithm to solve the DFLP optimally. Since the type of the problem is a NP-hard one,Therefore the author presented two heuristics using dynamic programming. Lacksonen and Enscore [7] surveyed the static and dynamic facility layout problems in varying area by mathematical programming approaches. Urban [8] developed a steepest descent pairwise exchange technique similar to CRAFT presented by Armour and Buffa [9], which consider forecast windows.Conway and Venkataramanan [10] used a genetic algorithm to solve the DFLP, and Kaku and Mazzola [11] used a tabu search heuristic. Balakrishnan and Cheng [12] improved the GA presented in Conway and Venkataramanan [10] to solve the DFLP. Balakrishnan et al. [13] presented two heuristic algorithms, which improved Urban's steepestdescent pairwise exchange heuristic algorithm. The first algorithm uses Urban's algorithm to generate solutions for the DFLP. The second algorithm combines Urban's algorithm with DP. Baykasoglu and Gindy [14] presented a simulated annealing (SA) heuristic. Using the test problems they showed that the SA performed better than the developed GAs. Balakrishnan et al. [15] presented a hybrid Genetic algorithm for the DFLP. Also Baykasoglu and Gindy [16] corrected their computational results reported in Baykasoglu and Gindy[14]. McKendall and Shang presented hybrid ant systems for the dynamic facility layout problem[2]. They developed hybrid ant systems (HASs) to solve the DFLP. Then to test the performance of the meta-heuristics,They used two data sets taken from the literature in the analysis. The results show that the HASs are efficient techniques for solving the DFLP. Also McKendall et al. [5] two simulated annealing (SA) heuristics developed for the DFLP.The results obtained showed that the proposed heuristics were very effective for the dynamic facility layout problem. Baykasoglu et al. [17] used of the ant colony optimization (ACO) algorithm to solve the DLP by considering the budget constraints.Rezazadeh et al. [18] extended an improved version of the discrete particle swarm optimization (DPSO) algorithm proposed by Liao et al. [19] to solve the dynamic facility layout problem (DFLP).Dong M et al[20] presented a new kind of dynamic layout problem with machines' adding/removing at different planning periods where machines have unequal sizes and are represented by continual coordinates. A general solution framework of shortest path based SA algorithm for this new DPLP is given. McKendall and Hakobyan [4] developed heuristics for the dynamic facility layout problem with unequal-area departments.

II. Dynamic Facility Layout Problem (DFLP) in Cell Manufacturing

New appendixes are attached to the DFLP in the current paper. First, we consider the dynamic layout in cell manufacturing. The machines and candidate locations were divided into diverse groups each of which constitute a separate section. There are relationships only among internal machines together, but each machine is only replaceable by the machines belonging to the same section during the consecutive periods. To explain more, assume that we are supposed to assign 16 machines to 16 locations but not all of the locations are candidate for each machine. Thus, the machines and locations are divided into diverse groups which the specific relationships among them are possible. Fig. 1 illustrates the purpose:

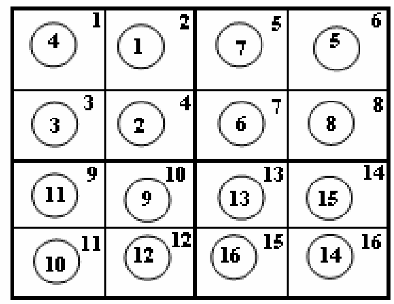

Fig. 1. Layout of cell manufacturing with 16 machines and 16 locations.

In above the figure, machines (circles) are assigned to the locations. Different groups are separated by bold lines. Section 1 includes locations 1, 2, 3, and 4, as seen. Similarly, the locations 5-16 are in the sections 2-4. on the other hand, section 1 is only assignable to machines 1, 2, 3, and 4. This approach is completed by assigning of section 2 to machines 5, 6, 7, and 8, section 3 to machines 9, 10, 11, and 12, and section 4 to machines 13, 14, 15, and 16; for example, machine 1 to location 2, machine 2 to location 4, machine 3 to location 3, and machine 4 to location 1. The locations for machines 5-16 are similarly distinguishable.

Both rearranging costs and material handling costs are changing from one period to another. Time value of money is also considered in the paper. In other word, the mathematical model's objective function is the minimum sum of the rearrangement and material handling costs among machines of the different sections, considering time value of money. This means that the objective function is the present worth of total costs in diverse periods considering interest of money.

The mathematical model given for this problem is nonlinear and all the decision variables are of binary integers. The output of the mathematical model is locating the machines in each section for each period.A similar formulation can be found in Balakrishnan and Cheng [21], except that in this paper, facility layout is conveyed in cell manufacturing condition and at the same time, considering the time value of money. The DLP involves selecting a static layout for each period and then deciding whether to change a new layout in the following period. If the shifting costs are low, the layout configuration would tend to change more often

ISBN : 978-602-97809-0-1

to retain material handling efficiency. The opposite is true for high shifting costs [22].

In the following, you will observe the mathematical model of the dynamic facilities Layout Problem considering the mentioned assumptions:

Min

$$Z=\sum_{t=2}^{T}\sum_{f=0}^{m-1}\sum_{i=1+n_f}^{n_{f+1}}\sum_{j=1+n_f}^{n_{f+1}}\sum_{l=1+n_f}^{n_{f+1}}A_{tijl}Y_{tijl}r^t+$$

$$\sum_{t=1}^{T}\sum_{f=0}^{m-1}\sum_{k=1+n_f}^{n_{f+1}}\sum_{i=1+n_f}^{n_{f+1}}\sum_{j=1+n_f}^{n_{f+1}}\sum_{l=1+n_f}^{n_{f+1}}C_{tijkl}X_{tij}X_{tkl}r^t. \quad (1)$$

s.t.

$$\sum_{i=1+n_f}^{n_{f+1}}X_{tij}=1 \qquad j=1+n_f,...,n_{f+1} \qquad (2)$$

$$t=1,...,T \quad f=1,...,m-1 \quad n_0=0 \quad n_m=N$$

$$\sum_{j=1+n_f}^{n_{f+1}}X_{tij}=1 \qquad i=1+n_f,...,n_{f+1} \qquad (3)$$

$$t=1,...,T \quad f=1,...,m-1 \quad n_0=0 \quad n_m=N$$

$$Y_{tijl}=X_{(t-1)ij}X_{til} \qquad i,j,l=1+n_f,...,n_{f+1} \ (4)$$

$$t=2,...,T \quad f=1,...,m-1 \quad n_0=0 \quad n_m=N$$

$$X_{tij}=\{0,1\} \qquad i,j=1,...,N, \qquad t=2,...,T \ (5)$$

$$Y_{tijl}=\{0,1\} \qquad i,j,l=1+n_f,...,n_{f+1} \qquad (6)$$

$$t=2,...,T \quad f=1,...,m-1 \quad n_0=0 \quad n_m=N$$

Where N is the number of machines and locations, T the number of periods,r the discount rate, A_{tijl} the cost of shifting machine i from location j to l in period t (where A_{tijl} =0) ,and C_{tijkl} the cost of material flow between machine i located at location j and k located at l in period t . The number of sections is m. f is the slack numerator of section. N_f is the number of machine (and location) with the most highest number in section f^{th} . Machines (and locations) are numbered from 1 to n_m. Machines (and locations) of section 1 are named from 1 to n_1, the ones from section 2 are named from n_1+1 to n_2 …, and those of section m are named from $n_{m-1}+1$ to n_m.

$$X_{tij}=\begin{cases}1 & \text{if machine } i \text{ is assigned to location } j \text{ in period } t.\\ 0 & \text{otherwise.}\end{cases}$$

$$Y_{tijl}=\begin{cases}1 & \text{if machine } i \text{ is shifted from location } j \text{ to } l \text{ at the beginning of period } t.\\ 0 & \text{Otherwise.}\end{cases}$$

The objective function Eq.(1) minimizes the sum of the material flow and layout rearrangement costs during the planning horizon.

Constraints Eqs.(2) and (3) ensure that each facility location is assigned to one facility and each facility is assigned to one facility location at each period, respectively. Constraint Eq.(4) adds the rearrangement costs to the material flow cost if a facility is shifted between locations in consecutive periods. Lastly, the restrictions on the decision variables are given in Eqs. (5) and (6).

III. A HURISTIC ALGORITHMS FOR THE DFLP FOR THE CASE of CELL MANUFACTURING

The quadratic assignment problem is NP-hard .DFLP is the developed version of QAP, so that its model is nonlinear and all of the decisions variables are binary integers. The output of the mathematical model is locating the machines in each section for each period. It takes a long time to solve the model through the exact algorithms (It is a NP-hard problem) . Thus, the existing software packages could only solve it in low dimensions. The dimension, here, depends on the number of machines (or equally the locations) and planning horizon periods.

In the previous chapter we presnted an Integer Nonlinear Programming (INLP) model. INLPs are time consuming to be solved if not low dimension. When the number of machines (and locations) is 4 and planning horizon length is 2, the mathematical model would be solved by Lingo10 software package. The time required to solve the problem, the lowest possible dimension problem is about an hour. For higher dimensions, like 8 machines (and locations) and 2 periods, it takes more than 16 hours. As it goes, for even higher dimensions might take few days. The solution given by Lingo is a local optimum one. We conclude the current available software packages for such problem solving processes are inefficient. There are no other ways but to use meta-heuristic algorithms.In this section, simulated annealing (SA) and tabu search (TS) meta-heuristics for the DFLP are presented.The algorithms will be described in details later. Then, obtained upshots of objective function quantity and run time will be compared.

A. *Simulated Annealing Algorithm*

In fact, SA is an analogy between physical annealing process on solids and the process of solving hybrid optimization problems. The algorithm, like other meta-heuristic methods, attempts to use a controlled procedure for making stochastic neighbour answers for solution of hybrid complex problems. General structure of SA algorithm, shown in table 1, is significantly modeled. The notation being used in the pattern is as follows:

S : Current solution;
S^* : Best obtained solution;
$f(S)$: Objective function value, when its argument is S ;
n : Repetition numerator;
T : Primary temperature Level;
L : Number of repetitions of internal loop for any level of temperature;
p : Probability acceptance of neighbour solution when it is not better than the previous one;

The algorithm begins the procedure of achieving the optimum solution by creating a primary solution. In every internal cycle, a neighbour solution, S_n , is created for the current solution, S . If S_n is better than S , the current solution is substituted by the generated one; otherwise, the neighbour solution is accepted based on a probable criterion, $p = \exp(\frac{-\Delta}{T})$; where $\Delta = f(S_n) - f(S)$. Temperature level in every repetition of external cycle is reduced, using a function of temperature decrease (See table 1).

Settlement of controlling parameters plays a key role in the quality of solutions given by the SA algorithm.

SA parameters in the problem are defined as below:

Primary temperature (T_0) is chosen in a way, in which the acceptance probability for solutions first of worse neighbour is an amount between 0.8 to 0.9.

To reduce temperature, the geometric function of temperature decrease is used ($T_r = \alpha T_{r-1}$); where T_r is the heat degree in r^{th} stage, and α is the temperature decrease factor.

To check the equilibrium criterion in any heat degree, as many solutions as epoch would be created.

Stopping criterion is based on two things. One is achieving to the ultimate heat degree. If this condition is not satisfied, the number relating to the total quantity of generated solutions is used for stopping criterion.

To generate a neighbour solution, you should choose a random period in which two cells and two machines in each one should be selected. Exchanging the locations belonging to the selected machines, we calculate the thrift cost. Be careful to select those two machines whose exchange would cost least.

TABLE I.

GENERAL STRUCTURE OF SIMULATED ANNEALING ALGORITHM

```
Initialize the SA control parameter (T_0, L)
Select an initial solution, S_0
Set T = T_0, S = S_0, S* = S_0; Calculated f(S_0);
While the stop criterion is not reached do:
    Set n = 1;
    While n < L do:
        Generate solution S_n in the neighbourhood of S_0
Calculate Δ = f(S_n) − f(S);
        if Δ ≤ 0
            S = S_n
        else
            generate random number, r ∈ (0,1);
            if ( r ≤ p = e^(−Δ/T) )
            S = S_n; n = n + 1;
            end
        end
        if ( f(s) < f(s*) )
            S* = S_n;
        end
    end
    reduce ehe temperature T;
End
```

B. Tabu Search Algorithm

A tabu search algorithm requires an initial solution and a neighbourhood structure and proceeds by transiting from one solution to another using moves. All the neighbours of a current solution are examined and the best non forbidden move is selected. Note that this move may decrease the quality of the solution. A tabu list stores all the previously exploited moves which are now forbidden. Generally an optimization problem can be demonstrated as following:

$$
\begin{aligned}
&Min \quad C(x) \\
&s.t. \\
&x \in X
\end{aligned}
$$

An optimization problem, with objective function, $C(x)$, and constraint sets of X , could generally be either linear or nonlinear. Here, X is the feasible area and every feasible solution, like $x \in X$, has a neighbour solution Set, like $N(x) \subset X$, as any neighbour solution, like $x' \in N(x)$, could be obtained by running a one-step movement on x .

The general structure of TS algorithm is as below:

1) *STEP 1 -Primary value assigning:*

Generate a primary solution, $xnow$.

Assume the current solution be the best possible solution obtained so far; $xbest = xnow$

$BestObj = C(xnow)$.

2) STEP 2 - Choosing a neighbour solution:

Choose a solution from the neighbourhood of current solution; $xnext \in N(xbest)$. If stopping criterion is satisfied, stop the algorithm.

3) STEP 3 – Updating:

Put $xbest = xnext$ and if $C(xnow) < BestObj$, run step1-b, and then go to step 2.

Two approaches are mentioned in TS algorithm to generate neighbour solution. A period and then a cell in the first approach are randomly selected, respectively. The locations of the two selected machines are exchanged in a random manner. Second approach is to exchange the locations of the two selected machines in all cells. After exchanging the two facilities, a new neighbour solution is obtained in the 1st and 2nd choices. While running the algorithm, approaches 1 & 2 are performed in sequence.

The TS algorithm is stopped when the final value is lower than the final value obtained by SA algorithm.

IV. COMPUTATIONAL RESULTS

In this chapter, we present computation results to solve DFLP in cell manufacturing through meta-heuristic simulated annealing and TS. The proposed heuristics were programmed using the Delphi 7 programming language, and the set of test problems were solved on a Pentium IV 2.66 GHz PC.In table 2, dimensions of the problem are defined as 1 to 6.

TABLE II.

DIMENSIONS OF THE PROBLEM

Problem size T	Problem size N	Problem Number
2	8	1
	16	2
	32	3
5	8	4
	16	5
	32	6

Where N is the number of machines and locations, also T is the number of periods. First, we solve the problem with SA algorithm. Controlling parameters, to which the solution is sensitive, include α temperature decrease factor), Epoch (period length to check the equilibrium criterion), and Num (the total number of accepted solutions to check stopping criterion).As illustrated in table 3, eight problems are defined through diverse choices.

Each test problem was solved three for problems P1 ,…, P8 for different dimensions (See table4) .Relative Run Time of the best solution is shown in a separate column.

Table 5 shows the best results of three sequent running of TS algorithm for DFLP in cell manufacturing.By comparing tables 4 and 5, we find that for problem 1 and 2 the amount of objective function of SA and TS algorithms is the same. Where problem number is 3 and 4, SA algorithm has provided some better answers.Also for problems 5 and 6 the amount of objective function TS is lesser, it is while in most of the cases the the run time for SA algorithm is less.

TABLE III.

PARAMETER SETTINGS FOR THE SA HEURISTIC

Parameter settings	α	Epoch	Num
P1	0.95	10	100
P2	0.95	10	500
P3	0.95	30	100
P4	0.95	30	500
P5	0.99	10	100
P6	0.99	10	500
P7	0.99	30	100
P8	0.99	30	500

V. CONCLUSION

The DFLP is the problem of finding positions of machines on the plant floor for multiple periods such that machines do not overlap, and the sum of the material handling and rearrangement costs is minimized. In other words, for each period in the planning horizon, the layout is determined such that the sum of the material handling cost for each layout and the cost of rearranging machines between each pair of consecutive layouts is minimized. DELP in Cell manufacturing considering time value of money was discussed in the paper. A new mathematical model for the problem is presented. Being an NP-hard one, the problem is time consuming to be solved through software of mathematical models solution. For solving it two meta-heuristic algorithms – a simulated annealing and a tabu search one- are suggested. At the end, comparison accomplished with SA and TS algorithms.

TABLE IV

SOLUTION RESULT FOR SIMULATED ANNEALING ALGORITHM

Problem number	P1	P2	P3	P4	P5	P6	P7	P8	min	run time (milliseconds)
	Best solution	**Best solution**	**Best solution**	**Best solution**	**Best solution**	**Best solution**	**Best solution**	**Best solution**		
1	1248	1248	1248	1248	1248	1248	1248	1248	**1248**	16
2	2745	2749	2753	2738	2752	2735	2739	2739	**2735**	93
3	8057	7981	7961	7974	8007	7857	8018	7969	**7857**	250
4	6426	6413	6413	6401	6434	6381	6361	6343	**6343**	172
5	14348	14292	14363	14433	14424	14295	14461	14220	14220	359
6	42011	41515	41543	41385	41490	41543	41598	41510	41385	390

TABLE V.

SOLUTION RESULTS FOR TABU SEARCH ALGORITHM

Problem number	Best solution	run time (milliseconds)
1	**1248**	0
2	**2735**	4758
3	7899	5507
4	6353	6427
5	**14194**	10546
6	**40892**	156

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ISBN : 978-602-97809-0-1

Defects Prediction on Plastic Injection Moulding Process

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***Abstract* - Major problems faced by plastic manufacturing factory were high defective percentage in produced product. This study is carried out at a plastic manufacturing factory which carried out injection mould process located in Prai, Penang. Injection mould process is one process to generate various products based on plastic. In this study researchers would study those products called Finder Base as study material by obtaining defect data from the specific factory to study the process capacity of the creation by using capability process index (C_{pk}) and also predicting any defect in the month of November and December 2009. From analysis made, it has been discovered that Finder Base product's manufacturing process is not capable in the manufacturing process because during 34th months of the product take out just nine month only index's value $C_{pk} \geq 1$. While defect forecast in the month of November and December 2009 method used moving average (MA) found defect number increasingly rise against previous months with 2850 defect unit forecasted in the month of November and 2815 defect unit in December 2009.**

***Keywords* - Defective, Plastic, Capability, Forecast**

I. INTRODUCTION

Goods usage based on plastic in Malaysia continue to increase where increasingly widespread plastic material use his use together with residential population development growing from time to time by rapid economic development see much industry based on plastic manufacturing grew rapidly in our country. Plastic product we always see and use daily such as food wrapper, electronic equipment, vehicle accessories, home appliance, toy, automotive equipment, furniture etc. Material utilization increase base on plastic are because plastic having own advantage such as flexible, having high absorbency on shock loading (impact load) and vibration, resilient and malleable rust . Plastic goods use widespread now because of several factor such as light and cheap by own unique color and tidiness design. The increasing demand on products based on plastic had caused plastic manufacturing industrial development in Malaysia.

Malaysian Plastic Manufacturer Association (MPMA) President said, plastic manufacturing industry is one economic contributor to our country. News from Bernama said that, plastic industry in Malaysia remain stay when grow 8.3 percent and sales recorded RM7.96 billion in first half of the year 2008 from the RM7.35 billion in the year 2007. Exports recorded strong growth 18 percent with RM4.6 sales billion compare RM3.9 billion in that same period year 2007. To remain competitive in global market, companies need to take advantage from the increased of material to expand respective business profile and by the attracted of large overseas market. All companies should continue improve product, process and business, whether in manufacturing excellence, production speed, in production quality or in product design.

II. RESEARCH BACKGROUND

Study-conducted researcher is about plastic product defect based on injection mould process. In this study researcher will studies defect on the type of plastic product. This study is made at a factory which carried out injection mould operation. Researcher has chosen plastic manufacturing factory in Prai, Penang as study location. In plastic manufacturing industry not all those products produced according to the standards their wish for, those products do not follow standards in categorized as disabled product. Disabled definition as any failure to one unit is in order to meet specification to one particular quality feature, when assessment involves use. While defect also any unit have one or more disabled, probable involving a number disabled features. It used when one product unit or service in assess in consumption pattern [1].

A. *Problem Statement*

Main problem faced by plastic manufacturing factory was high defect level in either their production products namely Finder Base (EC 213) a plastic components in Canon lens's camera. This component is one of the parts in camera components lens. This product selection is predicated most frequent component or products always have problem in

ISBN : 978-602-97809-0-1

manufacturing process compared to another product. From the interview with quality control unit in plastic manufacturing factory, most frequent defect occurring on this product was flashing. Among frequent other defects occurring on this product are such as Warpage/ Bend, Sink Mark and Short Mould. Table 1 shows characteristics for Finder Base 's products

TABLE I

PRODUCT FEATURES

Product Name	**Finder Base**
Component No.	EC 213
Types Of Material	ABS Techno Nc401 Pc138
Colour	Black
Defect	*Flashing, Warpage/ Bend, Sink Mark, Short Mould*

Figure 1, 2, 3 and 4 below shows a few usual defect type examples in occurred on Finder Base products.

Fig. 1 Flashing type's defect

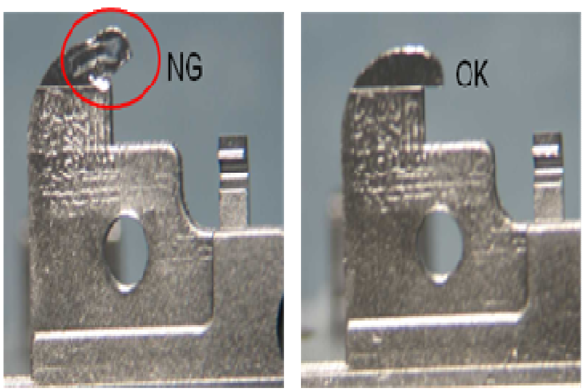

Fig. 2 Warpage/Bend type's defect

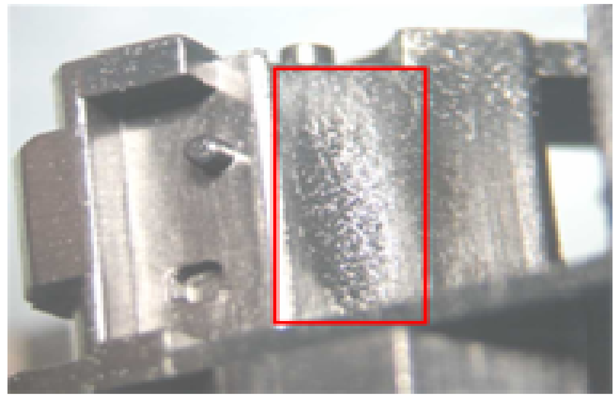

Fig.3 Sink Mark type's defect

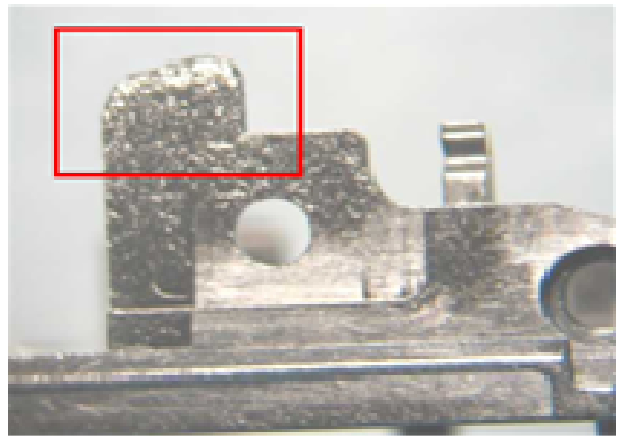

Fig. 4: Short Mould type's defect

III. LITERATURE STUDY

From studies which is done by [2] formulate that quality control basic technique was one method to increase quality and output productivity and ensure need or customer specification filled. In this study, some methods from sevens quality control basic technique was practiced to resolve two inside major flaw type products manufacture process billet in steel industry. Two that major flaw type based on Pareto Chart was pin hole and distortion. By apply a few quality control basic technique such as Pareto chart, Control Chart, cause and effect diagram, scatter diagram, flow chart and check sheet a few solution measure plan repair had used to increase product quality billet. Research results showed percentages rate of reduction two that major flaw type, namely pin hole as much as 11% and distortion as much as 2%.

[3] had studied why occurrence of defect in plastic manufacturing in his study entitled "Plastic Product Failure Due To Design, Material or Processing Problem". In his study, he divided into two causes main class damage namely second first class and class. Most plastic product handicap case happened is due to failure at first level as in injection mould process and also in second class of class operation such as material or used raw material during unsuitable process.

Based on [4] perusal, states that temperature mould is highest influence on quality of a product. Temperature influence influenced by type material plastic used, because every type of basic material plastic own temperature level different processes. [5] formulate in his study in carried out at a plastics industry that one factory method used trial and error in machine coordination and had no specific studies on those products conducted will experience sufficiently large defect floor. As such, one factory could not find real factors power in minimize product defects. Defect is products that cannot fulfill the normal character in specification. It fall into two principal divisions namely primary features and secondary features. Primary features is defect which occur after products manufacture process made such as short mould, sink mark, void and secondary features is defect which occur after the products are used like broke 'crack' [6].

IV. METHODOLOGY

Methodology Study provide as guideline to studies which operate whether from aspect to obtained data or analysis of data. Organized and effective study methodology would facilitate study process implemented by ensure study-conducted is parallel to his objective. Study methodology efficient would ensure related and useful data only grouped and included in analysis so that could produce result more accurate.

V. DATA ANALYSIS

A. *Capacity Index Process (C_{pk})*

Overall, index value minimum process capacity is $C_{pk}=1$. Increasingly invaluable mean capacity process capacity process is better. If index value $C_{pk}\geq 1$, its mean process fulfill of specification and more capable in process. If $C_{pk} < 1$, it shows capacity is weak process. (Neil Polhemus, 2002) Data's in analysis index form process capacity, C_{pk} (Capability Process Index) namely either quality control tool to assess inside products manufacture process industry whether capable in operation or no capable by using QI MACROS 2009 Excel liquidware.

1) Study Analysis Of Data Based on Capacity Process Index (C_{pk}).

Based on Table II, shows defect data products for Finder Base's component. From analysis of data schedule found in year 2006 this products is first year take out in December show production process is not capable or weak because $C_{pk} <$ 1 value.During 34 months of this products taken out, just nine month, this process fulfill of specification and potential in process by referring $C_{pk} \geq 1$ value. In year 2007, only four month of process in the potential position those are on February, June, August and December. C_{pk} index in year 2008 showing that only four month of this products manufacture process be in process capable namely in May, July, August and November. While in year 2009 only one month only C_{pk} index ≥ 1 namely in August.

TABLE II

CAPACITY PROCESS INDEX (C_{PK}) OF FINDER BASE DEFECT.

Year	**Month**	**Product defect**				**Cpk**
		Finishing	Warpage/ Bend	Sink Mark	Short Mould	
2006	Dec	2230	617	212	968	0.88898
2007	Jan	2550	514	230	1237	0.9191
	Feb	885	593	641	919	1.0503
	Mac	2811	603	330	1411	0.9243
	Apr	3219	874	177	1951	0.8987
	May	3016	545	424	1078	0.954
	Jun	954	397	327	910	1.0864
	Jul	2792	398	274	1218	0.948
	Aug	1872	346	215	1861	1.1398
	Sep	2277	273	216	478	0.9828
	Oct	1525	326	237	613	0.9411
	Nov	2842	558	225	354	0.9749
	Dec	2249	231	189	252	1.0123
2008	Jan	1591	239	113	351	0.9448
	Feb	1281	491	118	438	0.8751
	Mac	1260	366	150	663	0.8938
	Apr	448	279	286	591	0.9819
	May	1227	236	77	1286	1.088
	Jun	1208	243	202	604	0.953
	Jul	1066	169	217	813	1.0183
	Aug	658	100	250	704	1.0195
	Sep	1165	144	198	547	0.9471
	Oct	1006	178	143	264	0.975
	Nov	1105	426	144	1031	1.0016
	Dec	1120	303	200	657	0.9302
2009	Jan	1180	434	255	544	0.896
	Feb	1257	530	327	265	0.946
	Mac	1207	290	191	283	0.9693
	Apr	895	310	149	513	0.8888
	May	1177	277	138	457	0.9156
	Jun	1168	283	260	437	0.9704
	Jul	1240	356	252	338	0.9681
	Aug	1080	237	215	188	1.0013
	Sep	670	240	422	231	0.9658

2) Defect Forecasting Finder Base Products for November and December 2009.

For this purpose researcher use ForecastX Excell liquidware which accounts one of the liquidware occur in Six Sigma liquidware. Table III show schedule example produced by using ForecastX Excell liquidware for this analysis purposes.

TABLE III

MONTHLY FORECAST SCHEDULE

Forecast -- Moving Average Selected			
	Flashing Forecast		
Date	Monthly	Quarterly	Annual
Nov-2009	1,530.26		
Dec-2009	1,509.68	3,039.95	3,039.95
Jan-2010	1,479.09		
Feb-2010	1,496.56		
Mar-2010	1,457.90	4,433.55	
Apr-2010	1,406.10		
May-2010	1,358.75		
Jun-2010	1,370.66	4,135.51	
Jul-2010	1,328.85		
Aug-2010	1,312.88		
Sep-2010	1,284.52	3,926.25	
Oct-2010	1,277.51		
Avg	1,401.06	3,883.82	3,039.95
Max	1,530.26	4,433.55	3,039.95
Min	1,277.51	3,039.95	3,039.95

3) Forecast Schedule Defect for Month November and December 2009.

TABLE IV.

DEFECT FORECAST OF NOVEMBER AND DECEMBER 2009

Year	Month	Product Defect				Total Defect
		Flashing	*Warpage/ Bend*	*Sink Mark*	*Short Mould*	
2009	Nov	1530	365	235	719	2850
	Dec	1510	357	236	712	2815

Table IV above showed defect forecast for Finder Base's products of November and December 2009 method used moving average (MA). In the month of November found defect type flashing is highest defect forecast compared to other defect types with defect number 1530 defect unit and number total 2850 unit. In December found defect flashing is highest defect forecast to four that defect type namely 1510 defect unit and number total was 2815 unit.

VI. CONCLUSIONS

In analysis has been done in previous chapter, researcher wish to summarize that this study has answer all objective of the study issue. researcher have conducted study in plastic factory producing by taking those products called Finder Base in produce through moulding method mould as study material. Product selection this is predicated to products most problematic in his manufacturing process in this factory. This products experience defect floor highest as compared with other products. In study analysis in make, researcher found most capacity index C_{pk} process in Finder Base products's defect for period 34 his production month is $C_{pk} < 1$. These show process capacity Finder Base products manufactures was weak and not follow real specification. Just nine month only of 34 Finder Base production's month is in capacity in manufacturing process where $C_{pk} \geq 1$.

At the same time also, in find out forecast for number defect of November and December are soaring if in compare with previous month respectively 2850 unit and 2815 unit. For the overall, we can conclude that defect occur on Finder Base products is because no specific specialization to prevent this disorder from continue to repeat. Method used by plastic manufacturing factory is inside prediction method overcomes the defect problem. Based on index value process capacity (C_{pk}) in Table III found more than half C_{pk} index's value monthly defect products is less than 1. This shown weakness in product manufacturing process Finder Base.

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ISBN : 978-602-97809-0-1

Thermal Cycling Effects On Properties Of Steel Grade Used For Heat Exchangers: Doe Pproach

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Abstract **- In this paper, the influence of thermal cycling on the corrosion and hardness has been studied for low carbon steel material. This type of steel is cheap and extensively used in industry including heat exchangers, cooling towers and similar heat transfer equipments. During the normal operation of these equipments, this material is subjected to thermal cycles (heating and subsequent cooling) which are usually below the first phase transformation temperature for steel (≈ 723°C). Previous work was either considering standard heat treatment methods or using the classical method of changing one parameter each time. In this work the temperature range selected is below the 723 °C and the response surface methodology in the Design of Experiment (DOE) was implemented to tackle these shortcomings. Therefore low carbon steel specimens were prepared and thermally cycled for 20, 30 and 40 cycles at temperatures of 400, 500, and 600 °C respectively. During one thermal cycle the specimen underwent heating and rapid cooling in water. Corrosion and hardness were measured for the selected number of cycles and thermal cycling temperatures. The influence of thermal cycling on the hardness and corrosion of the low carbon steel was determined and analyzed and interesting conclusions were drawn.**

Keywords **- Thermal cycling, corrosion, heat exchanger, hardness, low carbon steel**

I. INTRODUCTION

This Steel is the world's most important material, multi-functional and most adaptable material. About 5% of iron element is present in earth's crust [1]. Without steel, the world as we know it would not exist: from oil tankers to thumb tacks, from trucks to tin cans, from transmission towers to toasters [2]. Or we can say steel is arguably world's most "advanced" material. It is very versatile material with a wide range of attractive properties which can be produced at a very competitive production cost [3].

Carbon steel is by far the most widely used kind of steel. The properties of carbon steel depend primarily on the amount of carbon it contains. Most carbon steel has a carbon content of less than 1% [4]. Low carbon steel is easily available and cheap having all material properties that are acceptable for many applications , including structural beams, car parts and bodies, kitchen appliances, cans, pipe line, railways, tractors and agriculture implement, petrochemical and engineering industries, the list is endless [1 and 5].

In like these applications the carbon steel parts may be subjected to heating then cooling many times throughout the operation; these heating and cooling is called *thermal cycling*. When a hot part is rapidly cooled in a solution such as water that produces a high heat transfer, the temperature differences create high thermal stresses which often cause deformation [5-6]. This distortion works on scattering of atoms and increasing the distortions in the microstructure and also works on the creating of stresses. These internal reasons resulting from the operations of the heating and cooling and changes in its dimensions (expansion and contraction), results on an increase in hardness, and from nature of the metal if it is increased in hardness, would be more resistant to wear (particularly erosion), but these stresses and these distortions may make the metal more susceptible to corrosion on the contrary than it is in the hardness and wear resistance [7]. This may affect the mechanical and tribological properties of the metal. This phenomenon is observed in many of applications as in various types of heat transfer equipments such as heat exchangers and boilers (See Fig. 1).

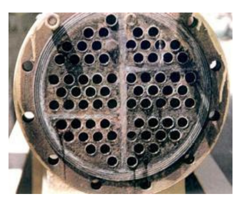


Fig.1 Corrosion and erosion of heat exchangers tubes

Jokhio et al. [7] conducted various types of heat treatment on carbon steel and found that water quenching of low carbon steel specimen has the highest tensile strength and hardness. However this treatment gives the lowest ductility compared to other treatments. They concluded that quenching is recommended when the strength and hardness is the prime factor in design. The microstructure of steel consists of matrix of ferrite and pearlite. The grain fines of pearlite increases by increasing the rate of cooling. However, they have not

ISBN : 978-602-97809-0-1

considered the temperatures below the first transformation temperature (A1). T. Foley and A. Levy [8] conducted erosion study on low carbon steel and found that the ductility of the steels (and consequently hardness) had a significant effect on their erosion resistance which increased with decreasing ductility. This suggests that the hardness can be utilized as an erosion resistance performance parameter.

II. MATERIALS AND METHODS

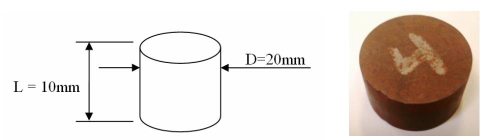
A. *Material*

Table (1) shows the chemical composition of the low carbon steel used in this investigation. The material which has ASTM code A576 Grade 1018 has very close chemical and mechanical characteristics to the ASTM A214 heat exchanger and condenser tube material and is chosen because it is available on rods which is suitable for the research work requirements [8]. Specimens were cut from a rod of 20 mm diameter in the form of cylindrical shape with 20mm in diameter and 10mm in length (See Fig.2). The specimens, in the as-received condition, were annealed to get rid of any stresses which might be introduced during manufacturing and cutting.

TABLE (1)

ASTM-A576, GRADE1018 CHEMICAL COMPOSITION

Element	C	Mn	ph	S
%	0.14 - .21	0.25 -0.4	0.4	0.05



Specimen dimensions Physical shape

Fig. 2: test specimen

B. *Methods of Experiments*

In this work a response surface methodology (*RSM)* design of experiment was implemented to plan the experimental work. The *RSM* range was selected based on literature values and also after performing few trials. After the design factors and their levels were set, the design of experiment matrix based on the Central Composite RSM method was created using MINITAB software (See Table 1). Subsequently, the thermal cycling processes, the hardness, and corrosion performance tests were carried out according to the designed experiment matrix listed in Table (1).

C. *Description of the Thermal Cycling Process*

This process involved the steps as shown schematically in Fig. (3). Specimens for each temperature and number of cycles setting (Exp. No) were heated to the required temperature according to Tables (1). Then they were allowed to homogenize at that temperature for 1 hour. After that the specimens were immediately (rapidly) cooled in water at a constant ambient temperature (between 25 to 35 ^{o}C). This constitute one cycle. For each experiment No. the previous steps were repeated to the required number of cycles. After all experiments were completed, specimens were then taken out for hardness, and corrosion testing. The hardness values were determined using 100kg load on Rockwell (HRB- kg/mm^2) hardness tester. The corrosion test was based on subjecting the specimens to the environmental (atmospheric) corrosion for a period of 3 months. This period was decided after few trials for determining the suitable exposure period that would produce sufficient amount of corrosion that can be measured.

III. RESULTS AND ANALYSIS

After the RSM matrix is completed by introducing the results as shown in Table (1), the design matrix was analyzed using RSM routines in MINITAB software. The full quadratic model was selected to analysis the response surfaces. The output results were generated in the form of contour plots and three dimensional response surface plots; statistical models were also produced.

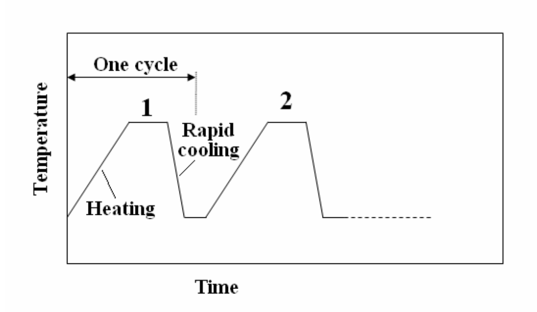


Fig. 3 The thermal cycling process

TABLE 1

THE RSM DESIGN MATRIX

Exp. No	Number of cycles	Cycling Temp. ^{o}C	Hardness (HRB)	Corrosion Wt loss (g)
1	30	600	81	0.58
2	20	400	81.5	0.498
3	20	500	85.4	0.373
4	40	400	83.1	0.449
5	40	500	91	0.361
6	40	600	80.5	0.982
7	30	400	82.6	0.513
8	30	500	88.4	0.339
9	20	600	83.3	0.653

ISBN : 978-602-97809-0-1

A. *Hardness RSM Analysis*

The hardness results were analysed using response surface methodology (*RSM*), and the interactions of thermal cycling parameters were identified.

1) The RSM model: Regarding the statistical model, the statistical analysis for the full quadratic model hardness results resulted in coefficients of determination of R^2 and R^2-Adj = 86.7% and 65 % respectively, which shows that the performed hardness regression is very good (see appendix-A). The RSM model showed small p-values for the thermal cycling temperature and thermal cycling temperature squared (p = 0.023 and p = 0.025 respectively) suggesting these effects are important, slightly large p-value for the interaction of cycling temperature and number of cycles (p = 0.374) and intermediate p-value for the number of cycles (p = 0.639); this suggesting that the main effecting processing parameters were the thermal cycling temperature, and the less effecting one was the number of cycles, while the interaction of cycling temperature and number of cycles had an intermediate effect. Therefore, the verified model of hardness is as follows:

$$\boldsymbol{HRB} = -83.989 + 0.54334\,\boldsymbol{C} + 0.65567\,\boldsymbol{T} + 0.00134\,\boldsymbol{C}^2 - 0.00063\boldsymbol{T}^2 - 0.00110\,CT \qquad \ldots(1)$$

Noting that, ***HRB*** is the hardness in RB, **C** is number of cycles, ***T*** is cycling temperature (°C).

2) *Hardness RSM parametric study:* The effects of thermal cycling processing parameters on hardness are presented in Figures (4) and (5) as 3D surface plot and contour plot obtained using MINITAB regression model of equation (1). All these graphs are held and identified at middle values of processing parameters. As shown in the 3D- surface plot of Figure (4), the effect of the cycling temperature is more significant than the number of cycles. This may show that either the number of cycles is not that much significant as compared to the thermal cycling temperature or that the selected cycles range is not sufficient to clearly explore its effects. This is recommended to be as a future work in this subject. Regarding the number of cycles, the increase is almost linear within the selected range. However, the effect of the cycling temperature is increasing the hardness in a non-linear curve until a peak at about the 500 °C, and then it is decreasing again.

The overall response looks like a tilted saddle. These findings are confirmed by the contour plot of Figure (5), which shows that the effect of the number of cycles may reasonably be represented by horizontal lines. The effect of the cycling temperature is very clear with a region of maximum hardness around the 500 °C temperature. This temperature is the start of the grain re-crystallization where after this temperature stress reliving would usually take place. Before this 500 °C temperature hardness increases due to residual stresses building up. This residual stresses are generated from the rapid cooling of the thermal cycling processes. However, for the 600 °C temperature results this residual stresses would be relieved each time the specimens are reheated for the subsequent cycle.

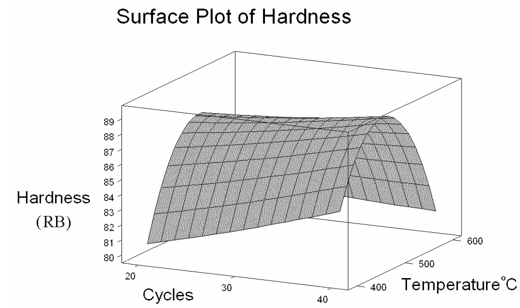


Fig.4 The 3D-surface plot of the hardness as a response and cycling temperature and No. of cycles.

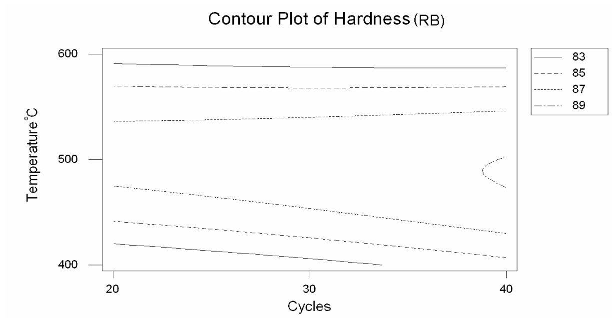


Fig. 5 The contour plot of the hardness as a response and cycling temperature and No. of cycles.

B. *Corrosion Rate RSM Analysis.*

The corrosion rate results were analysed using response surface methodology (*RSM*), and the interactions of thermal cycling parameters were identified.

1) *The Corrosion rate RSM model:* Regarding the statistical model, the statistical analysis for the full quadratic model for corrosion rate measurements resulted in coefficients of determination of R^2 and R^2-Adj = 88.9 % and 70%, which shows that the performed corrosion rate regression is good (see appendix-A). The RSM model showed small p-values for the thermal cycling temperature and thermal cycling temperature squared (p = 0.041and p = 0.045 respectively) suggesting these effects are important, slightly large p-value for the number of cycles and the interaction of cycling temperature and number of cycles (p = 0.2 and p = 0.18 respectively) and intermediate p-values for the number of cycles squared (p = 0.40); this suggesting that the main effecting processing parameters were the thermal cycling temperature, and less effecting one was the number of cycles

and the interaction of cycling temperature and number of cycles, while the number of cycles squared had an intermediate effect. Therefore, the verified model of corrosion rate is as follows:

$$\boldsymbol{CR\ (g)} = 8.0106 - 0.08799\,\boldsymbol{C} - 0.02706\,\boldsymbol{T} + 0.00075\,\boldsymbol{C}^2 + 0.00003\,\boldsymbol{T}^2 + 0.00009\,\boldsymbol{CT} \quad \ldots(2)$$

Noting that, ***CR*** is the corrosion rate expressed as the weight loss in grams, **C** is number of cycles, ***T*** is cycling temperature (^{o}C).

2) *Corrosion rate RSM parametric study:* The effects of thermal cycling processing parameters on corrosion rate are presented in Figure (6) to Figure (7) as 3D surface plot and contour plot obtained using the MINITAB developed model of equation (2).

As shown in the 3D- surface plot of Figure (6), the effect of the cycling temperature is more significant than the number of cycles. However, based on the results obtained, regarding the number of cycles, the decrease of corrosion rate with increasing the number of cycles is almost linear within the selected range. The effect of the cycling temperature is decreasing the corrosion rate in a non-linear curve until a minimum at about 500 ^{o}C, and then it is increasing again. These findings are confirmed by the contour plot of Figure (7), which shows the effect the number of cycles as approximately horizontal lines. The effect of the cycling temperature is very clear with a region of minimum corrosion rate around the 500 ^{o}C temperature. This temperature is the start of the grain re-crystallization where after this temperature stress reliving would usually take place. Before this 500 ^{o}C temperature, corrosion was high and decreases due to residual stresses building up (more stored energy). This residual stresses are generated from the rapid cooling of the thermal cycling processes. However, for the 600 ^{o}C temperature results even though this residual stresses would be relieved each time the specimens are reheated for the subsequent cycle, the corrosion rate increases again due to oxidation which is reported to start at about 570 ^{o}C.

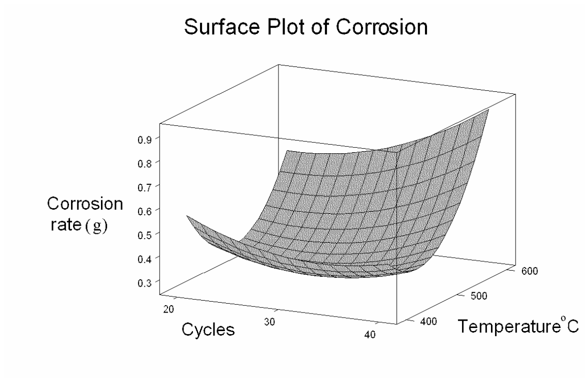


Fig. 6 The 3D-surface plot of the corrosion rate as a response and cycling temperature and No. of cycles.

IV. CONCLUSIONS

From this experimental study the thermal cycling temperature was found to have more significant effects than the number of cycles on both the hardness and the corrosion rate. Increasing the thermal cycling temperature generally was found to increase the hardness until about 500^{o}C where peak hardness is obtained, and then it is followed by a decrease in the hardness**.**

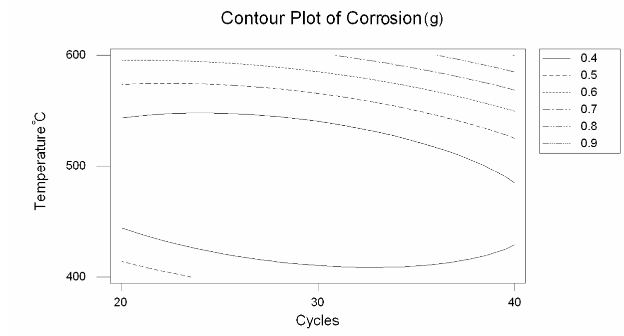


Fig.7 The contour plot of the corrosion rate as a response and cycling temperature and No. of cycles

Increasing the thermal cycling temperature also, decreased the corrosion rate until it comes to a minimum at about 500 ^{o}C then it increases again. However, increasing the number of cycles, was found to increase the hardness but not to the same extent of the temperature and increase the corrosion rate but not to the same extent of the temperature. It is interesting to note that there is a temperature where peak response values were obtained for both hardness and corrosion tests which is the 500^{o}C. This seems to be a critical temperature in this steel type and designers need to be aware of the changes occurring around it. This type of material showed weak hardness and corrosion properties as the temperature goes above 500 ^{o}C, which suggests that this material may not be suitable above this temperature for applications where the performances considered are essential requirements. Finally, empirical models were developed which predicts the hardness and the corrosion rate performance of this type of steel within the selected temperature and number of cycles range. This is a good achievement as no model could be obtained from the previous literature on these issues.

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ISBN : 978-602-97809-0-1

APPENDIX-A: RSM REPORTS

A1-Response Surface Regression: Hardness versus Cycles and Temperature

The analysis was done using un-coded units.

TABLE A-1
ESTIMATED REGRESSION COEFFICIENTS FOR HARDNESS MODEL

Term	Coef	SE Coef	T	P-value
Constant	-83.99	41.8941	-2.005	0.139
Cycles	0.54	1.0445	0.520	0.639
Temperat	0.66	0.1530	4.284	0.023
Cycles*Cycles	0.00	0.0149	0.089	0.935
Temperat*Temperat	-0.00	0.0001	-4.193	0.025
Cycles*Temperat	-0.00	0.0011	-1.041	0.374

S = 2.114   R-Sq = 86.7%   R-Sq(adj) = 64.6%

TABLE A-2
ANALYSIS OF VARIANCE FOR HARDNESS

Source	DF	Seq SS	Adj SS	Adj MS	F	P-value
Regression	5	87.604	87.6044	17.5209	3.92	0.145
Linear	2	4.187	82.0385	41.0192	9.18	0.053
Square	2	78.578	78.5778	39.2889	8.79	0.056
Interaction	1	4.840	4.8400	4.8400	1.08	0.374
Residual Error	3	13.404	13.4044	4.4681		
Total	8	101.009				

A.2. Response Surface Regression: Corrosion rate versus Cycles and Temperature

The analysis was done using un-coded units.

TABLE A-3
ESTIMATED REGRESSION COEFFICIENTS FOR CORROSION RATE MODEL

Term	Coef	SE Coef	T	P-value
Constant	8.01061	2.15652	3.715	0.034
Cycles	-0.08798	0.05377	-1.636	0.200
Temperat	-0.02706	0.00788	-3.435	0.041
Cycles*Cycles	0.00075	0.00077	0.979	0.400
Temperat*Temperat	0.00003	0.00001	3.312	0.045
Cycles*Temperat	0.00009	0.00005	1.737	0.181

S = 0.1088   R-Sq = 88.9%   R-Sq(adj) = 70.4%

TABLE A-4
ANALYSIS OF VARIANCE FOR CORROSION RATE

Source	DF	Seq SS	Adj SS	Adj MS	F	P-value
Regression	5	0.283926	0.283926	0.056785	4.80	0.114
Linear	2	0.106975	0.159198	0.079599	6.72	0.078
Square	2	0.141230	0.141230	0.070615	5.96	0.090
Interaction	1	0.035721	0.035721	0.035721	3.02	0.181
Residual Error	3	0.035518	0.035518	0.011839		
Total	8	0.319444				

ISBN : 978-602-97809-0-1

Location Determination of New Branch for Laboratory Clinic X Using Analytic Network Process (ANP) and Feasibility of Investment

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Abstract - **The higher level of public awareness towards health, the higher the competition among health service providers. Laboratory Clinic X, one of the health service providers, is a Laboratory Clinic that is developing rapidly and participating in the competition among other service providers. In a highly competitive environment, the selection of a new branch location that has high competitiveness is a top priority. It is important to obtain a location that can provide maximum benefits and high competitiveness in accordance with company objectives. Five alternative districts are determined by identifying target market of Laboratory Clinic X, including population density, potential age population, and high-wealthy level population. Each of the criteria weights is determined using the pair-wise comparison method. The weight multiplied by the rank held each district, furthermore the five alternative districts are determined; Wonokromo, Semampir, Sawahan, Simokerto, and Tambaksari. The selection criteria and sub criteria are identified based on Porter's Diamond Model. One of the significant sub criteria is the investment feasibility of each district using NPV, IRR, and payback period. The investment feasibility calculations indicate that Wonokromo District the largest weight; NPV IDR 60.646.579.867, 29% IRR, 5 years and 4 months of payback period. Furthermore, P-Median Method is used to find sub optimal from each location. The ANP assessment was conducted using expert judgments. Furthermore, weighted gained by each district shows Wonokromo District get first priority, with a weight of 0.2038, District Tambaksari the second priority with a weight of 0.0942, Simokerto District get 0.0782 of weight, District Semampir get 0.0726 of weight, and Sawahan District 0.0502. As the district with the highest weight, District Wonokromo is chosen as the best location of new branches Laboratory Clinic X.**

Keywords - **Laboratory Clinic Location Selection, Porter's Diamond Model, P-Median Method, Investment Feasibility, ANP.**

I. INTRODUCTION

The increasing of public awareness about health causes the increasing of the need for clinical laboratories. The existence of more clinical laboratories will increase competition so the Laboratory Clinic X should choose the right location in order to survive and even flourish.

In determining the location of new branches, we need to analyze the characteristics of the population in each district, the competitive advantage they had, existing demand in the district, access to supplier, the availability of infrastructure network, competition, and other criterion.

II. TEORITICAL FRAMEWORK

This research is using these approaches and theories: Market Target, Porter's Diamond Model, Analytic Network Process (ANP) Method, P-Median Method, and the feasibility of investment using the calculation of Net Present Value (NPV).

A. *Market Target*

First stages of the research is identifying the market target for Laboratory Clinic X to obtain five district alternatives. This is not done by [8] in his research, where alternative locations are selected based on one criterion, which is the population density. This study not only using population density but also involving potential age and number of population with upper-middle income.

After identified, the priority weight is calculated for each criteria using pairwise comparison based on assessment which is done by Laboratory Clinic X's management. Furthermore, a weighted value is calculated by multiplying the weight rating value of each district, so we can gain five alternatives with have the highest weighted value.

B. *Porter's Diamond Model*

Identification of competitiveness criteria based on Porter's Diamond Model for evaluating five alternative locations. The criteria identification based on the Porter's Diamond Model is done by [8] and [2] and in this research, respondents are expert of land use, transportation, infrastructure, and and regulations. Those respondents are city planning consultant, government, and academic experts.

Porter's Diamond Model is consists of six elements [3], which are:

1. Factor conditions, i.e., factors of production, such as labor resources, capital, etc.
2. Demand conditions, i.e., the nature of consumer demand in the area.
3. Firm strategy, structure, and rivalries.
4. Related and supporting industries: The presence or absence in a nation of supplier industries and related industries that are globally competitive.
5. Government policy and political environment.
6. Chance such as changing market demand, disasters, and technological developments.

Sub-criteria are gained based on existing criteria of Porter's Diamond Model, compared to several references and previous researchs, and adjustments to the observed objects by the laboratory clinic.

C. *P-Median Method*

The calculation to obtain the optimal number of sub district in each district is done using the P-Median Method (Myopic Algorithm approach).

D. *Investment Feasibility*

Furthermore, as an input in assessing the economic factor, the feasibility of investment is done for the five alternatives locations using the calculation of Net Present Value (NPV), Internal Rate of Return (IRR) and payback period.

E. *Analytic Network Process(ANP)*

ANP which was developed by Thomas L. Saaty, provides a procedure to assess and measure the ratio scale of priorities for the influence distribution between the factors and groups of factors in the decision [6].

Within the criteria and sub criteria that have been identified based on Porter's Diamond Model, the relationships between criteria and sub-criteria is identified. This process is an advantage of Analytic Network Process (ANP), which is in accommodating the interdependencies between the criteria and sub-criterion. [7]

In determining the location of Laboratory Clinic X's new branch, there are various interactions and dependencies between the criterion, sub criterion, and alternatives, so, the ANP method is applied. Assessment is done using pairwise comparison among criterion, among sub-criteria, and between the sub-criteria and the alternatives by some experts, such as city planning experts from academic field, city planning consultant, and the management of Laboratory Clinic X. The values gained from the experts are calculated using the average geometry formula then entered into the matrix of combined opinion that will be input for ANP method. Locations with highest priority weight is selected as the new Clinical Laboratory X's branch location.

F. *Sensitivity Analysis*

In this research, sensitivity analysis is evaluated toward one of the parameters in investment feasibility, that is demand.

III. DATA COLLECTION AND IMPLEMENTATION

Three criteria for the selection of a new Laboratory Clinic X's branch location based on Market Target, are population density, potential age (25-59 years), and number of population with middle-upper income. Five districts with highest weighted value will be the alternative district.

$$y_n = a.PD_n + b.PA_n + c.PI_n \quad \text{........................(1)}$$

Explanation:

y_n = Weighted value for the n^{th} district
a = Weight of population density criteria
b = Weight of potential age range criteria
c = Weight of population number with middle-upper income
PD_n = Population Density Rate in the n^{th} district
PA_n = Potential Age Population Rate in the n^{th} district
PI_n = Number of population with middle-upper income Rate in the n^{th} district

The values of a, b, and c are the weight of each criteria gained from research done by some experts using pairwise comparison.

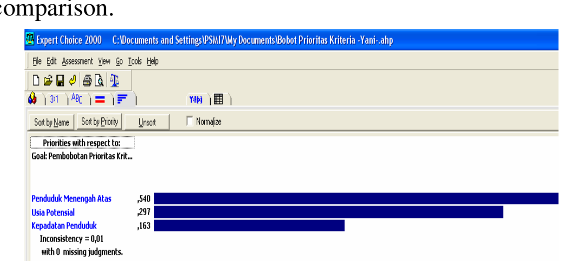

Figure 1. Pairwise Comparison of Selection Criterion

Based on pairwise comparison's result, the weight value of population density criteria is 0.163, the weight value of potential age criteria is 0.297, and the weight value of population number with middle-upper income is 0.54. The value of PD_n, PA_n, and PI_n that shows a district rating based on population density, potential age, and population number with middle-upper income is calculated using the following formula:

$$PD_n = (PD_n / \text{Total PD})*100 \quad \text{...................(2)}$$

Explanation:

n : The n^{th} district

PD : Population density

PD_n : Population Density Rating in the n^{th} district

TABLE 1.
DISTRICT'S RATING VALUE BASED ON POPULATION DENSITY

No.	District	Density (person/km^2)	Value Rating
1	Sawahan	32216.0	8.57
2	Tambaksari	24821.9	8.56
3	Semampir	22053.3	7.41
4	Wonokromo	22045.5	7.17
...	....	....	....
28	Bulak	10531.3	1.35
	TOTAL	**2,605,957**	**100**

$R(PD_{sawahan})= (32216/2605957)*100$
$= 8.57$

Same calculation to obtain a rating value is done to the potential age and population number with middle-upper income criterion.

After the rating value for each district based on each criteria is known, the calculation of weighted values are done.

TABLE 2.
DISTRICT'S WEIGHTED VALUE

No	District	PD_n	Weight of PD	PA_n	Weight of PA	PI_n	Weight of PI	Weighted value (y_n)	
1	Sawahan	8.57	0.163	9	0.297	4.34	0.54	8.954	3
2	Tambaksari	8.56	0.163	8.48	0.297	4.04	0.54	8.498	5
3	Semampir	7.41	0.163	7.25	0.297	7.15	0.54	11.051	2
4	Wonokromo	4.8	0.163	7.47	0.297	11.09	0.54	15.014	1
5	Krembangan	4.58	0.163	4.87	0.297	5.57	0.54	8.344	
6	Tegalsari	4.48	0.163	4.75	0.297	4.98	0.54	7.68	4
7	Kenjeran	4.45	0.163	4.1	0.297	3.32	0.54	5.809	
8	Bubutan	4.09	0.163	4.52	0.297	2.99	0.54	5.6	
9	Simokerto	3.81	0.163	4.06	0.297	6.25	0.54	8.661	
10	Sukolilo	3.74	0.163	3.83	0.297	5.79	0.54	8.088	
11	Sukomanunggal	3.62	0.163	3.68	0.297	4.38	0.54	6.625	
12	Tandes	3.6	0.163	3.68	0.297	1.74	0.54	3.961	
....	....	....	....	....	....	....	....	....	

Based on the weighted value, five alternative districts are determined, they are: Wonokromo District, Semampir District, Sawahan District, Simokerto District, and Tambaksari District.

Districts have a very large area and it will complicate the assessment of specific criterion. To overcome that difficulty, the optimal sub district is determined for each district using P-Median method, with Myopic Algorithm approach.

$$\text{Minimize} \sum_i \sum_j h_i d_{ij} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

h_i: Demand at node i

d_{ij}: Distance between demand point at node I with node j, which is the built candidate (d_{ij} is zero if i = j)

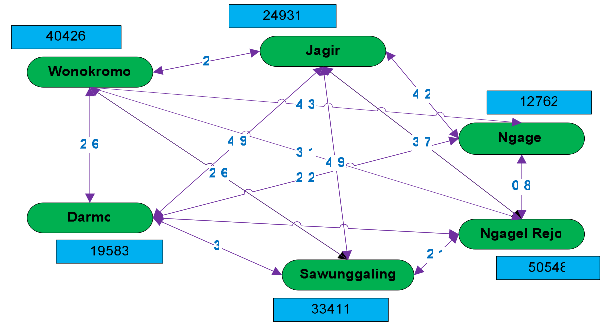

Figure 2. Sub District Network at Wonokromo District

TABLE 3.
DISTANCE BETWEEN SUB DISTRICTS IN WONOKROMO DISTRICT

No.	Sub District	Wonokromo	Jagir	Ngagel	NgagelR	Darmo	Sawunggaling	Population Number
1	Wonokromo	0	2	3.4	3.1	2.6	2.6	40,426
2	Jagir	2	0	4.2	3.7	4.9	4.9	24,931
3	Ngagel	3.4	4.2	0	0.8	2.2	4.1	12,762
4	NgagelRejo	3.1	3.7	0.8	0	2.1	4	50,548
5	Darmo	2.6	4.9	2.2	2.1	0	3	19,583
6	Sawunggaling	2.6	4.9	4.1	4	3	0	33,411

Wonokromo Sub District

= (0 * 40426) + (2*24931) + (3.4*12762) + (3.1*50548) + (2.6*19583) + (2.6*33411)

= 387520

The calculation is done to all existing sub district in the Wonokromo district until the demand-weighted distance for each sub district is obtained. Minimum demand-weighted distance is the optimal sub district.

TABLE 4.
WONOKROMO DISTRICT'S TOTAL DEMAND-WEIGHTED DISTANCE

		WONOKROMO DISTRICT (Node j)					
No	Nodei	Wonokromo	Jagir	Ngagel	NgagelRejo	Darmo	Sawunggaling
1	Wonokromo	0	80852	137448	125321	105108	105108
2	Jagir	80852	0	104710	92245	122162	122162
3	Ngagel	84765	104710	0	10210	28076	52324
4	NgagelRejo	39562	47219	10210	0	106151	202192
5	Darmo	131425	247685	111206	106151	0	58749
6	Sawunggaling	50916	95957	80290	78332	58749	0
	Total	387520	576424	443864	412258	420246	540535

From the calculation above, it is known that the Wonokromo Sub District is the optimal sub district from Wonokromo District with a minimum average distance to all demand points.

Average distance = Total demand weighted distance/Total Demand
= 387520 / (181661)=2.13 km

Calculation of demand-weighted distance and average distance to all demand points are done for five districts in order to obtain the sub district with an optimal average distance.

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TABLE 5.
DEMAND-WEIGHTED DISTANCE AND AVERAGE DISTANCE

Median Number	**Location** (Sub District)	**Demand-Weighted Distance**	**Average Distance**
1	Wonokromo	387520	2.13 km
1	Wonokusumo	359558	1.85 km
1	Kupang Krajan	309913	1.39 km
1	Simokerto	276254	1.22 km
1	Ploso	90634	0.89 km

After identifying the optimal sub district from each district, criteria and sub criteria for selecting the locations Laboratory Clinic X are identified using Porter's Diamond method. Sub criteria are identified based on previous research and adjustments are made by some experts (Table 6).

TABLE 6
CRITERIA AND SUB CRITERIA FOR SELECTING LABORATORY CLINIC X'S LOCATION

Level 1: Ultimate Goal	Level 2: Criteria	Level 3: Sub-Criteria	Level 4: Alternatives
Getting a new branch location for Laboratory Clinic X based on its competitiveness.	Condition Factor (C_1)	Availability of infrastructure (SC_1)	
		Availability of Public transportation (SC_2)	
		Closeness with hospital (SC_3)	
		Congestion level (SC_4)	
		Soil physical conditions (SC_5)	**Wonokromo District (Ae_1)**
		Free of Floods (SC_6)	
		Free of polution (SC_7)	
		Proximity to police stations and fire extinguisher (SC_8)	
		Availability of sewerage drainage (SC_9)	
		Permit ease (SC_{10})	
	Demand Condition (C_2)	Existance medical school (SC_{11})	**Semampir District (Ae_2)**
		Population characteristics (SC_{12})	
		Community acceptance (SC_{13})	
		Marketing Scope (SC_{14})	**Sawahan District (Ae_3)**
		Economics Factor (SC_{15})	
	Company's strategy structure and competitiveness (C_3)	The absence of clinical laboratory (SC_{16})	
		Existance of CSR (SC_{17})	
		Local Appropriation for laboratory (SC_{18})	
	Supporting and related industries (C_4)	The existence of health services, such as hospitals, health centers, and physicians (SC_{19})	
		Proximity to suppliers of the clinical laboratory (SC_{20})	
		Proximity to a pharmacy and related industries (SC_{21})	
	Government (C_5)	Legal restrictions (SC_{22})	**Simokerto District (Ae_4)**
		Government policy (SC23)	
		Political environment (SC24)	
	Opportunity/ Change (C6)	Level of community acceptance (SC25)	
		production costs (SC26)	**Tambaksari District (Ae_5)**
		Crime rate (SC27)	
		Changes in market demand (SC28)	

From twenty-eight identified sub-criteria, there are two sub-criteria which are not valid, which are:

1. Soil physical conditions (SC5)

   This sub criterion is considered not significant in the selection of the Laboratory Clinic X's new branch location. So, sub-criteria SC_5 is removed and not included in the next process.

2. Significant changes in production costs due to events such as fuel, steel, and iron prices rising, and the energy crisis (SC_{26})

   This sub-criterion is invalid because the sub-criterion is considered not giving different assessments in each alternative district.

Economy factor is one of the sub criteria in Porter's Diamond Model. So, the economy factor is calculated by calculating Net Present Value (NPV), Internal Rate of Return (IRR) and payback period. The NPV calculation for Wonokromo District is shown by Table 8.

TABLE 7.
WONOKROMO DISTRICT'S NET CASH FLOW

Year	ARUS KAS			NET CASH FLOW
	OPERATION ACTIVITY	INVESTMENT ACTIVITY	FUNDING ACTIVITY	
0	-	-17906422635		-17906422635
1	878989984.4	705741339.8	-1074385358	510345966.1
2	1320823374	2026564714	-1074385358	2273002730
3	1818752037	2482447349	-1074385358	3226814028
4	2338767082	3031202717	-1074385358	4295584440
5	2904147827	3564897256	-1074385358	5394659725
6	3526321045	4155892723	-1074385358	6607828410
7	4197228417	4845850210	-1074385358	7968693268
8	4929336601	5612892436	-1074385358	9467843679
9	5729054053	6374095107	-1074385358	11028763802
10	6603452862	7287008697	-1074385358	12816076201
11	7560815540	8122504099	0	15683319639
12	8508556548	9191474483	0	17700031031
13	9556896444	10192999421	0	19749895865
14	10716319386	11399237320	0	22115556706
15	11998392795	12629697239	0	24628090034
16	13415878826	14010874731	0	27426753557
17	14982857278	15608871339	0	30591728617

ISBN : 978-602-97809-0-1

18	16714861128	17397779063	0	34112640191
19	18629025985	19249207400	0	37878233385
20	20744254884	21427172819	0	42171427703

IRR	0.289983335
NPV	60.445.764.441
Payback Period	5 years and 4 months

Based on the calculation, the Wonokromo District's NPV is Rp.60.445.764.441,00, its IRR is 28.9%, and its payback period is in five years and four months. Furthermore, the same calculation is done, in order to feasibility of investment for the other alternatives as follows:

TABLE 8.
FEASIBILITY OF INVESTMENT OF EACH DISTRICT

Feasibility of Investment	Semampir District	Sawahan District	Simokerto District	Tambaksari District
NPV (Rp)	20.347.080.593	11.043.224.549	10.695.000.476	14.158.684.019
IRR	18%	7%	15%	6%
Payback Period	9 years	14 years11 months	10 years 6 months	15 years10 months
Decision	Feasible	Not Feasible	Feasible	Not Feasible

Based on the calculation of NPV, IRR, and payback period above, it is known that the districts which are not feasible in terms of investment are Sawahan District and Tambaksari District. This result will be used as one of the sub-criteria assessment in ANP questionnaire with the following assessment:
<0: Very not good
1-29: Not good
30-59: Good
60-79: Very good
80-100: Absolutely good

TABLE 9
ASSESSMENT CATEGORIES IN FEASIBILITY OF INVESTMENT

District	NPV	Rating	Assessment Category
Wonokromo	60.646.579.867	91.2	Absolutely good
Semampir	20.347.080.593	30.6	Good
Sawahan	-11.043.224.549	-16.6	Very not good
Simokerto	10.695.000.476	16.1	Not good
Tambaksari	-14.158.684.019	-21.3	Very not good
Total	66,486,752,368		

Assessment categories obtained from the feasibility of investment calculation will be used to assess the sub-criteria in economic factors as one of the attributes in the ANP.

Valid sub criteria are used as questionnaire inputs in the model and in the weight priority determination using Analytical Network Process (ANP) method. ANP method is used to determine the weight of each alternative to select a location with best competitiveness and potential. Before the weighting determination of criteria, sub-criteria, and alternatives are done, the relationship among the criteria, among sub-criteria, and between the sub-criteria and alternatives are identified. After identified, validation is done by conducting brainstorming with some experts in order to get valid relationships. An ANP model using the Super Decision software is shown below. In this model, interdependencies among the criteria in the 'criteria cluster', the relationship among sub-criteria in the 'sub-criteria cluster', and the relationships between each node in the sub-criteria cluster with each node in the alternative cluster are determined. The relationship among criteria will show the importance of a criteria compared with the other criteria, similarly with the relationship among sub-criteria. A sub-criteria node connected with nodes of other sub-criteria node based on its the basis of their relationship with a sub-criteria node.

Questionnaire based on expert judgment compares the location selection criteria, sub-criteria, and between the sub-criteria and alternative locations. Experts needed in this assessment of optimal location is Surabaya city planning expert and experts working in the health services field, especially laboratory clinic. Experts who have the expertise in Surabaya city planning are consists of the Surabaya city planning consultant and Surabaya city planning experts from the academic field. Meanwhile, experts from the laboratory clinic health services field is the branch manager and marketing team of Laboratory Clinic X.

Here are the results of sub-criteria priority weights using ANP method

TABLE 10
SUB CRITERIA PRIORITY WEIGHTS

No	Sub criteria	Weight	Limiting
1.	Infrastructure	0.154	0.0769
2.	Public Transportation	0.089	0.0446
3.	Closeness to Hospital	0.031	0.015
4.	Traffic Density	0.029	0.014
5.	Flood Free	0.0004	0.00018
6.	Pollution	0.023	0.0012
7.	Closeness to police & fireman	0.001	0.00049
8.	Waste Drainage	0.018	0.0091
9.	Existing Land	0.148	0.0738
10.	Related Institution	0.024	0.117
11.	Accordance to Public's Character	0.031	0.0156
12.	Public Acceptance	0.022	0.011
13.	Marketing Scope	0.084	0.042
14.	Feasibility of Investment	0.274	0.137
15	Unavailability of Other Laboratories	0.025	0.0127
16.	Social Responsibility	0.01	0.0051
17.	Policy Maker Preference	0.009	0.0043
18.	Helath Services	0.007	0.0036
19.	Closenees with supplier	0.017	0.0087
20	Closeness with pharmacy	0.0138	0.0069
21.	Legal restriction	0.0001	0.00005

22.	Government Policy	0.0016	0.0008
23.	Political Environment	0.0008	0.0004
24.	Public's social condition	0.0048	0.0024
25.	Crime Level	0.0018	0.0009
26.	Market Demand Changes	0.0021	0.001

TABLE 11
PRIORITY WEIGHTS' ALTERNATIVES

Alternative	Normalized by Cluster	Limiting
Wonokromo District	0.40841	0.203813
Semampir District	0.14558	0.072649
Sawahan District	0.10066	0.050231
Simokerto District	0.15668	0.078192
Tambaksari District	0.18867	0.094155

IV. CONCLUSION

Based on calculations using the ANP method, among the six criteria in Porter's Diamond Model, which are consists of the condition factor, demand factor, competitive strategies, support and related institutions, government, and changes, the criterion that has the most impact in the selection of the laboratory clinic is the demand criterion, with a priority weight of 0.202.

Competitiveness sub criterion, which is considered in the selection of the Laboratory Clinic X's new branches location, is consists of twenty-six sub-criteria, where the five most influential sub-criteria based on the weighting using ANP method are the feasibility of investment (NPV, IRR, and payback period) with a weight of 0.14, availability of network infrastructure with a weight of 0.077, existing land use with a weight of 0.074, public transportation with a weight of 0.045, and scope with a weight of 0.042.

Calculation of weighted values based on the market target, the priority weights, which are calculated by pairwise comparison, and rating values result five alternative districts, which are Wonokromo, Semampir, Sawahan, Simokerto, and Tambaksari District.

Optimal sub districts for each district based on P-Median method, are Wonokromo Sub District in Wonokromo District, Wonokusumo Sub District in Semampir District, Kupang Krajan Sub District in Sawahan District, Simokerto Sub District in Simokerto District, and Ploso Sub District in Tambaksari District.

The selected location based on priority weights obtained using ANP method is Wonokromo District with a weight of 0.204, then Semampir District with a weight of 0.073, next Sawahan District with a weight of 0.051, Simokerto District with a weight of 0.0782, and Tambaksari District with a weight of 0.094.

Wonokromo District as the selected location (with highest priority weight) also has the highest feasibility of investment value with Net Present Value (NPV) of Rp. 60,646,579,867.00, IRR of 29%, and payback period of five years four months. Based on the sensitivity analysis, a 51% decline in the demand of Laboratory Clinic X in Wonokromo District is the maximum reduction that can be accepted without changing the feasible decision.

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ISBN : 978-602-97809-0-1

Introducing Inverse Layer Manufacturing Method for Geometric Reconstruction

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Abstract - **This paper deal with development of new method for complex geometric reconstruction by using the inversion of layer manufacturing concept.**
Reverse engineering is developed to reduce research and development cost by improving existing object. In this method, reconstructing object into 3D model is very important step, especially for complex object. There are tools in duplicating object into 3D model, such as CMM, vivid camera, 3D scanner, CT scan, etc. Those mentioned tools have their specific benefit, but they have similar characteristics, high cost investment. Compared to others, CT scan has its advantage in recognizing inner or hidden shape of a 3D object in one process, where other tools should scan twice or more. Meanwhile, in the design process, rapid prototyping is developed to rapidly realize product into real shape to make a product become easier to be analysed before it is confirmed. One of rapid prototyping method is layer manufacturing, by which an object is constructed layer by layer. Concerning to the CT-scan and layer manufacturing method, research about geometric reconstruction using 'inverse layer manufacturing' method is introduced. Aims of the research are develop quick, simple and low cost method to perform geometric reconstruction in CAD model without leaving accuracy. The goal is to provide cheap, quick and automatic method to reconstruct 3D complex object into CAD model by using commercial digital camera as sensor.

Keywords - **reverse engineering, complex shape, inverse layer manufacturing, digital image processing, CAD, 3D scanning**

I. INTRODUCTION

High speed creativity, high quality, and tight competition with low price product is recently become tremendous. A new product can emerge in every month or even week. It can be achieved by implementation of reverse engineering which reduce design processes.

Development of reverse engineering has been done with various methods like CMM, vivid camera, 3D scanner, CT scan, etc. Reverse engineering must be able to be applied at products, especially for product with complex shape.

In this paper, a new method is introduced. Reverse engineering is developed by inversing layer manufacturing method. A viable approach to develop 3D digital model using simple method has been done and reasonable achievement with low price is introduced.

A 3D object is sunk in a material such as gypsum. A principle like those which is implemented in CT-scan is used. Sunk-object is sliced in certain layers and each layer is then captured by using digital camera. Edge of each image is then recognized by a process using Mathlab software and output in the form of wireframe.

Using this method, a cheap, simple, and useful method to reconstruct a complex geometrical model is introduced.

II. THEORY

A. *Reverse engineering*

Reverse engineering is the general process of analysing an object in order to determine how it was designed or how it operates. Reverse engineering is not confined to any particular purpose, but is often used as a part of a company's research and development. The process of taking something apart and revealing the way in which it works is often an effective way to learn how to build a new product or make improvements to an existing product [1].

B. *3D scanning*

A 3D scanner is a device that analyzes an object or environment by collecting data on objects shape and possibly its appearance (i.e. color). The collected data can then be used to construct digital, three dimensional models that may useful for a wide variety of applications. These devices are used extensively by the entertainment industry for the production of movies and video games. Other common applications of this technology are industrial design, orthotics and prosthetics, reverse engineering and prototyping, quality control/inspection and documentation of cultural artifacts [2].

C. *CT scan*

CT scan, also called CT or computerized tomography is an X-ray technique that produces images. This device is widely used in medical application to capture image of the human body. The 3D image resulted from this device makes visualization of all part of human anatomy is better than those in conventional X-ray. Internal structures can be visualize in cross section rather than the overlapping projected images typically produced by conventional X-ray[3]. An illustration of CT scan process is shown in figure 1.

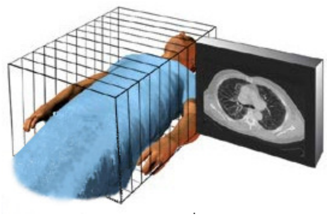

Fig. 1 CT scan slices [3].

D. Layer Manufacturing

Layer Manufacturing is a process where a solid object is constructed by progressively building up wafer-thin horizontal cross-sections, one on top of another [4]. An illustration of layer manufacture process is shown in figure 2.

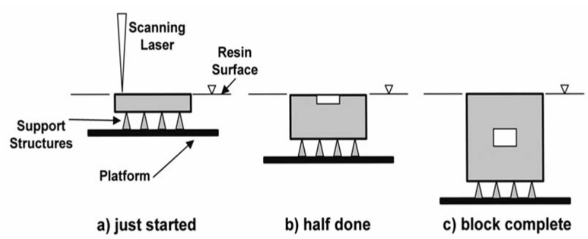

Fig. 2. Layer manufacturing process [5].

E. Digital Image Processing

Generally, there are steps of digital image processing [7] :

- Image Acquisition. In this step, required image or proper data is selected.
- Image Preprocessing. An image may be distorted, unclear, or have bad contrast, etc. Image conditioning is required to eliminate noises of an image.
- Image Segmentation and Edge Detection.
- Feature Extraction and Selection

The explanation of digital image process can be illustrated in figure 3.

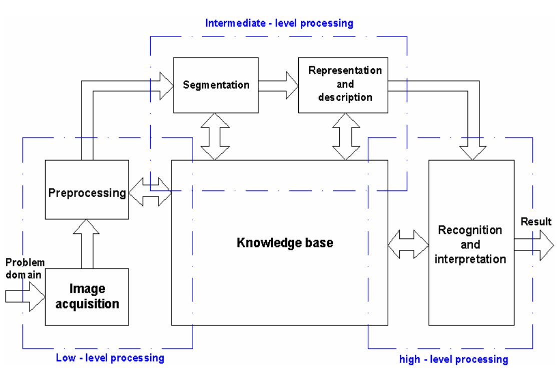

Fig. 3 Digital image processing [7].

F. AutoCAD Script

Script file is an ASCII text file that contains a series of AutoCAD commands and can be created in any basic text or ASCII editor. The files must be saved and created with *.scr as file extension [6].

III. Experiment

In this work, the experiments were divided into following steps:

- Selecting engineering complex shape product. In this step, mouse body cover is selected for its complex surface and its dual side, the outer and inner surface.

Fig. 4. Mouse body cover as measured object

- Camera calibration.
- Implantation mouse body into resin to be sliced.
- Images capturing.
- Image processing to produce vector.
- Running the script in AutoCAD software to reconstruct the mouse body cover.

A. Camera Calibration

Calibration is necessary to ensure that image quality is good enough or reasonable to reconstruct an object.

Calibration is done by capturing images of circles, with exact dimension using the digital camera. This process is used to examine the consistency of digital camera in capturing image.

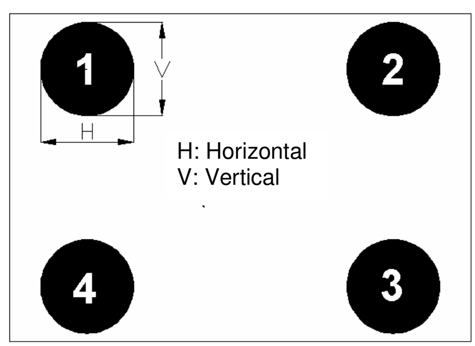

Fig. 5. Circle geometry portrait object scheme

The object is arranged in four corners of the captured area of the camera as it is shown in figure 5.

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Information about the camera consistency was obtained in table 1 and table 2. Result shows that position of an object will not affect geometric shape and dimension significantly.

It should be note that in this case, camera is not used as measurement device, but it is used to recognize a shape.

TABLE I
HORIZONTAL ACCURACY ASSESSMENT (60 MM DIA)

Horizontal	Position			
	1	2	3	4
Circle 1	60.0	60.0	60.3	60.0
Circle 2	60.8	60.8	60.8	60.8
Circle 3	60.5	60.5	60.3	60.3
Circle 4	58.0	58.0	58.0	58.0
Circle 5	58.7	58.7	58.7	58.7

TABLE II
VERTICAL ACCURACY ASSESSMENT (60 MM DIA)

Vertical	Position			
	1	2	3	4
Circle 1	58.7	58.5	58.7	58.7
Circle 2	60.0	59.7	60.0	59.7
Circle 3	60.0	60.0	60.0	60.0
Circle 4	57.5	57.5	57.5	57.5
Circle 5	59.0	59.0	59.0	59.0

B. Implantation Object into Resin

Implantation is done to produce solid block in dimension 80 x 80 x 25 with object sunk in it. This block is then sliced by using CNC machine to perform slicing with constant thickness precisely. The thinner the more precise 3D model could achieve. Care should be taken to make good contrast between object and resin colour.

Fig. 6. Sliced solid block. Resin with object inside.

C. Images Retrieval

Image of the slicing result is captured by digital camera right after it is sliced. It is done by mounting a digital camera at a certain position with constant X-Y position. Moreover, Z distant is also kept at the specific distance from the upper surface of the block. Schematic diagram of the image pick-up process is shown in figure 7.

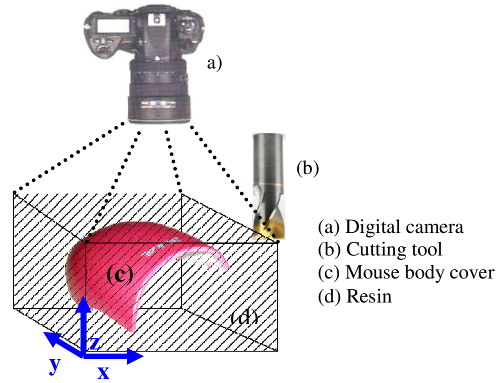

Fig. 7. Image capture of mouse body.

D. Images Processing to Produce Wireframe

Image processing used to detect the edge of each image that is captured from each sliced surface of the object. This process needs good contrast, and low noise of the image to make edge recognition process easier.

Edge recognition is performed by using Mathlab application function. Points that are recognized as edges of the image are then registered to be vector by using one of AutoCAD function, SCRIPT.

Using the AutoCAD script, edges are then turned from a collection of points into a wireframe. In the further process, wireframe is then saved in IGES format in order to make it easier to be processed in other CAD software. The schematic of image processing to produce wireframe could be illustrated in figure 8.

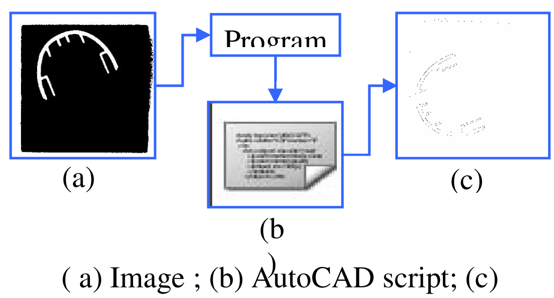

Fig. 8. Schematic process to built wireframe from captured image.

E. 3D Reconstruction

Wireframes which is generated in previous process is then placed layer by layer as they are sliced. All wireframe are constructed by inverse layer manufacturing method. Mouse body wireframe which has been reconstructed is shown in figure 9.

To construct wireframes into a surface, a CAD (Delcam's Power Shape) software is used. Surface can be developed

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from these wireframe, but it is still not easy to get high quality smooth surface. Care must be taken to build required shape.

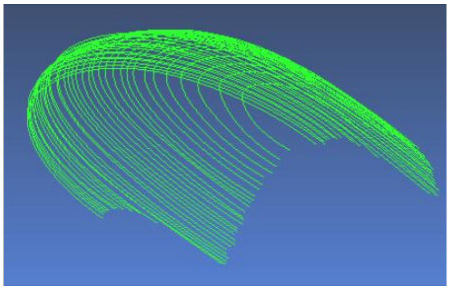


Fig. 9. Mouse body reconstructed wireframe

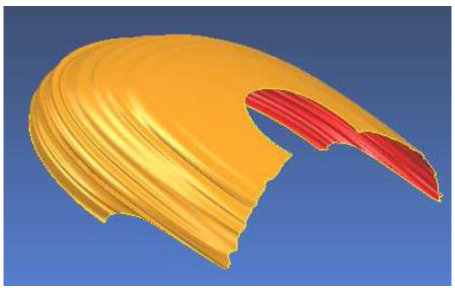


Fig. 10. Mouse body surface constructed directly from wireframe

The unsmooth surface which resulted from collection of wireframe can be understood since wireframe do not have information about normal vector. When surface is created, the software assuming that normal vector of wireframe is parallel to wireframe's plane. Figure 10 shows the reason why unsmooth surface is produced from wireframes.

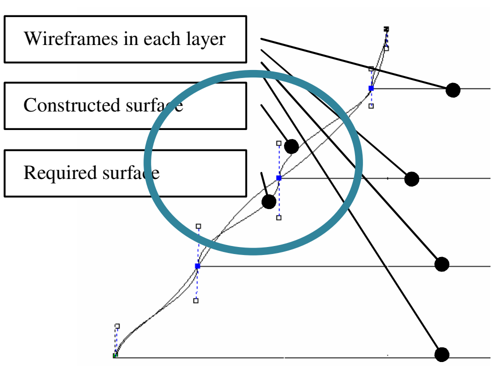
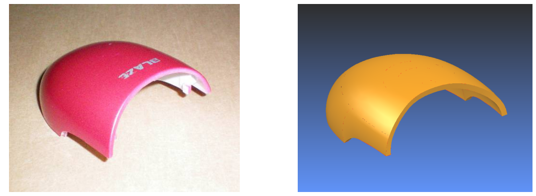


Fig. 11. Cross section of surface construction

This problem can be overcome by creating a driving curve. That is a curve which will drive surface to follow its shape to meet the required cross section.

In this stage of research, driving curve is created manually, and the result can be shown as follow:



(a) (b)

Fig. 11. Comparison of ; (a) 3D real object, (b) 3D CAD model;

IV. CONCLUSION

Inverse layer manufacturing method with commercial digital camera can be used for 3D complex shape reconstruction and it is worked very well. This method is introduce alternative solution for low-cost, simple, and rapid modelling that is very important in reverse engineering.

V. FUTURE WORK

In order to increase data processing speed and shape accuracy, an artificial intelligent should be implemented in this project. Surface accuracy using automatic surface generation is necessary to perform high speed digital 3D model reconstruction.

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ISBN : 978-602-97809-0-1

In-process Correction Systems in a Small Repetitive Manufacturing Enterprise

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Abstract - **Parts suppliers always expect high quality parts in order to give best value for customer. However, in many cases, these suppliers are often faced by higher manufacturing cost. Specifically, due to lack of precision equipment, part suppliers should increase their production capacity in order to replace product failure. In this case, effort to trade-off between increasing manufacturing cost and satisfying customer leads to a model for estimating the best product tolerance. This raise question on how much increase in unit cost is comparable than reduction of cost of product failure? To deal with the above question, part suppliers can have in-process correction strategy that can reduce the number of product failure before final inspection. In this paper, a model for comparing manufacturing unit cost and cost of product failure is developed. In estimating quality failure loss, we consider a quadratic loss function. Optimizing the expected quality loss function will result in an optimum quality characteristic value. The optimization is expected to result in reduction of product failure.**

Keywords - **manufacturing cost, in-process correction, tolerance design**

I. Introduction

A manufacturing process produces varying output caused by inevitable random variations or biases, which in many cases they may come from material, operator, method or process. The occurrence of variance in production system, which is invariably complicated and too expensive to get rid of, contributes to the tolerance to product planning and process planning stage to product quality characteristics, which are a functional requirement for customers. From the point of view of product designer, design tolerance constitutes a variable which is related to functionality of product. Meanwhile, according to process planner, design tolerance constitutes information that lays the foundation for machining process selection (along with machining parameter) which is directly related to manufacturing costs.

It will be interesting to undertake a careful evaluation or further to conclude the effect of such variations to the efficiency of manufacturing systems. Due to product's variation, inspection of finished product is coming into consideration in order to meet or satisfy customer requirements or specifications. Since manufacturing automation has been growing popular and the production lot size becomes smaller, many producers turn to inspect all outputs known as a complete inspection plan [1]. Further, modern manufacturing automation enlarges the role of automated inspection or testing as one important basic function. However, modern inspection automation is expensive, especially for small manufacturing enterprises (SME) in many developing countries [2].

In SME, manual inspection, which is accomplished using manual tools or method, has intensively employed as a simple but effective sensor technology. This simple technology makes in or between process inspections available for SME [2,3]. By this way, the deviate parts or components from a manufacturing process can be detected earlier so that can afterward avoid at the subsequence processes. Output of each process can be carefully inspected and a correction activity is often necessary before it is succeeded to the subsequent process.

In this paper, the designs of in or between processes inspection and correction systems are considered. Our concern is only with the quality improvement of output and the cost related to this effort. The loss as the hidden quality cost, together with the cost of inspection and correction as the measurable costs are evaluated to obtain the optimal tolerance for each systems based on their economic performance. An optimization procedure not only leads us to set the most economic tolerance, but also simultaneously supports the management in selecting or evaluating the policies concerning inspection and correction in order to improve the quality of product.

After this introduction chapter, the discussion on inspection and correction systems will follow. A model to optimize the cost will be formulated; it is followed by a numerical example, and finally the conclusion of this paper.

II. INSPECTION AND CORRECTION

Two inspection and correction systems are considered, i.e., without and with additional correction facility (see Fig.1). The first system is chosen due to its simplicity, e.g., correcting the non-conforming output using the same existing facility. The second system uses additional facility for correction. Compare to the first system, the second has two advantages, i.e., (i) it may have higher capacity (more output, but it is not the main objective) and (ii) the most important is that the correction can

ISBN : 978-602-97809-0-1

be done better than the process (improvement for better quality of output). However, the second system needs additional facility or equipment, so that requires additional investment for correction (higher cost). Trade off between two conflicting factors, i.e., cost and quality, is unavoidable.

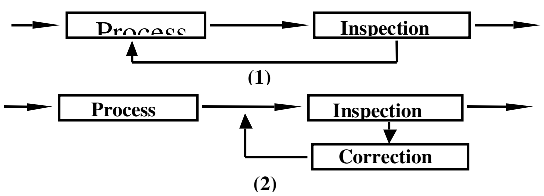

Fig. 1 Two inspection and correction systems.

Another important matter in product or process design is setting a proper tolerance of product or its components. Traditionally, tolerance is considered as a given parameter known as the specification limit. Ideally, the product characteristic should be produced perfectly at the required target value. This requirement pushes producers to provide a tighter tolerance to keep or to improve their market share. Accordingly, it is important to assure that product characteristics are unbiased and have high precision or minimum variance [4]. Then it is necessary to search the optimal economic condition of this "variability of cost" in accordance with the set tolerance.

In tolerance setting, Taguchi [5] introduced a quadratic loss function. This loss function approximately reflects the balance between costumer's loss due to variation of performances and producer's effort for improving the performance itself [6]. In the Taguchi's approach, the tolerance is set on the basis of the cost of making one unit of product. Due to inspection and correction, the tolerance itself influences the cost. Therefore, the tolerance can be determined through an iterative approximation or tabulated values [7].

III. MODEL FORMULATION

Taguchi (1988) introduced quadratic loss function of output from a process as $L(\Delta) = k\Delta^2$, where k is a constant and Δ is a deviation from the target value. Consider that the process output is a random variable y_j, where j=1 for the first system, and j=2 for the second system, follows a distribution function $f(\mu_j, \sigma_j)$, where μ is the mean value and σ is standard deviation. Assume that $f(\mu_j, \sigma_j)$, is a normal probability function, the expected loss function is

$$E\left[L(y_j)\right] = k\sigma_j^2\left(2\Phi(t) - 1 - 2t\phi(t)\right), \quad (1)$$

where Φ(.) and φ(.) are the cumulative and density normal probability functions respectively, and t is the designed tolerance level [6].

For the first system, the correction is done using the same facility, and thus both processes have the same result $(\sigma_{corr} = \sigma_j)$. With the second system, a correction should give better result than the process, and thus it can be assumed that correction can have smaller standard deviation $(\sigma_{corr} < \sigma_j)$.

Note that the main process, inspection and correction are performed in certain operation times, namely t_{Pj}, t_{Ij} and t_{Cj} respectively,. Assume that there is total time limitation for production *T*, than there are also limitations of number of process, inspection and correction (namely n_{Pj}, n_{Ij} and n_{Cj} respectively). For the first system, all result of process and correction must be inspected, so that it is clear that $n_{I1} = n_{P1} + n_{C1}$. Accordingly, the maximum capacity is determined by $n_{I1}.t_{I1} \le T$ or by $n_{P1}.t_{P1} + n_{C1}.t_{C1} \le T$, depending on which has longer time, for inspection or for process and correction. In many cases at SME, in one hand, simple product usually employs simple inspection, which often has much smaller operation time than time for process or correction. On the other hand, complicated product is processed using sophisticated equipment shortly, but may require longer time for inspection.

Using a designed tolerance *t*, there is a proportion of acceptable and unacceptable products, denoted by P_j and $\bar{P}_j = 1 - P_j$ respectively. With this proportion, for the first system we can define the expected number of correction as $n_{C1} = n_{P1}.\bar{P}_1$. Since corrected product can be out-of-tolerance again, then the expected number of correction is $n_{C1} = n_{P1}.\bar{P}_1/(1 - \bar{P}_1)$. With a limited total time for production *T*, we can formulate the limit of number of process for the first system as

$$n_{P1} \le \frac{T}{t_{I1}(1 + \bar{P}_1/(1 - \bar{P}_1))}, \quad (2)$$

or

$$n_{P1} \le \frac{T}{t_{P1} + t_{C1}.\bar{P}_1/(1 - \bar{P}_1)}. \quad (3)$$

These limits clearly affect the number of output or the production capacity of the system. If both times for process and correction are assumed equal, because they share the same facility or equipment, then Eq.(3) can be simplified into

$$n_{P1} \le \frac{T}{t_{P1}(1 + \bar{P}_1/(1 - \bar{P}_1))}. \quad (4)$$

For the second system, as in the first system, all result of process and correction must be inspected, so that it is clear that $n_{I2} = n_{P2} + n_{C2}$. Since process and correction use different facility or equipment, their capacities are independent. Accordingly, the maximum capacity is determined by $n_{I2}.t_{I2} \le T$, by $n_{P2}.t_{P2} \le T$, or by $n_{C2}.t_{C2} \le T$, depending on the longest time for inspection, for process or for correction.

Note that, the expected number of the first correction is $n_{C2\,(I)} = n_{P2}.\bar{P}_1$, and the expected number of second or more correction is $n_{C2\,(II)} = n_{C2\,(I)}.\bar{P}_2/(1 - \bar{P}_2)$, where $\bar{P}_2$ is proportion of unacceptable product using different correction facility. Using the same designed tolerance t, the proportion $\bar{P}_2$ can be different with $\bar{P}_1$ because they have different standard deviation. With a limited total time for production *T*, we can formulate the limit of number of process (or production) for the second system as

$$n_{P2} \le T/t_{P2}, \quad (5)$$

$$n_{p2} \le \frac{T}{t_{C2}\left(\bar{F}_1 + \frac{\bar{F}_1 \bar{F}_2}{1-\bar{F}_2}\right)}, \tag{6}$$

or

$$n_{p2} \le \frac{T}{t_{I2}\left(1+\bar{F}_1 + \frac{\bar{F}_1 \bar{F}_2}{1-\bar{F}_2}\right)}. \tag{7}$$

In both systems, (except for Eq.(5)), the limit of number of process is a function of $\bar{F}_1$ and/or $\bar{F}_2$, which thus it depends on the level of precision of process and correction facilities, and their designed tolerance *t*. Higher process and correction precision, and tighter tolerance will result in lower number of production. However, on the other hand, higher precision and tighter tolerance will result in better output product quality, i.e. smaller expected loss to the customer as in Eq.(1).

For the first system, all output will not exceed the designed tolerance. In this case, the characteristic of output product follows a truncated distribution as follows

$$f(y_1)_{output} = \frac{1}{1-\bar{F}_1} \cdot f(y_1), \tag{7}$$

For the second system, there are two types of characteristic of output product, i.e. (i) output from process that meets designed tolerance, and (ii) output that does not meet designed tolerance and thus needs correction. In this case, we can have two conditional probability, i.e. $q = \Pr\,[Process\,|Inspected]$ and $1-q = \Pr\,[Corrected\,|Inspected]$. These probabilities can be determined using the number of process n_{p2}, inspected n_{I2}, and corrected n_{C2} (as defined before), and thus we have

$$q = \frac{(1-\bar{F}_1)}{(1+\bar{F}_1.\bar{F}_2/(1-\bar{F}_2))}. \tag{8}$$

Using this probability, the characteristic of output product follows a truncated distribution as follows

$$f(y_2)_{output} = \frac{q}{1-\bar{F}_1} \cdot f(y_2) + \frac{1-q}{1-\bar{F}_2} \cdot g(y_2), \tag{9}$$

where $g(y_2)$ is the probability density function of correction.

IV. NUMERICAL EXAMPLE

A small manufacturing enterprise produces a metal part for school laboratory equipment in a mass order. Since this metal part will be used for laboratory experiment, it requires a certain level of precision. The daily production capacity is 1000 time units. For the first system, the time for process $t_{Pj} = 10$, for inspection $t_{Ij} = 5$, and for correction $t_{Cj} = 8$.

Using these time parameters, we can calculate the limited number of process by varying the designed tolerance *t* from $0.5\sigma_1$ to $3.0\sigma_1$, as shown in Fig.2. We found that the maximum capacity of production (lowest number of process that can be performed) is determined by Eq.(3), which is determined by process and correction. As the tolerance is tighter, the number of correction becomes smaller. Using this maximum capacity of process, we can calculate the total number of process, correction and inspection as shown in Fig.3.

Similarly, for the second system (using better correction with $\sigma_{corr} = 0.8\sigma_1$) the maximum capacity of process is shown as in Fig.4, and we found that the maximum capacity of process (lowest number of process that can be performed) is determined by Eq.(5), which is determined by process. Using this maximum capacity, we can calculate the total number of correction and inspection as shown in Fig.5.

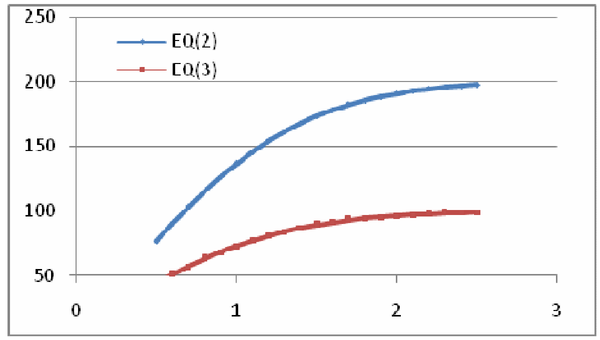

Fig. 2 Maximum capacity of first system.

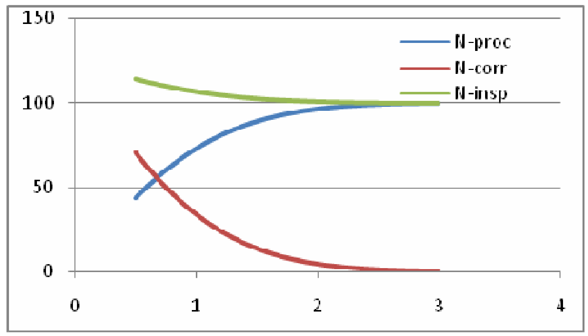

Fig. 3 Number of process, correction and inspection for the first system.

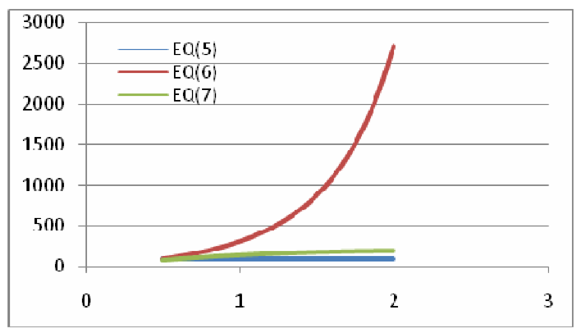

Fig. 4 Maximum capacity of second system

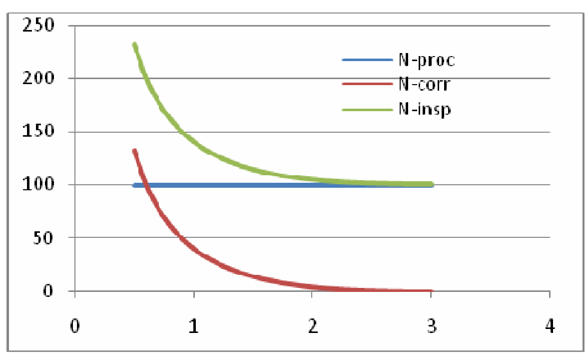

Fig. 5 Number of process, correction and inspection for the second system.

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The cost for process, correction and inspection are 2 unit cost, 1.8 unit cost, and 0.5 unit cost respectively. From customer survey, the company found that the parameter for loss function is 60 unit cost. The total cost of process, inspection and correction, and the expected loss to customer for the first system is given in Fig. 6, and for the second system is given in Fig.7. Comparing the sum of total cost and loss of both systems, we can determine the optimum tolerance as shown in Fig.8.

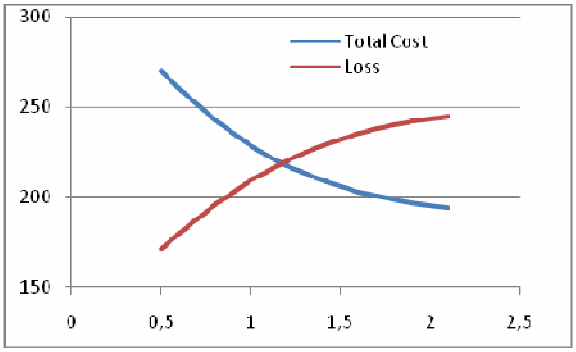

Fig. 6 Total cost and expected loss of first system.

Fig. 7 Total cost and expected loss of second system.

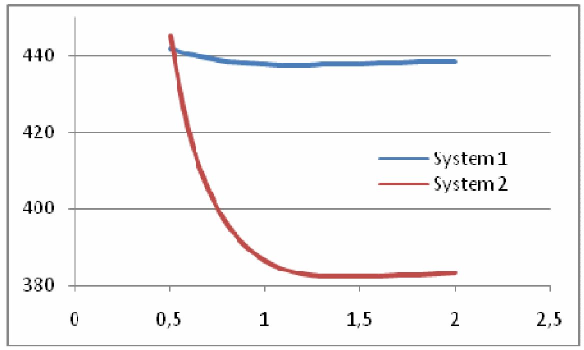

Fig. 8 Minimizing cost and loss for both systems.

From Fig. 8, we can find the optimum tolerance limits of both systems that minimize the sum of total cost and the expected loss to customer, i.e. 1.2 σ_1 and 1.4 σ_1 respectively.

V. CONCLUSION

Two systems in-process or between-process inspection and correction are considered. Correction of the first system is constructed using the same process, while the second system uses additional facility or equipment. By minimizing the sum of total costs of process, inspection and correction, and the expected loss for the customer, the optimal tolerances can be obtained. However, the decision to choose the best system should be made after considering the cost for investing additional correction facility, and the opportunity cost of producing more output.

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ISBN : 978-602-97809-0-1

Generating an Efficient Schedule in a No-Wait Two Stage Flexible Flow shops with maximizing Utilization

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Abstract - **In this paper the problem of maximizing the utilization in a no-wait two stage flexible flow shop is studied. Also A new heuristic algorithm is developed to solve the problems. For evaluating the performance of the algorithms, numerical experiment is designed to compare the effectiveness of the algorithm with MDA, LPT, SPT and Johnson. For appraisal between algorithms we performed simulation and results show that our proposed algorithm performs well in most of situations.**

Keywords - **scheduling, no wait, two stage, flexible flow shop, utilization**

I. INTRODUCTION

Machine scheduling problems can be found in many domains. It originated in manufacturing; Scheduling plays a crucial role in manufacturing systems and in the service industry. So it is very important to develop effective and efficient advanced manufacturing and scheduling technologies and approaches [1, 2]. In practice an efficient schedule can enhance utilization and satisfy customer needs. One of the most applicable flow shop problem in practice is a flexible flow shop, also known as a hybrid flow shop or flow shop scheduling problem with parallel machines or flexible flow line which has been studied by many researchers among them includes those investigated by S. Li. [3] and M.Zandie et al [4]. For a literature review in this area the readers are referred to that of L.Richard and W. Zhang [5]. In flexible flow shop scheduling problems, we have a set of n jobs j = {1, 2 . . . n} that need to be processed at m working stages i = {1, 2 . . . m}. Each stage might have several identical machines in parallel (mi). When there are more than one parallel machine at each stage, two major decisions need to be made (1) allocation of the machines to the jobs at each stage and (2) jobs sequencing on each machine. In a flow shop, the scheduling problem can also be considered in two scenarios namely with and without waiting time in operations intervals. In a flow shop with waiting time, the jobs are processed from one machine to the next machine allowing waiting time in between, whereas, in a no-wait flow shop system, the jobs are processed from one machine to the next one without waiting time.

Among all types of scheduling problems, no-wait flow shop has important applications in different Industries including chemical processing by Rajendran [6], food processing by Hall & Sriskandarayah [7], concrete ware production by Grabowski & Pempera [8], and pharmaceutical processing by Raaymakers & Hoogeveen [9]. As an example in a chemical industry, if the waiting time is allowed between each subsequent stage, it may lead to the change in the material property (e.g. degrading the polymer).

For the no-wait flow shop scheduling problems with single objective, it is strongly NP-hard when the number of machines is more than two [10]. Reddi and Ramamurty[11] And Wismer [12] have formulated the no wait flow shop scheduling problem as an asymmetric travel salesman problem. With respect to the performance measure, the review of the literatures reveals that most of the researchers investigated the flexible flow shop scheduling in terms of makespan performance measure. For further review of the research on no wait flexible flow shop scheduling problem, the readers are referred to the paper published by Wang Z et al [13] and Hall NG, Sriskandarayah [7]

Our work is motivated from the research carried out by Jinxing Xie et all [14]. They proposed a new heuristic algorithm to minimize makespan in a flexible flow shop with no waiting time. In their algorithm, at first they select machines after that jobs select for scheduling. Each job that closet to $|P_{1J} - T|$ is selected.

$(T = T_2 - T_1 \ , \ T_2 = \min(t_{2l}) \ \& \ T_1 = \min(t_{1i}))$ Then that job scheduled as soon as possible on available machine in both stage. Each job for scheduling compare to T and each job is closer to T is selected. But in our algorithm each job compare to $W_{i,l}$ that in these there are $m_1 \times m_2$ numbers for comparison that T is one of them. In this paper we investigate the no wait two stage flexible flow shop scheduling problems with maximizing the utilization. The aim of this paper is to investigate the performance of the proposed heuristic approach to solve a no wait two stage flexible flow shop scheduling problem with maximizing utilization. The remainder of this paper is organized as follows. In Section 2, the problem studied in this research is described in details. In Section 3, the framework of the proposed algorithm is explained followed by further description using an illustrative example and the details of the two stage flexible flow shop scheduling problem to be solved are described. Numerical experiments developed to solve the problems are explained in section 4. This is followed by presenting the simulation results. Finally Section 5 presents the summary of the research with the concluding remarks and recommendation for further researches.

II. PROBLEM DESCRIPTION

The structure of the problems studied is as follows. A set of n jobs $J=\{j_1, j_2, ..., j_n\}$ are to be processed in a flexible shop. Each job consists of two operations to be processed in a two subsequent stages namely S_1 and S_2. No waiting time is allowed between the two subsequent operations. Stage S_1 and S_2 have m_1 and m_2 identical machines respectively. The processing times of job j are p_{1j} and p_{2j} respectively. As illustrated above, each job has $m_1 \times m_2$ possible schedules and hence n jobs have $n!$ possible schedules. Therefore in total there are $n! \times m_1 \times m_2$ possible solutions for this problem. The two stage no wait flexible flow shop problems are NP-hard in the strong sense [31]. In this paper we proposed a heuristic algorithm to the problem described above. The framework of this algorithm is explained at next section.

III. THE FRAMEWORK OF THE PROPOSED ALGORITHM

This study uses a heuristic algorithm to solve a no-wait two stage flexible flow shop scheduling problem with maximizing of utilization. The concept of the proposed algorithm is described at below: Let's denote the S_1 the first stage and S_2 second stage. Assume that there are m_1 parallel machines in first stage that is shown by $[M_{1,1}, M_{1,2}, ..., M_{1,m_1}]$ and m_2 parallel machines in second stage depicted by $[M_{2,1}, M_{2,2}, ..., M_{2,m_2}]$.

TABLE.1

THE JOBS' PROCESSING TIME OF THE EXAMPLE.

j	1	2	3	4	5	6	7	8
P_{1j}	10	12	3	5	7	11	9	4
P_{2j}	7	4	20	30	9	9	13	6

The details of our proposed algorithm are presented at below:

Step 0 : *Set* $t_{1i} = 0$ ($i = 1, 2, ..., m_1$) and $t_{2l} = 0$ ($l = 1,2,...,m_2$) $t_{2l} - t_{1i} = W_{i,l}$

Set $k = \{1,2,...,n\}$ and L to empty

Step 1 : compute $W_{i,l}$ then find $\arg\min\{\,|P_{1j} - W_{i,l}{}_f\,|,\ j \in k\,\}$ if we had more than one job that have equal $\min|P_{1j} - W_{i,l}|$, we select the one has greather processing time (P_{1j}) than others in first stage, otherwise we can select one of them arbitary.

Set $k = k \setminus \{j\}$ and add j to L

Step 2 : if $P_{1j} - W_{i,l} < 0$ then $t_{1j} = t_{1j} + p_{1j}$ and $t_{2j} = t_{1j} + p_{2j}$

if $P_{1j} - W_{i,l} \le 0$ then $t_{1j} = t_{2j}$ and $t_{2j} = t_{2j} + p_{2j}$

Step 3 : if $k = \varnothing$, stop and compute

$$Utilization = \frac{\sum_{j=1}^{n} (p_{1j} + p_{2j})}{\sum_{j=1}^{n} (p_{1j} + p_{2j}) + \sum Idle\ \text{time}}$$

otherwise , go to step 1

The proposed algorithm is further described using a simple problem with 8 jobs and two machines at each stage. The processing times of the jobs are shown in Table.1 When the algorithm begins to run, $t_{11} = 0$, $t_{12} = 0$ and $t_{21} = 0$, $t_{22} = 0$, therefore $W_{i,l}$ is zero. Thus, job 3 should be processed first. [See Table.2] The corresponding schedule produced by the MRS1 for the example is shown in Fig.1 in the figure, the number in a rectangle stands for the index of the corresponding job. Rectangles with shadows in the figure mean the machines are waiting to process jobs. Finally, we get the should with Utilization=0.8983.

$$Utilization = \frac{(61+98)}{(61+98+8+1+4+5)} = 0.8983$$

TABLE.2

FIRST ITERATION OF THE ALGORITHM

j / w_f	1	2	3	4	5	6	7	8
$w_{1,1} = 0$	10	12	3	5	6	11	9	4
$w_{2,1} = 0$	10	12	3	5	6	11	9	4
$w_{1,2} = 0$	10	12	3	5	6	11	9	4
$w_{2,2} = 0$	10	12	3	5	6	11	9	4

IV. DATA SETS AND ANALYSIS

In this section at first we introduce parameters of the simulation model. This includes the scale of the problems in terms of the number of the jobs, processing time and due dates. This is followed by introducing the simulation model developed using Visual Basic language. Next the results of the simulation study are illustrated and the performance of the proposed approach is compared with those of the others in different scenarios.

A. Parameters of the simulation model

In this study we investigated the performance of the proposed approach for a fairly large number of the problems. In terms of the number of machines, the problems studied in this research are classified in two main categories namely small and large problem. Parameters in our proposed algorithm are:1- Number of the machines (NM): In this problem we consider 3 level for small scale and 3 level for large scale.2- Number of jobs (n): similar to the number of machines, we consider 3kinds of number of jobs for each level of number of machine that totally is 9 different combinations.
3-Distribution of the processing times (DF): We consider four types of distribution, i.e., the 2type of normal distribution and 2type of uniform distribution. 4- Algorithms: In this study we test 4 algorithms beside the MRS1 algorithm which are MDA [14], LPT, SPT and Johnson [15].

B. Simulation process

This section describes the results of the computational experiments performed to evaluate the performance of the proposed algorithm compared with those of other algorithms. The model was developed using Visual Basic language, and the tests were performed using a 3.4 GHz, 895 MB memory personal computer. We examined the effectiveness of the algorithms for 216 different problems and in different scenarios. The simulation experiments were analysed using the Minitab analysis of variance (ANOVA) and SAS (statistical analysis software) for hypothesis test analysis. The results are presented in the next section.

C. Simulation results

As described earlier, the performance of the proposed approach was compared with those of the other five algorithms namely MDA, LPT, SPT and Johnson algorithm for 216 different problems. The results indicate that in 211 problems out of 216 problems (in 97.6% of the cases); the proposed approach outperforms the other algorithms. Figure.2 shows the results. Since the study was conducted for a large number of the problems, it is not possible to present the results in details. However in order to illustrate the performance of the proposed approach on each specific problem, the detailed results for ten specific problems, randomly selected, are presented in Fig.3 In order to testify significant of the superiority of the proposed approach, we performed ANOVA and hypothesis test. ANOVA results are presented in Table.3. These results show that equal hypothesis (i.e. the performance of the proposed algorithm is equal to that of the other algorithms) is rejected because P-value is smaller than α (i.e. P-value < 0.05) Therefore four further hypothesis test were conducted to testify the significance superiority of the proposed algorithms' performance compared to the others. As shown in Table.4, the proposed algorithm outperformed the other algorithms studied.

TABLE.3

ONE-WAY ANOVA TEST

Hypothesis Test
Null hypothesis: Mean MDA = Mean MRS1 = Mean LPT = Mean SPT = Mean Johnson
Alternative: At least one of them is not equal

Source	DF	SS	MS	F	P
Factor	4	3 .6957	0.92395	468.83	0.000
Error	1075	2.118	0.00197		
Total	1079	5.814			

ISBN : 978-602-97809-0-1

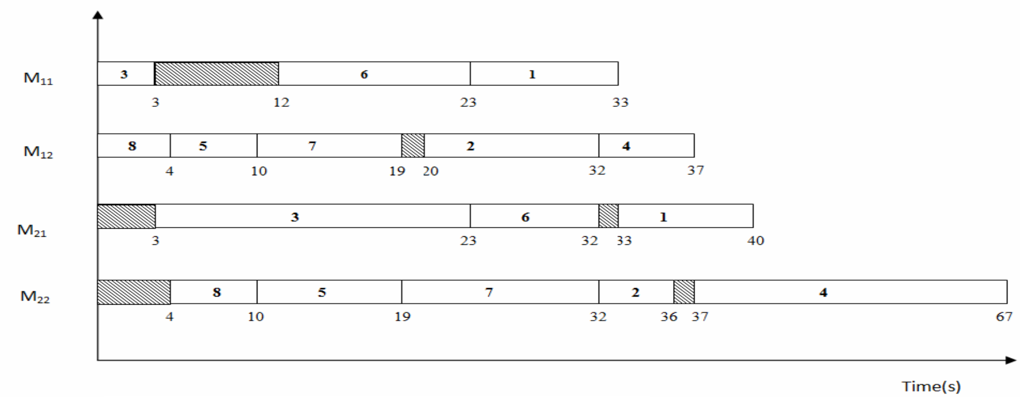

Fig.1 The schedule generated by the MRS1 for the example

TABLE.5

SENSITIVE ANALYSIS

Parameters	Levels	Performance
Scale	Small	95.37%
	Large	100%
Distribution function (DF)	Uniform	97.22%
	Normal	98.148%
Number of machines (NM)	M1 > M2	100%
	M1 = M2	95.83%
	M1< M2	97.22%

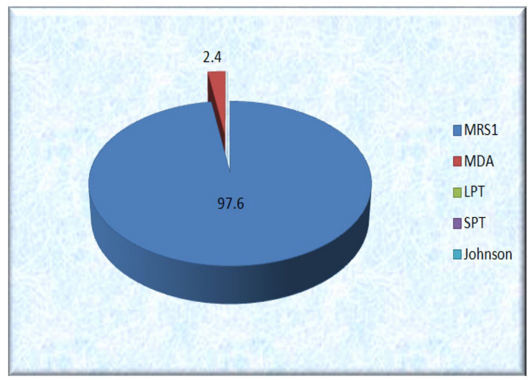

Fig 2. The proposed algorithm outperformed ratio (for 216 probelm)

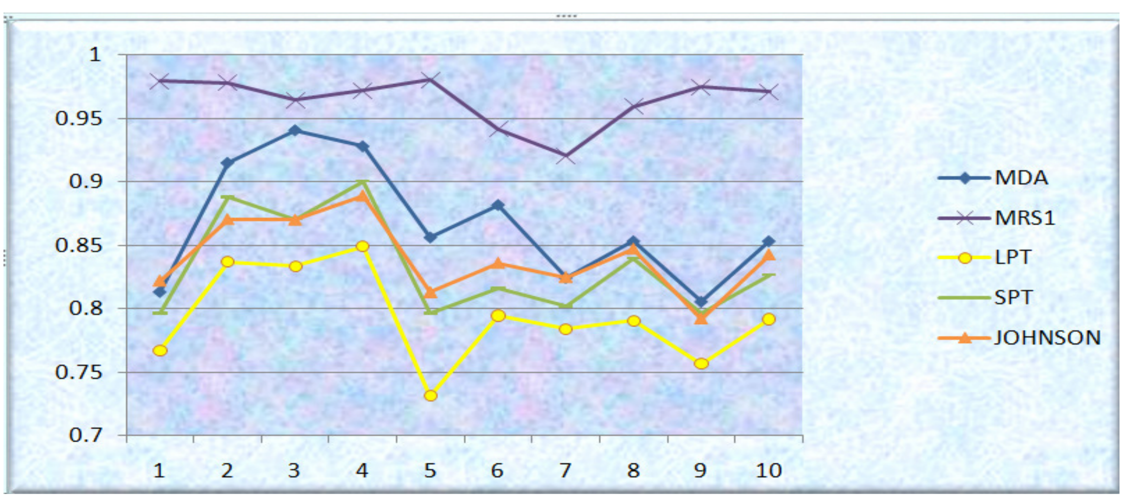

Fig.3 Performance of algorithms in 10 problems

TABLE.4

HYPOTHESIS TEST

Number of hypothesis test	**hypothesis test**	**P-Value**	**Accept/ Reject**

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Examination of the Table.5 shows that distribution function has weak impact on performance of algorithms. Also scale similar to DF has little impact on performance. By consideration Table.5 we show that if number of machines at first stage bigger than number of machines at second stage , performance of our algorithm reach to 100% and when number of machines in second stage bigger than number of machine at first stage , performance of our algorithm reach to 97.2%. So we recommend that our algorithm is used when the numbers of machines in two stages are not equal.

V. Conclusion

In this paper, we focus to develop a heuristic algorithm to solve no wait two stages flexible flow shop scheduling problems with maximizing utilization. Numerical experiments designed to evaluate the effectiveness of the algorithms. Extensive simulations are conducted under different situations and the results show that our algorithm significantly outperforms the other algorithms in most of situation in terms of the average machine utilization. The superiority of the proposed method is more significant for the cases where the number of machine at first stage and second stage are not same and when the number of job is large. For further research it is recommended to investigate the performance of the proposed module in terms of other performance measure such as, Mean flow time, Mean Tardiness

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ISBN : 978-602-97809-0-1

New Heuristic Approach to Find Optimal / Near Optimal Sequences to Minimize Tardiness / Earliness of Jobs in Parallel Flow Line Set Up

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Abstract - **This paper addresses a simple new heuristic algorithm to find an optimal sequence to minimize the weighted sum of job tardiness and earliness in parallel flow line set up, which is defined as a set of processing lines with unrelated similar finite machines in each line. For validation, the computational results of developed heuristic on randomly generated large size problems are compared with the solution obtained through complete enumeration in terms of CPU time and solution quality.**

Keywords**- Scheduling – Tardiness / Earliness - Heuristic.**

I. INTRODUCTION

In recent years, the focus of scheduling research community has been on the development of heuristic procedures for some well known NP-hard scheduling problems such as the one considered in this paper. From a review of the literature, it can be noticed that several heuristic approaches in the field of flow shop scheduling have been designed. Johnson's /1/ Rule has been the basis of flow shop scheduling heuristics. Palmer /2/ first proposed a heuristic for the flow shop scheduling problem to minimize make span. The heuristic generates a slope index for jobs and sequences them in a descending order of the index. Campbell et al. /3/ proposed Campbell, Dudek, Smith (CDS) heuristic which is a generalization of Johnson's two machine algorithm; it generates a set of m -1 artificial two-machine problems from an original m-machine problem, then each of the generated problems are solved using Johnson's algorithm. Gupta /4/ used the concept of Palmer's "slope index" for the heuristic that he improved. Dannenbring /5/ proposed a variation of the CDS heuristic. Nawaz et al. /6/ proposed that, a job with longer total processing time should have higher priority in the sequence. They used this approach as the main idea for their heuristic. They showed that, their heuristic (NEH) outperformed the CDS algorithm. Hundal and Rajgopal /7/ made an improvement in the Palmer's method and CDS. Ho and Chan /8/ developed a new improvement heuristic for the permutation flow shop problem. T'kindt et al. /9/ developed mathematical programming formulations, a branch and bound algorithm, and a heuristic algorithm for solving the two-machine flow shop scheduling problem with the objective of minimizing total completion time, subject to the constraint that the make span is minimum. Pan et al /10/ presented three mixed binary integer programming models and six heuristic algorithms to solve the general reentrant permutation flow shops scheduling problem with make span as the performance measure.

Allahverdi et al /11/ addressed the m-machine no-wait flow shop scheduling problem with a weighted sum of make span and maximum lateness criteria. They proposed a hybrid simulated annealing and a hybrid genetic heuristics, which can be used for the single criterion of make span or maximum lateness, or the bi criteria problem.

Most research is concentrated on to find a sequence of n-jobs that minimizes make span, which can be defined as the completion time at which all jobs complete processing. However, relatively few papers exist for other performance measures such as the average flow time. In fact, given that the average flow time minimization problem was shown to be NP-hard Gonzalez and Sahni /12/ for $m \geq 2$, it is necessary to develop computationally efficient heuristic procedures that generate close optimal sequences. Chan and Bedworth /13/ proposed a heuristic for minimizing average flow time for static and dynamic flexible manufacturing cells. Their paper dealt with cell scheduling when minimizing the mean flow time for n-job and m-machine problem in static and dynamic environments.

Piersma and Van Dijk /14/ dealt parallel machine scheduling with unrelated machines using local search heuristics such us neighborhood search. Moon-Won Park and Guo-Hui Lin et al. /15/ discussed parallel machine scheduling problem, in which the conventional weighting function technique has been used. Dong-Won Kim et al /16/ addressed the problem of unrelated parallel machine scheduling with setup times and a total weighted tardiness objective. They proposed four search heuristics to the problem.

Mauro Dell Amico et al /17/ considered parallel machine scheduling problem to assign each job to exactly one machine so as to minimize the maximum completion time of a job. They presented a metaheuristic and an exact algorithm and analyzed their average behavior on a large set of test instances from the literature. The metaheuristic algorithm, which was based on a scatter search paradigm, computationally proved to be highly effective and capable of solving to optimality a very high percentage of the publicly available test instances. The exact algorithm, based on a specialized binary search and a branch-and-price scheme, was able to quickly solve all remaining instances to optimality.

Woeginger /18/ derived two fully polynomial time approximation schemes for parallel machine scheduling on a fixed number of machines subject to a grade of service provision. Both results substantially simplify a recent construction by Ji and Cheng /19/. From the literature survey, it has been observed that a lot of effort has been put on the development of heuristics on flow shop and parallel machine scheduling.

In this work, a new heuristic approach is devised for solving n-job × m-machine × k-line parallel flow line scheduling problem with the objective of minimizing the weighted sum of job tardiness and earliness. One reason for this consideration is the increasing pressure of high competition while customers expect ordered goods to be delivered on time. The proposed heuristic was tested with randomly generated problems and the results were compared with the solutions of complete enumeration in terms of solution quality and CPU time.

II. PROBLEM REVIEW

The machine group consists of 'm' machines $M_1, M_2 \ldots M_m$, each performing a different function and the same set of machines but with different capacities is arranged in number of stages. All machines are available and ready to start processing at t=0. There are 'n' independent simultaneously available jobs, identified by integers i=1, 2 . . . n to be processed sequentially on the existing stages of a production facility. Each job consists of 'm' operations whose precedence structure is a strict ordering of the operations, where, for each job, the first operation requires machine M_1, the second operation requires M_2, etc.

The objective is to identify better job sequences so as to minimize the weighted sum of job tardiness and earliness in the addressed parallel flow line scheduling problem. The objective function Z (X) is represented as follows in the equation (A).

$$\text{Min } Z(X) = \alpha * \text{Tardiness} + \beta * \text{earliness} \qquad \text{------ (A)}$$

$$\text{Tardiness} = \max\{0, C_i - d_i\}$$

$$\text{Earliness} = \max\{0, d_i - C_i\}$$

Where,

α and β are weightage factors with the assumption of $\alpha+\beta=1$.

C_i: completion time of job i and

d_i: due date of job i.

Following assumptions are considered in defining the problem.

- No interruption of an operation is allowed-each must be scheduled into a single continuous time interval.
- The operation of a job on machine m cannot start until the corresponding job's completion on m-1 has finished.
- The individual job processing time is deterministic and it includes transportation time between two workstations.
- Breakdown of machine is not allowed.
- Any job could be processed in any line.
- Each machine can process at most one job at a time.
- Due date of all jobs are deterministic by normal distribution.
- When the jobs to be scheduled are non preemptive, i.e. when a job must be executed without interruption, two types of real-time algorithms (devoted to the static and dynamic problems).

A problem is said to be dynamic when new jobs can emerge at any time in the system and the characteristics of the job are known only when the jobs emerge. In the static problem the jobs to be scheduled and the related constraints are known at the beginning of the process. This is the case in this paper. New heuristic aiming at minimizing the weighted sum of job tardiness and earliness is proposed and compared the developed new heuristic's efficiency with the optimal solution arrived by the complete enumeration.

III. SOLUTION METHODOLOGY

A. *Necessity of heuristics*

A heuristic program is an algorithm that, using a pseudorandom starting algorithm and a local transformation N, computes a sequence $s_l, s_2, \ldots$ of trial solutions. The program terminates when local optimality of the current trial solution is verified by searching its neighborhood exhaustively. In application to the flow shop problem, incumbent solutions are replaced on a first-improvement-found basis. For each run of the program from a new starting solution s_l, a sample of the local optima is computed. The program is usually used by making as many runs as resources allow, and taking the best of the results.

B. *Proposed Heuristic Algorithm*

In the proposed heuristic, the jobs are assigned to a line, which takes minimum time to complete. Within each line jobs are arranged in ascending order of their total completion time. Then jobs are sequenced to the corresponding lines accordingly.

1. For each job i (i= 1, 2…n), find the completion time in each line k, (k=1, 2… q).
2. Find the due date of each job (d_i).
3. For each job fix a line (k), which completes the job in minimum time and while assigning jobs

   i) Maximum number of jobs assigned to a line should not exceed the number of jobs (i) divided by number of lines (k).

   ii) if a line is already engaged with jobs, compare the new jobs completion time in all the existing lines and allocate the line which completes earlier.

iii) if a job has same completion time in different lines, allot to the line with minimum number of allocations.

iv) if more than one job has the same completion time on a particular identified unallocated line, assign the job which has minimum due date.

4. In each line sort the jobs in ascending order of completion times. If there is a tie, give priority to the job with minimum due date, d_i.
5. In line 1, take the first two jobs i =1 & 2 from the sorted list and find the objective function value of the possible two partial sequences (1-2, 2-1). The better of these two is selected for further processing.
6. Place the next job i =3 in the next position to the previously obtained sequence. Now compare the two partial sequences of the jobs in the positions 2 & 3 and find the better of these two sequences.
7. Continue steps 5 and 6 until the allocation of last job.
8. The same procedure is repeated to all the lines to get the better sequences.
9. For the sequence obtained in step 8, find the completion times of all the jobs and compare them with the preset due date to measure the earliness/ tardiness of jobs.

IV. INFERENCE THROUGH COMPUTATIONAL EXPERIENCE

Number of problems is generated by varying number of jobs, machines and lines. The processing time of jobs is sampled from uniform distribution of [1-10]. Due date 'd_i' for each job is randomly generated from the uniform distribution [P× (1-TF-RDD/2), P× (1-TF+RDD/2)], where *P*=maximum processing time of a job in a line, for a given relative Range of Due Dates RDD (RDD = 0.2, 0.4, 0.6, 0.8, 1.0) and a given average Tardiness Factor TF (TF = 0.2, 0.4, 0.6, 0.8, 1.0).

To evaluate the performance of the developed heuristic, the results are compared with the optimal values of complete enumeration by means of percentage deviation as specified below:

% Deviation = $(f_h - f_o)*100 / f_o$

where, f_h –objective function value determined by the proposed heuristic;

f_o – Optimal objective function value determined by complete enumeration.

To perform computation, the developed new heuristic and complete enumeration are encoded in C, run in a Pentium IV based microcomputer and the performance of both algorithms are compared in terms of solution quality and CPU time by solving randomly generated large sized problems.

Computational results of the proposed heuristic and complete enumeration are depicted in Table 1. The CPU statistics are given in Table 2.

TABLE 1

COMPARISON OF ALGORITHMS IN TERMS OF PERCENTAGE DEVIATION FOR LARGE SIZE PROBLEMS

Problem Size (n, k, m)	Complete Enumeration	Heuristic	Heuristic % Deviation
8, 2, 3	52.79	54.1	2.42
9, 2, 3	72.4	74.6	2.95
8, 2, 4	53.9	54.1	0.37
9, 2, 4	75.4	76.9	1.95
8, 2, 5	51.59	53.2	3.03
9, 2, 5	76.09	78.4	2.95
8, 3, 3	27.1	27.9	2.87
9, 3, 3	40.8	41.7	2.16
8, 3, 4	21.1	21.9	3.65
9, 3, 4	35.2	36.1	2.49
8, 3, 5	26.8	27.1	1.11
9, 3, 5	36.4	37.7	3.45
8, 4, 3	15.7	16.1	2.48
9, 4, 3	24.1	25.2	4.37
8, 4, 4	17.9	18.5	3.24
9, 4, 4	29.3	30.4	3.62
8, 4, 5	18.3	18.9	3.17
9, 4, 5	25.9	26.8	3.36
8, 5, 4	17.9	18.2	1.65
9, 5, 4	19.1	19.8	3.54
8, 5, 5	19.6	20.2	2.97
9, 5, 5	20.8	21.3	2.35
8, 5, 6	76.4	78.3	2.43
9, 5, 6	96.8	98.6	1.83
8, 6, 4	21.6	22.1	2.26
9, 6, 4	24.3	24.9	2.41
8, 6, 5	19.2	20.0	4.00
9, 6, 5	27.8	28.5	2.46
8, 6, 6	64.6	66.1	2.27
9,6, 6	85.4	88.6	3.61

From the above, it is found that for all parallel flow line scheduling problems the developed heuristic gives results nearer to the optimal solutions determined through complete enumeration.

TABLE 2

COMPARISON OF CPU VALUES

Problem Size (n, l, m)	Complete Enumeration (seconds)	Heuristic (seconds)
8, 2, 3	327	7
9, 2, 3	2,380	8
8, 2, 4	414	3
9, 2, 4	1,605	5
8, 2, 5	290	9
9, 2, 5	1,259	5
8, 3, 3	584	7
9, 3, 3	1,732	5
8, 3, 4	130	3
9, 3, 4	3,263	1
8, 3, 5	203	1
9, 3, 5	3,248	2
8, 4, 3	726	3
9, 4, 3	2,081	6

ISBN : 978-602-97809-0-1

8, 4, 4	349	3
9, 4, 4	2,230	4
8, 4, 5	644	1
9, 4, 5	2,042	6
8, 5, 4	1,324	2
9, 5, 4	2,189	3
8, 5, 5	3,520	4
9, 5, 5	12,562	9
8, 5, 6	6,420	8
9, 5, 6	13,857	19
8, 6, 4	3,260	11
9, 6, 4	6,289	14
8, 6, 5	2,176	7
9, 6, 5	2,623	9
8, 6, 6	4,980	15
9,6, 6	14,387	8

The conclusion that can be drawn from the CPU time table is that an efficient implementation of the new heuristic is extremely fast.

V. CONCLUSION

Because of their dynamic nature and their practical interest in industrial applications, manufacturing scheduling problems have been the subject of extensive research in the past few decades. Scheduling problems are generally NP-hard, i.e. it is unlikely to find an optimal solution without the use of an essentially enumerative algorithm and the computational time increases exponentially with problem size. In a manufacturing system, the scheduling problem is further complicated when unforeseen events occur in the system. We developed a heuristic approach that has been successful in obtaining near-optimal solutions for problems that could not be solved exactly because of exorbitant computational requirements. Furthermore, these schedules are generated with highly acceptable computer processing requirements. Since new heuristic performs well, it is worth analyzing further its performances with respect to the number of jobs, machines and lines.

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ISBN : 978-602-97809-0-1

Job Shop Scheduling Problems with Alternative Routings using Variable Neighbourhood Descent to Minimize Makespan

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***Abstract* - This paper deals with a generalization of the classical job shop scheduling problem known as the flexible job shop scheduling problem (FJSP). A heuristic algorithm based on variable neighbourhood descent (VND) is put forward to tackle the problem such that the maximum completion time (makespan) of the schedule is minimised. The performance of this VND based approach is assessed using well known data sets from the literature. Some preliminary results are reported and very competitive results are also obtained when compared to the best known results from the literature.**

***Keywords* — Job shop, Alternative routings, Heuristics, Makespan**

I. INTRODUCTION

In the classical job shop scheduling problem (CJSSP), we are given a set of jobs J_i (i= 1, 2, .., n) that has to be processed on a set of unrelated machines M_k (k = 1, 2, …, m). Each job J_i is composed of a set of operations O_{ij} (j= 1, 2, .., l) which are processed in a specified order. Every operation O_{ij} follows a technology constraint, called a routing, which is fixed and known in advance. The operation O_{ij} has to be processed without interruption during t_{ij} units of time and a machine is constantly available from time zero. Each machine can process only one operation at a time and operations are performed without preemption. The objective is to find a schedule that minimise makespan ($C_{\max}$), i.e., the maximum completion times of all jobs.

The CJSSP is considered as a hard combinatorial optimisation problem (NP-hard) [1]. The problem has been widely studied and many solution methods, such as exact and heuristic techniques have been put forward. Exact methods are mainly based on the branch and bound algorithms (see [2]-[4]). These techniques guarantee to yield an optimal solution, however, the methods are found to be effective when solving small instances. Moreover, their implementation needs too much computational cost when the size of problems increases. Contrarily, heuristic approaches, which can solve larger problem instances within reasonable computing time, are good alternatives for such problems. These methods consist of priority dispatching rules [5], shifting bottleneck procedures (see [6]-[8]), local search such as tabu search [9], [10], simulated annealing (e.g. [11], [12]), variable neighbourhood search [13], and greedy randomized adaptive search procedures (GRASP) [14], and evolution schemes such as genetic algorithms (i.e. [15], [16]), and ant colony optimizations (for instance, see [17], [18]). For completeness, see [19] and [20] for comprehensive reviews on CJSSP.

This paper concerns with the flexible job shop scheduling problem (FJSP) as a generalization of the CJSSP which the model is a closer approximations to a variance of scheduling problems encounter in real manufacturing systems. The FJSP problem, also known as the job scheduling problem with alternative routings or machines, is an enhancement of the CJSSP by allowing an operation to be performed on any machines out of a set of available machines. The objective is to select for each operation, an eligible machine and a starting time which an operation must be processed so that the maximum completion times $C_{\max}$ of all jobs (makespan) is minimized. Therefore, the FJSP is more complex that the classical ones in terms of determining the operation routing sub-problem, that assigns each operation to a machine from a set of eligible machines and the scheduling sub-problem that consists of sequencing the assigned operations on all machines to yield a feasible schedule which minimize a predefined objective function [21]. Alvarez-Valdes *et al*. [22] demonstrate the complexity of the FJSP in a glass factory.

The high complexity of the FJSP makes this problem falls into NP-hard realm. Hence, many previous works in the FJSP concentrates on heuristic/ metaheuristic techniques. Nasr and Elsayed [23] propose a greedy heuristic procedure to deal with job shop scheduling problems with alternative machines. Brandimarte [24] decomposes the FJSP into the routing sub-problem and the scheduling sub-problem. The first sub-problem was solved by some well known dispatching rules and then tabu search algorithm was adopted to focus on the scheduling sub-problem. In the following research, tabu search are also applied by [21], [25], [26] to deal with the FJSP. Baykasoĝlu [27] put forward a linguistic based meta-heuristic in solving the FJSP. Jansen *et al*. [28] design a linear time approximation scheme for the FJSP. In recent years, genetic algorithms have been successfully developed to tackle the FJSP as shown in [29]-[31]. In the subsequent research, Gao *et al*. [32] combine genetic algorithms with variable neighborhood descent (VND) to deal with the FJSP. Prassetiyo *et al*. [33] tackle the FJSP by introducing a population based heuristic such as the ant colony system. Very recently, Saleh *et al*. [34] address the FJSP by designing two phase heuristic algorithms based on GRASP heuristic.

In this study, we propose a simple but powerful two phase heuristic schemes to address the FJSP with makespan criterion. In the first phase, priority dispatching rules such as shortest processing time (SPT) is used to deal with the routing sub-problem. The second phase is to schedule assigned operations using a variable neighborhood descent algorithm in order to find the best schedule that minimize makespan.

The remainder of this paper is organized as follows: in Section 2 we present the problem description. Section 3 describes the general framework of the VND heuristic. In Section 4, the computational experiments are discussed and finally, the last section summarizes conclusions and outlines some research avenues that would be worthwhile investigating in the future.

II. Problem Description

The flexible job shop scheduling problem (FJSP) can be defined as follows. We are given a set of independent jobs ($J_i = J_1, J_2, .., J_n$) and a set of unrelated machines ($M_k = M_1, M_2, \ldots, M_m$). A job J_i has a sequence of operation O_{ij} (j= 1, 2, .., l). Each operation O_{ij} can be performed on any among available machines out of a set of flexible machines. The problem is assumed as a static problem, in a sense that all data are known in advanced and all jobs and machines are available at time zero.

An example of a flexible job shop problem is illustrated in Figure 1. This example is taken from [21], which presents two jobs and three machines in the flexible job shop scheduling problem. Each operation has alternative machines except for O_{22}. Based on Figure 1, operation O_{11} can be executed by machine m_1 for 10 minutes or by machine m_2 for 15 minutes. The problem arises in allocating each operation to an available (a flexible) machine and in sequencing the operations on the machines to minimize one or more predefined objectives.

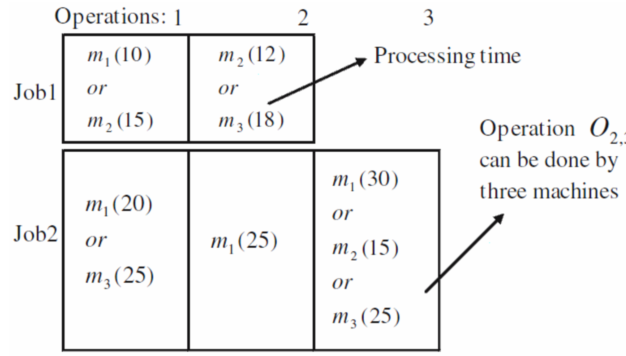

Fig. 1 Example of two jobs and three machines in the FJSP ([21])

III. Solution Framework

Our proposed algorithm is based on the work of Sevkali dan Aydin [13] which investigates the job shop scheduling with fixed routing (CJSSP) using VNS and Nasr and Elsayed [23] that the job shop scheduling problem with alternative routings/ machines using greedy algorithms.

A. A Variable Neighbourhood Descent (VND) for the FJSP

VND is a metaheuristic technique that systematically change neighborhood structures within a possibly randomized local search [35]-[37] to escape from local optima trap. The VND method is obtained if change of neighborhood structures is carried out in a deterministic way. VND has been adopted to find optimal or near optimal solutions for a number of combinatorial optimization problems. One can refer to [37] for more detail on applications of VND.

The idea behind VND is on simple principle that is a local minimum with respect to one neighborhood structure is not necessary so for another. Hence, VND is more applicable than any other metaheuristic approaches as the method does not need any parameters. In this study, we apply VND as a local search in finding the best schedule that minimize makespan.

B. The Proposed Algorithm

This section discusses an algorithm for the FJSP with makespan criterion. The algorithm consists of two phases that find the best allocation of each operation to a set of flexible machines and the best sequence of the all allocated operations that yield a schedule with the best makespan. In the first phase, the greedy algorithm of Nasr and Elsayed [23] is modified where initial solutions to choose alternative machines are generated randomly and then some priority dispatching rules are used to sequence the assigned operations. For simplicity, in this paper, we use shortest processing time (SPT) and other rules may also be applied.

The second phase is a local search that adapts the VNS method presented by Sevkali dan Aydin [13]. The basic idea behind this method is to change neighbourhood structures obtained in initial solutions by alternately applying exchange and insert processes.

For the sake of completeness, we introduce some notations that are used in the proposed algorithms, as follows:

n = number of job
m = number of machines
i = index for *job* i (i = 1, 2, ..., n)
j = index for operation of job i
k = index for machine k (k = 1, 2, ..., m)
r_{ij} = ready time of the jth operation of job i
R_k = ready time of machine k
C_{ijk}^{b} = completion time of the jth operation of job i on machine k for the bth schedule (b = 1, 2, ..., *maxiter*)
t_{ijk} = processing time of the jth operation of job i on machine k
MS_b = makespan for the bth schedule
S_p = sequence of p best schedules, p = 1, 2, .., *maxiter*
L_p = the jth operation of job i in a critical path for a partial schedule S_p
S_p^h = a partial schedule after *insert/exchange* processes at the hth iteration
C_{ijk}^{ph} = completion time of the jth operation of job i on machine k for the pth schedule at the hth iteration
MS = final makespan

The step by step of the proposed algorithm for solving the FJSP to minimize makespan is as follows:

Phase 1 (the Selection of alternative machines)

Step 1

Input data routings and processing times of all jobs. Set *maxiter* = max (2, $\left\lceil \frac{n}{4} \right\rceil$), *Ready time* of the first operation of each job = 0 ([r_{i1} = 0 $\forall$ i = (1, 2,..., n)]), *Ready time* of all machines = 0 ([R_k = 0 $\forall$ k = (1, 2,..., m)]), b = 1, l = 1, and p = max [2, 10%*maksiter*]

Step 2

If $b \le$ *maxiter* then choose randomly an alternative machine for every operation j and set $b = b+1$, else go to Step 3

Step 3

Schedule every operation of job i with its chosen alternative machine using shortest processing time (other priority dispatching rules may also be applied)

Step 4

Compute completion time for each job and the *makespan* from the schedules obtained at Step 3 using the following equations:

$$C_{ijk}^{b} = \max\ [r_{ij}\ ,\ R_k] + t_{ijk};\quad \forall i = (1,\ 2,...,n),\ \forall b = (1, 2,...,maxiter) \tag{1}$$

$$MS_b = \max\ [\, C_{ijk}^{b}\,], \forall b = (1,2,..., maxiter) \tag{2}$$

Step 5

Based on the obtained schedules at Step 3, choose p schedules with the smallest makespan (S_p) and set $S = S_p$ ($S = \{S_1, ..., S_{maxiter}\}$)

Phase 2 (the VND Procedure)

Step 6

For $p = l$, input S_p and L_p and set the last operations of the last job in the critical path into SO_L ($SO_L = \{O_{ijk}\}, O_{ijk} \in L_p$) and $h = 1$

Step 7 (the Insert Procedure)

Change the neighborhood structure by inserting the operations $O_{ijk} \in SO_L$ and schedule all the operations in S_p^h

Step 8

Compute completion time for each job and determine the makespan using the following equations:

$$C_{ijk}^{ph} = \max\ [r_{ij}, R_k] + t_{ijk}\ ;\ \ \forall\ \ i = (1,2,...,n) \tag{3}$$

$$MS^{ph} = \max\ [\, C_{ijk}^{ph}\,] \tag{4}$$

Step 9

Determine L_p in S_p^h and $SO_L = \{O_{ijk}\}$, $O_{ijk} \in L_p$ and set $MS_p = \min\ [MS_p, MS^{ph}]$ and $h = h + 1$

Step 10

If $SO_L = \{\varnothing\}$ then go to Step 11, else return to Step 7

Step 11 (the Exchange Procedure)

Change the neighborhood structure by swapping the operations $O_{ijk} \in SO_L$ and schedule all the operations in S_p^h

Step 12

As Step 8 and remove S_p from S

Step 13

If $MS_p \ge MS^{ph}$, set $MS_p = \min\ [MS_p, MS^{ph}]$ and $h = h + 1$ then go back to Step 7, else set $h = h + 1$ and return to Step 11

Step 14

If $S \neq \{\varnothing\}$, set $l = l + 1$ and return to Step 6, else continue to Step 15

Step 15

Select the schedule with the smallest makespan (MS = min (MS_1, ..., $MS_{maxiter}$))

IV. COMPUTATIONAL RESULTS

This section presents computational results when our proposed algorithm was tested using two well known instances from the literature. The first instance, adopted from Nasr and Elsayed [23] (NE for short), is a small problem, which consists of four jobs and six machines. The second one, taken from Brandimarte [24], is a large problem that has ten jobs and six machines. In order to evaluate our proposed algorithms, we compare our results with some published results from literature.

Table 1 shows the comparison of our results with other authors. The first column is the instance name. The second and third columns are the number of jobs and the number of machines for each data set, respectively. The fourth column is our results by the proposed algorithm. The remaining columns are the best results from [23], [33], [31], [30], [32], and [34]. The bold numbers in Table 1 refer to best makespan found for each instance and the shaded cells indicate that some authors do not conducted experiments for the instances.

Based on the results in Table 1, our proposed algorithm generally provides competitive results compared to the other publications. For example, in the case of NE data set, our algorithm yields better solution compared to [23] for one unit of time and gives similar makespan to the remaining published results.

TABLE 1

DETAILS OF COMPARISON OF ALL RESULTS

Data Sets	*n*	*m*	Makespan						
			The Proposed Algorithm	Nasr and Elsayed [23]	Prassetiyo *et al.* [33]	Moon *et al.* [31]	Pezella *et al.* [30]	Gao *et al.* [32]	Saleh *et al.* [34]
NE	4	6	**17**	18	**17**	**17**			**17**
MK-01	10	6	**40**				**40**	**40**	**40**

V. CONCLUSIONS

In this paper the job shop scheduling problem with alternative routings is studied. A variable neighbourhood descent based approach is proposed and its performance is evaluated using well-known problem instances. Two data sets are used. The small one contains four independent jobs and six machines and the large one has ten jobs and six machines. The results from both instances show that our proposed methods produce favourable outcomes when compared against those in the literature.

The following research directions may be worthy of investigation in the future. The work can be extended by hybridizing VND and other metaheuristics such as GRASP or threshold accepting algorithm to enhance the local search. An overview of heuristic search in general can be found in [38]. Another direct modification of the existing problem is a case of dynamic situation where jobs can arrive at a system at any time.

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

Batch Scheduling To Minimize Total Actual Flow Time In A Two-Stage Flowshop With Dedicated Machines In The Second Stage For Various Due Date

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***Abstract* - An electronic manufacturing company produces two types of headphone stereos (walkman), i.e., analog and digital headphone stereos, in a two stage flowshop. Both types are processed on a common machine in the first stage and then are processed on respective dedicated machines in the second stage. The company is facing a problem of scheduling as in many cases the company cannot meet promise due dates, and simultaneously there are queues in the first stage and idles in the second stage. A batch scheduling model has been developed to solve the problem, and the objective of the model is to minimize total actual flow time of all stereos through the shop. The actual flow time of a stereo is defined as the time that the stereo spends in the shop from the starting time for processing until its due date. The proposed model could accommodate the problem with more than two types of products, and this model tested for various due date while the parameters of process time, setup time, and number of parts have not changed. A heuristic procedure is proposed and the solution shows that the resulting batch sizes are unnecessarily equal, and the final schedule unnecessarily sequences batches of the same type consecutively.**

***Keywords* - two stage flow shop, common machine, dedicated machines, actual flow time.**

I. INTRODUCTION

An electronic manufacturing company produces two types of headphone stereos, i.e., analog and digital headphone stereos. As the circuit boards for both types consist of the same components, in the first stage of production the mounting processes could be undertaken on a common machine. The second stage then undertakes the remaining processes specific to each type of stereos. This condition can be considered as processing two types of products in a two stage flow shop consisting of a common machine for both types in the first stage, and unique machines each of which is dedicated to process a part type in the second stage. The company is facing a problem of scheduling as in many cases the company cannot meet promise due dates, and simultaneously there are queues in the first stage and idles in the second stage.

Reference [1] have dealt with a problem of batching in a two-stage problem with dedicated machines in the second stage, and adopted an objective of minimizing actual flowtime.

Reference [2] have dealt with a problem of batching in a two-stage problem with dedicated machines in the second stage, and adopted an objective of minimizing makespan. However, the problem has not considered any due date pinpointing one of the aspects of what customers really want. In addition, meeting a due date tends to be considered a more important objective than minimizing shop time as it could strengthen the customer loyalty, the key to success for any business in a highly competitive and global market place.

Reference [3]-[6] have proposed an objective called actual flow time including a due date in its definition, and implemented this objective to several batch scheduling models (see [7]).

This paper deals with a problem of batch scheduling in a two stage flow shop processing *G* types of products to minimize the total actual flow time, and for this paper, the model was tested by using several sets of data with a due date that is different, while the parameters of process time, setup time, and number of parts have not changed. Due date to be determined arbitrarily. A heuristic procedure is proposed to solve the problem.

II. BATCH SCHEDULING IN A TWO-STAGE FLOWSHOP

A. Actual Flow Time

Reference [5] define actual flow time of a job as the time that the job spends in the shop from its starting time for processing until its due date. The actual flow time, $FJ^{a}_{[i]}$, can be formulated as follows:

$$FJ^{a}_{[i]} = d - B_{[i]}, \quad i = 1,\ldots,n \qquad (1)$$

where d is a common due date for b jobs and $B_{[i]}$ is the starting time for processing $J_{[i]}$ (the job backwardly scheduled in position i counted from the due date).

If it is assumed that setup time, s, is constant and not included into job processing time, p_i, for job $J_{[i]}$ processed in the shop with a single machine, Equation (1) can also be reformulated as follows:

$$FJ^{a}_{[i]} = \sum_{j=1}^{i}\left(p_j + s_j\right) - s_i \quad i = 1, 2, \ldots, b \qquad (2)$$

If the job processing time is replaced by batch processing time, calculated by multiplying the batch size, Q, by processing time, t, for a part, the actual flow time, $FL^{a}_{[i]}$, for batch $L_{[i]}$ (the batch backwardly scheduled in position i counted from the due date) can be formulated as follows:

$$FL^{a}_{[i]} = \sum_{j=1}^{i}\left(t\ Q_{[j]} + s_j\right) - s_i \quad i = 1, 2, \ldots, N \qquad (3)$$

where N denotes the number of batches. Since each part in the batch must wait until all parts in the batch are completed, the actual flow time of each part is the same as the actual flow time of the batch. Thus, the actual flow times, $F^{a}_{[i]}$, of all parts in the batch are calculated by multiplying the actual flow time of a part by the number of parts in the batch. This can be written as follows:

$$F^{a}_{[i]} = \left\{\sum_{j=1}^{i}\left(tQ_{[j]} + s\right) - s\right\}Q_{[i]}, \quad i = 1, 2, \ldots, N, \qquad (4)$$

and the actual flow times, , of all parts processed through the shop can be written as follows:

$$F^{a} = \sum_{i=1}^{N}\left\{\sum_{j=1}^{i}\left(s + tQ_{[j]}\right) - s\right\}Q_{[i]} \qquad (5)$$

The general formulation of the total flow time for the problem concerned in this paper of G types processed in a flow shop with two stages can be written as follows:

$$F^{a} = \left\{\sum_{i=1}^{N}\sum_{j=1}^{i} t_0 Q_{[j]} + max\left(s + F^{a}_{[i-1]}, \sum_{g=1}^{G} X_{g[i]}\left(\sum_{g=1}^{G}\sum_{j=1}^{i} X_{g[j]}\left(t_g Q_{[j]} + s\right) - s\right)\right)\right\}Q_{[i]} \qquad (6)$$

Equation (6) can be rewritten as follows:

$$F^{a} = \sum_{i=1}^{N}\left[\left\{d - B_{[i]}\right\}Q_{[i]}\right] \qquad (7)$$

B. Problem Formulation

Let there be G different part types indexed by g, g = 1, 2,.., G. The types, with n_g standing for the numbers of parts of types g respectively, are requested at a common due date d, and to be processed in a flow shop with 2 stages. At the first stage all part types are processed on the same machine, i.e., M_0, and at the second stage each of the types is to be processed on each dedicated machine, i.e., M_g. The processing time on the first stage is the same for all the types, i.e., t_0, and the processing times at the second stage are t_g, g = 1, 2, …, G, respectively. The problem here is how to batch the multiple types and to schedule the resulting batches so as to minimize the total actual flow time of parts of the multiple types through the shop. The set up time on all the machines at both stages processing the types is the same, i.e., s.

The problem of batch scheduling in a two stage flowshop (consisting of a common machine in the first stage and dedicated machines in the second stage) processing G types of products to minimize the actual flow time can be formulated as the following CMIF Model.

CMIF Model

Minimize

$$F^{a} = \sum_{i=1}^{N}\left[\left\{d - B_{[i]}\right\}Q_{[i]}\right], \qquad (8)$$

subject to

$$B_{[1]} = d - \left(t_0 Q_{[1]} + t_g Q_{[1]}\right), \qquad (9)$$

$$B_{[i]} = \left(min\left[d - \left(s + F^{a}_{[i-1]}\right), d - \sum_{g=1}^{G} X_{g[i]}\left(\sum_{g=1}^{G}\sum_{j=1}^{i} X_{g[j]}\left(t_g Q_{[j]} + s\right) - s\right)\right]\right) - t_0 Q_{[i]}$$

$$i \geq 2, \qquad (10)$$

$$B_{[N]} \geq 0, \qquad (11)$$

$$F^{a}_{[i]} = t_0 Q_i + max\left(s + F^{a}_{[i-1]}, \sum_{g=1}^{G} X_{g[i]}\left(\sum_{g=1}^{G}\sum_{j=1}^{i} X_{g[j]}\left(t_g Q_{[j]} + s\right) - s\right)\right) \qquad (12)$$

$$X_{g[i]} = 0 \text{ or } 1 \quad \forall\ g \text{ and } i, \qquad (13)$$

$$\sum_{i=1}^{N} Q_{[i]}.X_{g[i]} = n_g \quad \forall\ g, \qquad (14)$$

$$Q_{[i]} \geq 1, \text{ integer} \quad \forall\ i, \qquad (15)$$

$$N \geq G. \qquad (16)$$

Constraint (9) shows that the batch processed last (i = 1) must be completed at the common due date. Constraint (10) shows a formulation of starting times of processing batch i (for $i \geq 2$). Constraint (11) shows that the batch processed first must be started at or after time zero. Constraint (12) shows the actual flow time of parts in the batch sequenced at Position i. Constraint (13) shows that the value of $X_{g[i]}$ must be 1 or 0, where $X_{g[i]} = 1$ indicates that the batch consists of parts of Type g and is sequenced at Position i, and $X_{g[i]} = 0$ indicates that the batch sequenced at Position i does not consist of parts of type g. Constraint (14) shows the material balance for each type. Constraint (15) shows that the batch sizes must be equal to or greater than 1 and integer. Constraint (16) shows that the number of batches must be equal to or greater than the number of types processed through the shop.

III. SOLUTION

The decision variables of CMIF Model are the number of batches (N), batch sizes and a batch sequence. Following the algorithm developed in [3], the number of batches is relaxed and set as a parameter in each iteration of the solution method proposed. The remaining steps of the proposed algorithm are based on the algorithm developed by [7]. The basic structure of the proposed algorithm for solving CMIF Model is the followings:

1. Set N=G and solve CMIF Model.
2. Improvement processes of the solution are conducted by increasing N by 1 in each iteration until a stopping rule is satisfied.
3. The stopping rule is that if $F_{a\,N} \geq F_{aN-1}$ has been achieved or the number of batches has been greater than the number of parts processed through the shop ($N > n_{total}$).

The detailed algorithm proposed to solve CMIF Model is the followings:

Step 1. Initialize the problem and set predetermined values of the parameters. Go to Step 2.

Step 2. Set the number of batches (N) equals the number of types of products (G), or $N = G$. Go to Step 3.

Step 3. Solve CMIF Model as a non-linear problem (for example, using the so called LINGO software), to determine batch sizes, a schedule of the resulting batches and total actual flow time for the schedule. Is the resulting schedule started before time zero?
- If no, the solution is considered feasible. Go to Step 4.
- If yes, then stop, and the solution is considered not feasible (the order is rejected).

Step 4. Set $N = G + 1$. Go to Step 5.

Step 5. Solve CMIF Model to determine batch sizes, a schedule of the resulting batches and total actual flow time or the schedule. Is the resulting schedule started before time zero?
- If no, then go to Step 6.
- If yes, then go to 9.

Step 6. Is F_{aN} less than or equal to F_{aN-1}?
- If yes, then go to Step 7.
- Otherwise, set $N = N - 1$. Determine this value as selected value of N and stop.

Step 7. Has $N = n_{total}$ been achieved?
- If it has not been achieved, go to Step 8.
- Otherwise, set $N = n_{total}$. Determine this value as selected value of N and stop.

Step 8. Set $N = N + 1$, and go to Step 5.

Step 9. Set $N = N$+1. Solve CMIF Model2 to determine batch sizes and a schedule of the resulting batches and total actual flow time for the schedule. Is the resulting schedule started before time zero?
- If no, then go to Step 7.
- If yes, then set $N = N$-2. The algorithm is then stopped.

IV. NUMERICAL EXPERIENCE

In order to show an implementation of the proposed algorithm, let us look at the following example. Suppose a two stage flow shop (with a common machine in the first stage and unique machines in the second stage) is to process 2 types of products, i.e., Type Y consisting of 8 units ($n_1 = 8$) and Type Z consisting of 10 units ($n_2 = 10$). The products are required at a common due date, due date determined arbitrarily as follow, $d_1 = 1000$, $d_2 = 70$, $d_3 = 30$, $d_4 = 20$, $d_5 = 10$, $d_6 = 8$. In the first stage, processing times for both types on the common machine (M_0) are the same, i.e., $t_0 = 0.24$. In the second stage, Type Y is to be processed on a dedicated machine M_1 with $t_1 = 0.40$, and Type Z on machine M_2 with $t_2 = 0.50$. All machines in both stages are required to be set up before processing a batch with $s = 0.10$.

By following the algorithm for solving CMIF Model the result for this example as follow:

TABLE 1
TOTAL ACTUAL FLOW TIME & THE BEST NUMBER OF BATCHES

d	N	F^a	The Best Number Of Batches	
			Type Y	Type Z
1000	10	60,72	4	6
70	10	60,72	4	6
30	10	62,52	4	6
20	9	62,58	4	5
10	9	63,08	4	5
8	9	62,70	4	5

TABLE 2
SEQUENCE AND BATCH SIZE (FOR DUE DATE 1000, 70 AND 30)

Batch Position	d = 1000		d = 70		d = 30	
	Size	Type	Size	Type	Size	Type
1	1	Z	1	Z	1	Y
2	2	Y	2	Y	1	Z
3	1	Y	1	Y	2	Y
4	2	Z	2	Z	2	Z
5	2	Y	2	Y	2	Y
6	2	Z	2	Z	2	Z
7	3	Y	3	Y	3	Y
8	2	Z	2	Z	2	Z

ISBN : 978-602-97809-0-1

9	2	*Z*	2	*Z*	2	*Z*
10	1	*Z*	1	*Z*	1	*Z*

By considering the results in Table 1, specifically for this case can be concluded that the maximum number of batches for product type *Y* is the 4 batches, the maximum number of batches of product type *Z* for $d \geq 30$ is 6 batches, and for $d \leq 20$ is 5 batches. While value for *d* in this case is determined arbitrarily, in order to obtain certainty will change the number of batches must be tested again for the due date between 20th minute to 30th minute.

In Table 2, can be seen that the batch size for the due date 1000, 70 and 30 are the same, the sequence generated to the due date 1000 and 70 are the same, while the sequence produced for the due date 30 is not the same.

TABLE 3
SEQUENCE AND BATCH SIZE (FOR DUE DATE 20, 10 AND 8)

Batch Position	*d* = 20		*d* = 10		*d* = 8	
	Size	Type	Size	Type	Size	Type
1	1	*Z*	1	*Y*	1	*Y*
2	2	*Y*	1	*Z*	2	*Z*
3	1	*Y*	2	*Y*	2	*Y*
4	2	*Z*	2	*Z*	2	*Z*
5	2	*Y*	2	*Y*	3	*Y*
6	2	*Z*	2	*Z*	2	*Y*
7	3	*Y*	3	*Y*	3	*Z*
8	2	*Z*	3	*Z*	2	*Z*
9	3	*Z*	2	*Z*	1	*Z*

In Table 3, can be seen that the batch size for the due date 20, 10 and 8 are the same, whereas different sequences generated. The cause of a different order is not sought in this paper.

The gantt chart for this case can be seen as follow:

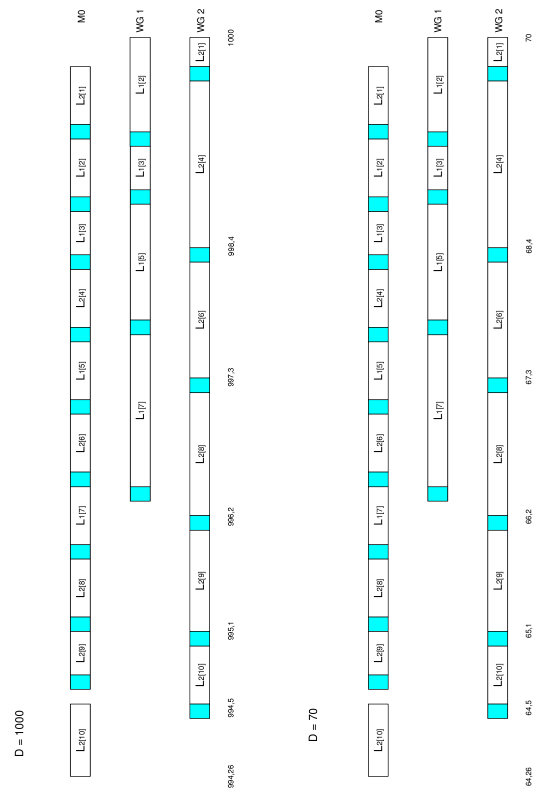

Fig. 1 Gantt chart for *d* 1000 and 70

Proceedings of ICIEBM 2010, Yogyakarta - Indonesia

ISBN : 978-602-97809-0-1

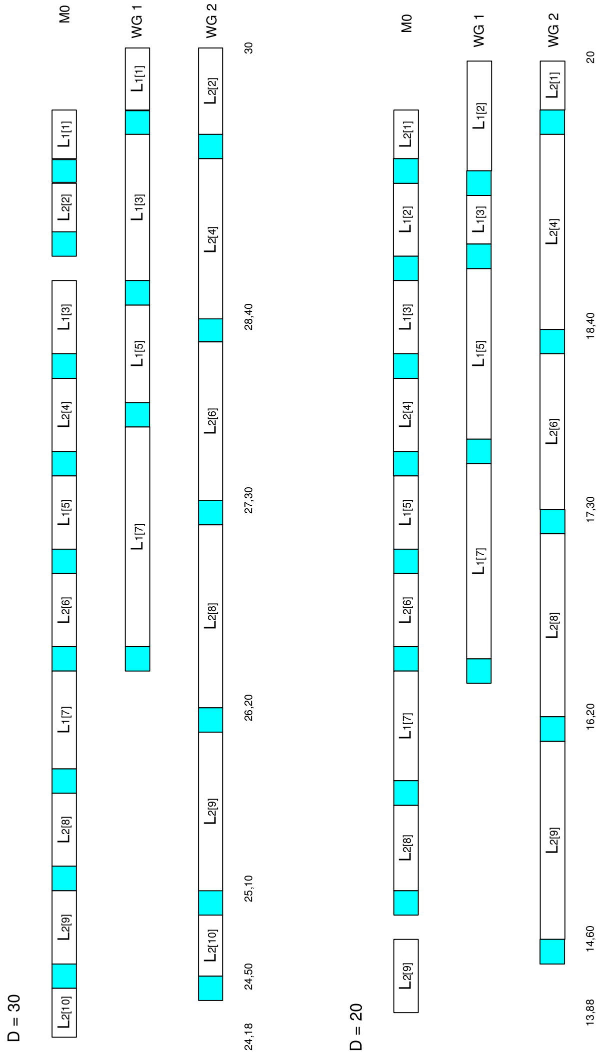

Fig. 2 Gantt chart for *d* 30 and 20

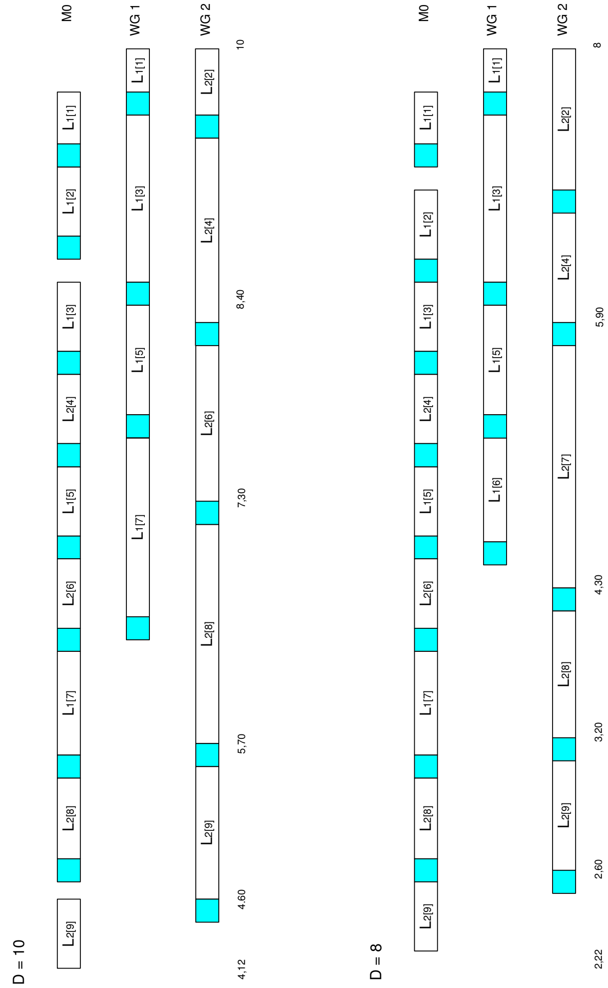

Fig. 3 Gantt chart for *d* 10and 8

V. CONCLUDING REMARKS

The batches can be obtained directly aligned to be processed at Stage 2 so that the waiting time of the machine is not too long. Based on this paper, the model proposed can be solving problems for the Stage 1 processing time is faster than the processing time in Stage 2 so that the waiting time in Stage 2 was not too long. This proposed model can solve the problems in the industry with time in the process of Stage 1 is greater than the processing time in Stage 2, but the results may not necessarily eliminate the waiting time in stage 2.

Based on testing, obtained model characteristic as follow: A type of product is not to be scheduled sequentially, but sorting can be done alternate with another product type; Batch sizes are produced must not have same size; When N_{maks} achieved, the escalation of due date will affect the sequence of batches produced.

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ISBN : 978-602-97809-0-1

Hydrodynamic effects during Waste cooking oil transesterification using CFD

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Abstract - **This work is presented as part of a preliminary study to model transesterification of Waste Cooking Oil (WCO). A Computational Fluid dynamics (CFD) technique was used to simulate flow of WCO in a 2 Litre reactor. A turbulent model of the Naviers Stokes' equation was used to solve the transient form of the equation for an axisymmetrical 2-D model and the effect of different impeller bottom distance and baffle were analyzed. Peak mean turbulence energy and dissipative energy rate were recorded at impeller bottom clearance *C*=0.23*T* for both baffled and unbaffled system. This provides a basis for a proposed dynamic modelling of transesterification WCO.**

Keywords - **Transesterification, waste cooking oil, CFD, mixing**

I. Introduction

The conversion of waste cooking oil (WCO) to biodiesel has presented the opportunity to prove the zero-waste property of the oil palm, particularly in Malaysia which is the leading producer of palm oil in the world. WCO, a by-product of palm oil, has little or no food value as a result of its degraded culinary properties, hence it has been advocated as a veritable biodiesel production raw material [1]. Mixing plays an important role during non-homogenous conversion of WCO to biodiesel [2-4], as the characteristics of mixing of non homogenous fluid varies due to changing rheological properties, hence the need to gain detailed knowledge of fluid flow in stirred tanks for transesterification of WCO.

Computational fluid dynamics (CFD) methods based on the Naviers–Stokes equation has become a powerful tool for studying fluid flow in stirred tanks and reactive mixing where turbulent models have been extensively used to investigate the complex flow structures for different impellers and baffle systems [5-7]. An advantage of CFD based method is that the fundamental equations governing fluid flow are solved for complex geometries and thus the scaling up and scaling down problems are reduced in order to arrive at an optimum mix. The mixing mechanisms are determined by variables such as impellers number and positions, impeller diameter/ vessel diameter ratio, bottom clearance, bottom shape, baffles and mixing intensity [2, 8-9]. Hence, with application of CFD hydrodynamics during reactive mixing are acquired [10] to establish its effect the on the kinetic of reaction [11].

Transesterification of WCO has been vigorous reported [1, 12-13]. The reaction terminates early, from observed laboratory studies [14], as a result of mass transfer and kinetics limitation [12, 15] and partly linked to the hydrodynamics during the mixing [2]. This has been understood, in part, to explain the early termination of transesterification of WCO. Reactor configuration has also been found to affect chemical reaction kinetics[16-17] with particular reference to baffle, impeller and speed of stirring [8, 18-19]. Curiously, among the various studies on transesterification, mixing seems to be least discussed.

Hence, the paper presents a numerical simulation of WCO flow in stirred tank using a 2-D model of a 2-Litre reactor for estimating kinetic data in transesterification of WCO. The Multiphysics coupling of the flow to the reaction is excluded from this presentation

II. Problem Definintion

In this work, the WCO flow is at described viscosity, density and temperature during transesterification [20-22]. The flow model combines the conservation of mass and momentum equations to develop the necessary flow equations describing the physical model used. The conservation of mass and momentum transport were modelled using the κ- ε model of Naviers Stokes' equation for incompressible fluid. This model is known to give better prediction of highly turbulent flows for Rushton impeller [23].

A. Governing Equations

The conservation of quantity φ is expressed as

$$\frac{\partial}{\partial t}(\rho\varphi) + \frac{\partial}{\partial x_i}(\rho u_i \varphi) = \frac{\partial}{\partial x_i}\left(\Gamma_\varphi \frac{\partial}{\partial x_i}\right) + S_\varphi \quad (1)$$

Where momentum, mass fraction, turbulent kinetic energy, mass, velocity are substituted for φ.

The flow is described by the Naviers Stokes' equation for incompressible fluid

$$\nabla.\text{u} = 0 \qquad (2)$$

$$\rho\left(\frac{\partial \text{U}}{\partial t} + \nabla.\left(U\text{U}\right)\right) = -\nabla\pi + \rho g + F \qquad (3)$$

$$F_{coriolis} = 2\omega V \qquad (4)$$

$$F_{centrifugal} = \omega \times \omega \times \overline{r} \qquad (5)$$

Where **F** in (3) for an axisymmetrical, 2D cross section represents the force acting thru radial (*r)* and axial (*z)* co-ordinates which are adopted as the body forces in the co-ordinates. Equation 4 and 5 accounts for the centrifugal and coriolis terms as a result of the rotating reference frame

For the closure of the equation, κ- ε turbulent model is employed, which describes turbulent flow using the effective viscosity and eddy viscosity assumption for a Newtonian fluid,

$$\eta_{eff} = \eta + \eta_T \qquad (6)$$

$$\eta_T = \rho C_\mu \frac{k^2}{\varepsilon} \qquad (7)$$

The momentum transport and continuity of the incompressible fluids in a transient state.

π, g and F are the molecular flux, gravitational and acceleration force respectively while the transport equations for κ-ε model are as follows;

$$\rho\frac{\partial \kappa}{\partial t} - \nabla.\left[\left(\eta + \frac{\eta_T}{\sigma_\kappa}\right)\nabla\kappa\right] + \rho\text{U}.\nabla\kappa = \frac{1}{2}\eta_T\left(\text{U}\nabla + \left(\text{U}.\nabla\right)^T\right)^2 - \rho\varepsilon \qquad (8)$$

$$\rho\frac{\partial \varepsilon}{\partial t} - \nabla.\left[\left(\eta + \frac{\eta_T}{\sigma_\varepsilon}\right)\nabla\varepsilon\right] + \rho\text{U}.\nabla\varepsilon = \frac{1}{2}C_{\varepsilon 1}\frac{\varepsilon}{\kappa}\eta_T\left(\text{U}\nabla + \left(\text{U}.\nabla\right)^T\right)^2 - \rho C_{\varepsilon 1}\frac{\varepsilon^2}{\kappa} \qquad (9)$$

For an axisymmetrical model the dependent variable related to the *κ-ε* model equation and the numerical values for the constants $C_\mu, C_{\varepsilon 1}, C_{\varepsilon 2}, \sigma_\varepsilon, \sigma_\kappa$ are as in [20]

B. Boundary conditions and reference frame

1) Impeller

This is specified as a sliding wall. All velocity components in the plane are zero, except that in the angular direction.

$$w_W = \omega \times r \qquad (10)$$

2) Cylinder surface

No slip condition applied stating that all velocity components equal zero:

$$\text{u} = (0, 0, 0) \qquad (11)$$

3) Axial symmetry

This specifies flow in the tangential direction of the boundary but not in the normal direction with radial velocity to zero [24] Referred for Equation 1 – 12

$$u = 0 \qquad (12)$$

III. CFD METHOD

Since vegetable oil kinetic studies are usually done in a laboratory reactor, a 2 litre stirred reactor with a Rushton impeller was employed, with WCO as the working fluid. The geometric details are as stated in table 1 and the stirring speed for the impeller was chosen based on previous optimized transesterification data [16, 24]. In this work, the reactor geometry is considered as rotationally symmetric. The velocities in the angular direction have a value different from zero, so the model included all three velocity components, even though the geometry is in 2D.

TABLE I

STIRRER REACTION CONFIGURATION

Impeller speed, rpm	600
impeller bottom clearance, *C* (mm)	0.*11T*-0.27*T*
Height, *H* (mm)	150
Tank diameter, *T* (mm)	130
Total Liquid Height*, L* (mm)	0.34*T*
Impeller Diameter, *D* (mm)	0.23*T*

The CFD flow simulation was carried out by discrediting the 2-D domain for fluid, impeller and baffle. At maximum mesh size of 0.003 and 474 triangular mesh elements was used for the discretizaton scheme. The flow solution was obtained by solving the governing equations in COMSOL Multiphysics 3.5 using the stationary segregated solver. All simulations were carried out on a Dell Inspiron Desktop equipped with an Intel (R) Core(TM) 2 Duo 2.80 GHz processor and 3GB of random access memory (RAM).

IV. RESULTS AND DISCUSSION

A. Hydrodynamics in Reactor

The simulated flow for the WCO (500g) was obtained using COMSOL Multiphysics. 3.5a for a baffled and unbaffled system. [9-10, 25] were referred guide for this model. The limitation of this 2-D model has been considered and represented as an approximate comparison.

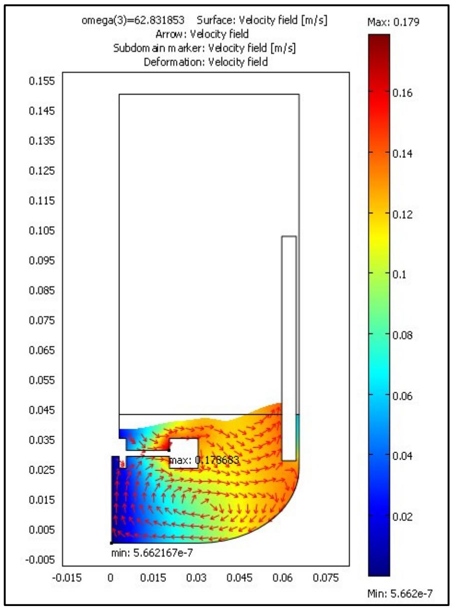

Figure 1: Simulated of swirl flow of WCO in 2L baffled reactor using Rushton impeller at C=0.23T

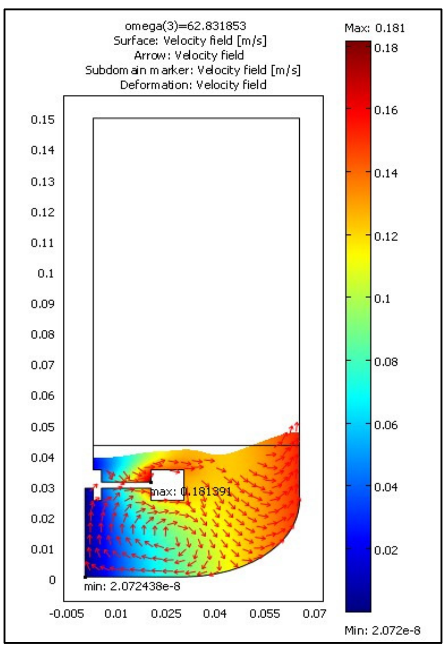

Figure 2: Simulated of swirl flow of WCO in 2L unbaffled reactor using Rushton impeller at C=0.23T

The limitation considered are that the WCO does not cover the entire volume of the tank like other works. There is no recirculation above the impeller (Figs 1 and 2) for this partially filled reactor compared to [9, 23] where a recirculation above the impeller is reported. Fig 3a is the axial velocity profile of the proposed model and in comparison Fig 3b [23] presents a degree of similarity.

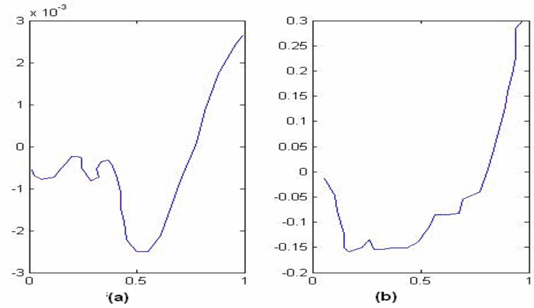

Figure 3: Comparison of axial velocity profile (a) present work, (b) Ochieng et al, 2008

B. *Tangential, radial and axial Velocity flow field*

This region of velocity measured is guided by [9] where the region closest to the impeller gave better simulation prediction. The velocity profile at $x=0.35T$ and $x=0.19T$ for impeller bottom clearance, 0.11T, 0.17T, 0.23T in the unbaffled system is presented in Fig 4. A similar trend was observed for the baffled system. The effect of clearance on tangential, radial and axial is as in Fig 5 for unbaffled system. The velocity peaked at the x=0.23T and dropped afterward. This was observed for both baffled and unbaffled system. This was as similarly reported in [23] where the systematic suppression of the lower circulation loop while decreasing clearance from 0.4T to 0.15T led to a loss in momentum as the fluid hits the bottom earlier before recirculation for reactor with liquid height .

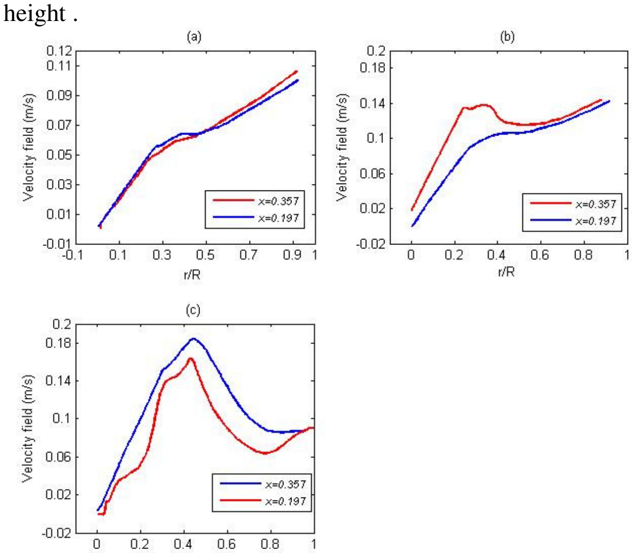

Figure 4: Axial velocity profile for unbaffled reactor above (x=0.35T) and below (x=0.19T) impeller at bottom distances, C (a) 0.11T (b) 0.17T (c) 0.23T

Although this is an axisymmetrical, 2D model, the trend of the radial profile is similar as with the axial velocity of [23]. The mean turbulent kinetic energy (maximum) and turbulent dissipation rate are also summarized in Fig 6.

In literature, the Rushton impeller generates two recirculation loops above and below it with the maximum velocity close to the wall or baffle [5]. Our model represents a WCO flow of less than 500 mL (< 50 mm liquid height). The recirculation loop is obviously only below the impeller and results in subsequent sloshing on the body the mixing. This profile is maintained after the initiation of impeller motion. The described circulation in the area below the impeller is only noticeable at x=0.223T in Fig 7 and 8 as reported in [9].

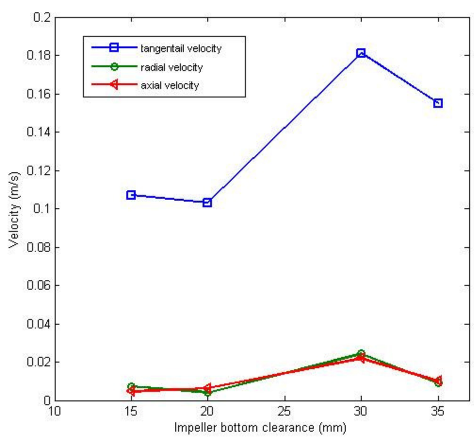

Figure 5: Simulated mean tangential, radial and axial velocity at impeller bottom clearance, C= 0.11T, 0.15T, 0.19T, 0.23T and 0.27T

V. CONCLUSION

The simulation carried out was used to understand the mixing flow in a 2 Litre tank for 500g of WCO. The 2 D axisymmetrical model was solved in COMSOL Multiphysics to show the hydrodynamic characteristics of the Rushton impeller at different impeller bottom clearance. Turbulent kinetic and dissipation rate energy peak at *C=0.23T* for both baffled and unbaffled system. While this information is part of a preliminary study and will be further compared and validated with other turbulent models, the information gathered would guide in modelling WCO transesterification where stirring is recommended for an extended period beyond the earliest completion time of reaction [14]. The stirrer might to be raised above this level, if not completely withdrawn to allow the glycerol layer to settle. The deliberate use of 500g WCO in the simulation was to be able to know the flow dynamics and use the solution for Multiphysics application of reactive flow simulation. Although, the 2-D model still requires further validation, this preliminary finding would be useful for multiphase mixing during WCO transesterification.

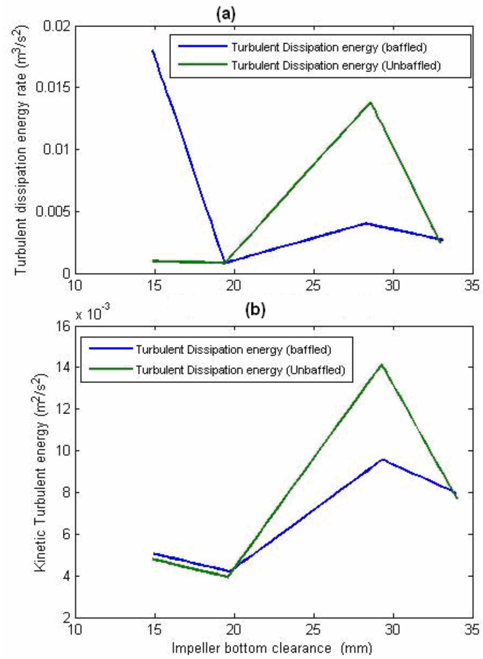

Figure 6: (a) Simulated mean turbulent kinetic and (b) dissipation energy rate for baffled and unbaffled reactor at C=0.23T

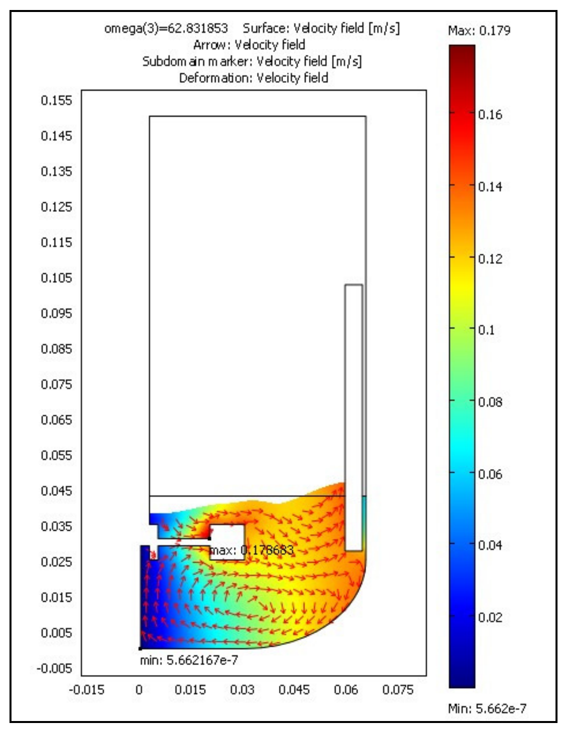

Figure 7: 2-D cross Section of Turbulent Swirl Flow of WCO in Unbaffled 2 Litre Tank at C=0.23T

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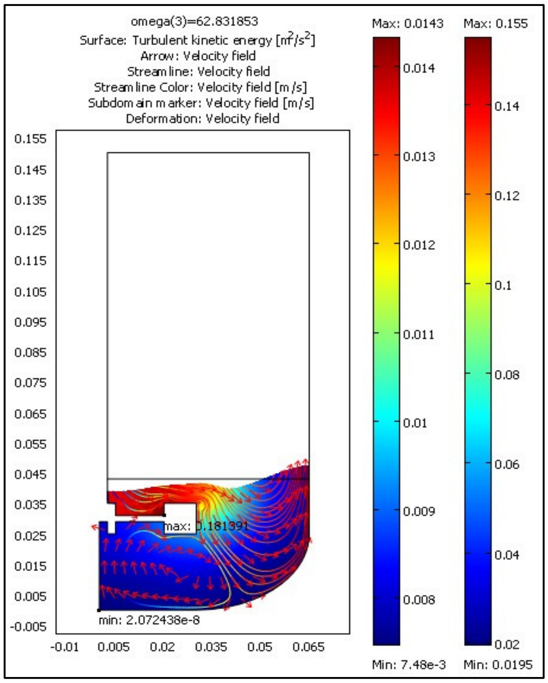

Figure 8: 2-D cross Section of Turbulent Swirl Flow of WCO in baffled 2 liter Tank at C=0.23T

APPENDIX. NOMENCLATURE

C	Impeller bottom clearance
F	Force
g	gravitational force
U	average velocity field
V	radial velocity
w	tangential velocity
r	tank radial co-ordinate
S_{φ}	Momentum Source
T	tank diameter
t	time
Greek symbols	
φ	**conservation quantity**
ρ	**density**
ω	angular velocity
μ	dynamic viscosity
κ	turbulent kinetic energy
ε	turbulent dissipation rate
η	kinematic viscosity
π	molecular flux
w_w	velocity

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

Impact of ERP system on productivity improvement: Case studies of four manufacturing companies in Malaysia

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Abstract - **The aim of this study is to investigate whether ERP investment brought productivity improvement to the organization as promised by the system provider. We used three productivity indicators adopted from the National Productivity Council of Malaysia. These indicators are competitiveness indicator, labour productivity indicator and capital productivity indicator. A total of four manufacturing companies were selected. These companies have been using ERP based systems for a minimum three years. Our findings showed mixed results. Of the three indicators, the labour productivity indicator had shown positive contribution whereas the remaining two indicators i.e. competitiveness and capital productivity had resulted in negative feedback. Generally, these indicators seem to show that the increase in labour cost was greater than the increase in the value-added created as a result of adopting an ERP system.**

Keywords — **ERP, productivity, competitiveness and benefits**

I. INTRODUCTION

The borderless world has created a lot of opportunities whereby business players can do businesses simultaneously in the local as well as international market. In the emerging knowledge-driven economy, IT instruments such as ERP plays a major role in enhancing economic growth. IT implementation always provides the competitive advantage in the effort to increase productivity and competitiveness. By utilizing IT efficiently, it will enable manufacturers to move to higher value-added activities and eventually provides the competitive advantage. ERP is a necessary tool for organizations to compete domestically and internationally. Without it, an organization may stand to lose its market share to competitors who are more aggressive [1] and [2]. A study conducted by National Productivity Council (NPC) in 2001 revealed that only 27.1% of respondents in manufacturing companies in Malaysia adopted ERP. The Malaysian Government through its agencies such as Malaysian Industrial Development Authority (MIDA) and Malaysian Trade and Development Corporation (MTDC) always encourages local firms to adopt Information Communication Technology (ICT) based technologies such as ERP. By incorporating this latest technology, it will further enhance efficiency and competitiveness of the local firms. To achieve this, there are several aids, funds and incentives promoted by the government.

II. RESEACH OBJECTIVE

Productivity measures the extent to which the given inputs are transformed into outputs [3]. Higher productivity means accomplishing more with the same or lesser amount of input resources. Productivity management is primarily concerned with improving operations and processes, through motivation as well as monitoring performance in order to achieve competitiveness. Various ways of measuring productivity have been used because good productivity management requires good productivity measures. The objective of this research project is to evaluate ERP performance according to productivity indicators for selected companies which successfully adopted ERP based systems.

III. RESEARCH QUESTION

ERP providers make many promises to their clients who adopt their ERP systems. Potential benefits include ease of use, integration of all functions in the organization, timely information, better communication, improved process times and reduced operating cost [4]. Are these true for local companies? So we propose this question to be answered: Are there any benefits obtained from ERP implementation?

ISBN : 978-602-97809-0-1

IV. LITERATURE REVIEW

Many researchers found that it was quite difficult to evaluate the contribution of IT based investment to business performance as well as to find reliable ways to ensure that the business benefits from the investments [5], [6] and [7]. Determining and investigating ERP benefits is important for a number of reasons. O'Leary [8] in his research on ERP's benefits reported that basically, there were three reasons as follows:

- It allows firms to investigate the alignment between their needs and what an ERP system can do.
- Establishing ERP benefits provides a basis or a benchmark for setting expectations for other ERP implementations.
- Once we understand what ERP benefits are likely to be experienced, then those potential benefits can be used as a basis to set up measurements for those benefits.

There were several approaches used by previous researchers to study on ERP benefits. These approaches included archival financial data analysis [2] and [9]; interviews [10] and [11]; and content analysis [12], [8] and [13]. ERP is widely perceived to hold the potential for significant improvement in business processes, customer responsiveness, and strategic decision making. By computerizing the processes, the company is expected to reduce costs through efficiency and enhance decision making by providing accurate and timely enterprise-wide information [2]. The use of financial indicators based on financial statements is very popular among the investors. In relation to this, Poston and Grabski [2] investigated whether ERP implementation is associated with improved financial performance. They carried out a survey of 62 companies from the Fortune 500. Results indicated a significant increase in costs as a percentage of revenue but a decrease in the number of employees as a percentage of revenue during the year after ERP implementation. The results also indicated a paradox where firms having fewer employees supporting more revenue simultaneously experienced higher cost to revenue ratios after their ERP implementation. ERP implementation was not found to be associated with changes in Residual Income (RI) within one, two or three years after ERP implementation.

A further extension of ratios from the ones used by Poston and Grabski was computed by Hitt *et al.* [9]. Using financial data, Hitt *et al.* [9] calculated nine ratios to measure business impact and productivity as a result from ERP investment. These ratios computed to determine value added, output and market value of the companies. The findings revealed that firms that invest in ERP tend to show higher performance across a wide variety of financial metrics. Even though, there is a slowdown in business performance shortly after the implementation, financial markets consistently reward the adopters with higher market valuation.

Beard and Summer [14] studied whether ERP systems can provide an organization with a sustained competitive advantage. They argued that ERP systems commonly applied the same set of applications supporting business operations. Therefore, if all companies use SAP software, then there will be no competitive advantage between one company to another company because all are using the same platform. Beard and Summer [14] found that there was no evidence that an ERP system reduces a firm's costs below what would have been the case if the ERP system was not implemented. They also found that the implementation of an ERP system would not assure a competitive advantage, but rather assures competitive parity. In contrast, companies without an ERP may find themselves at a competitive disadvantage.

Ross and Vitale [10] found that ERP provided both tangible and intangible benefits. Based on an interview of 15 companies in Europe, the respondents identified tangible benefits such as reduced reporting cycle, more accurate data especially bill of materials (BOM), reduced inventory by 30%, increased order fill rate, reduced logistic expenses, reduced manpower and reduced working capital. Apart from that, intangible benefits encountered were simplified systems support, increased flexibility to adapt to external changes such as the adoption of Euro, increased system reliability and improved sales force morale [10]. However, they also found that instilling discipline into relatively undisciplined organizations was a major challenge in implementing ERP systems successfully.

Matolcsy *et al.* [13] obtained financial information to compute seven financial ratios. Two different timeframe namely three years before ERP adoption and two years post ERP adoption were used. It was found that both univariate and multivariate tests indicated the adoption of ERP systems leads to sustained operational efficiency and improved overall liquidity [13].

In general, the financial ratios were the most popular approach used by the researchers [9], [13], [2] and [11]. The summary of financial ratios used is presented in Table 1.

TABLE 1

LIST OF FINANCIAL RATIOS QUOTED IN THE LITERATURE

No.	Ratio	Researcher
1.	Labour productivity	Hitt *et al*., 2002
2.	Return on assets	Hitt *et al.,* 2002
3.	Inventory turnover	Hitt *et al.,* 2002; Matolcsy, 2005
4.	Return on Equity	Hitt *et al*., 2002
5.	Net profit margin	Hitt *et al*., 2002; Matolcsy, 2005; Gefen and Ragowky, 2005
6.	Fixed asset turnover	Hitt *et al*., 2002; Matolcsy, 2005
7.	Sales days outstanding	Hitt *et al*., 2002; Matolcsy, 2005
8.	Debt to equity	Hitt *et al.,* 2002
9.	Tobin's q	Hitt *et al*., 2002
10.	SG&A/revenues	Poston and Granski, 2001

11.	COGS/revenues	Poston and Granski, 2001
12.	Number of employees/revenues	Poston and Granski, 2001
13.	Residual income	Poston and Granski, 2001
14.	Account payable days	Matolcsy, 2005
15.	Current ratio	Matolcsy, 2005
16.	Sales change	Matolcsy,2005

V. RESEARCH METHODOLOGY

Four manufacturing companies were selected for this research. These four manufacturing companies were chosen based on the following criteria:

- They must have adopted their ERP system for at least three years.
- The selected companies must be from manufacturing industry.
- The availability of financial statements for two or three years prior and three years post ERP implementation.

In this research, we applied productivity indicators as used by National Productivity Centre or better known as NPC of Malaysia. These indicators are competitiveness, labour productivity and capital productivity. The details of these indicators such as how these are calculated, the symbols used and what these indicators indicate are explained further below.

A. Productivity Indicator: Competitiveness

Competitiveness in terms of labour cost indicates the comparability of the industry in churning out products or services at the lowest possible labour cost. It is assumed that once ERP has been successfully adopted, the labour cost would reduce or would not increase substantially despite the company growing or the product demand increasing. There are three indicators under competitiveness as shown in Table 2. For added value, the calculation is based on profit before tax plus finance cost, plus depreciation,

TABLE 2

THREE COMPETITIVE INDICATORS AND ITS DESCRIPTIONS

Indicators	Description
(1) Labour Cost Competitiveness (LCC) *Formula:* = Added Value / Labour Cost	This ratio indicates how competitive the enterprise is in terms of labour cost.
(2) Labour Cost per Employee (LCE) *Formula:* = Labour Cost / Total Employees	This ratio measures the average remuneration per employee.
(3) Unit Labour Cost (ULC) *Formula:* = Labour Cost / Total Output	This ratio indicates the proportion of labour cost to total output.

B. Productivity Indicator: Labour Productivity

Primarily, this ratio is the amount of "wealth" created by each employee in the organization. In other words, labour productivity measures the efficiency and effectiveness of each employee in generating added value or total output. By investing in IT, it saves time and improves the control of the firm for the owners, employing less agents or employees to manage the firm [15]. There are two widely used indicators to compute this productivity. The indicators are shown in Table 3.

TABLE 3

TWO LABOUR PRODUCTIVITY INDICATORS AND ITS DESCRIPTIONS

Indicators	Description
(1) Labour Productivity (LP) *Formula:* = Added Value / Total Employees	Reflect the amount of wealth created by the company, relative to the number of employees it has.
(2) Total Output per Employee (TOP) *Formula:* = Total Output / Total Employees	The size of output generated by each employee of the enterprise. Gives an indication of efficiency. A high ratio reflects a good business strategy such as efficiency in value chain processes and vice-versa.

C. Productivity Indicator: Capital Productivity

This productivity indicator reflects the degree of efficiency in assets utilization and investment. As far as ERP is concerned, once the company adopts an ERP system, the system should be able to contribute positively in generating value to the organization. For this study, the Fixed Assets considered for computation are those fixed assets where ERP related costs are included only. That means fixed assets such as land, machinery, building and motor vehicles are not included. There are three types of productivity ratios which can be used to measure capital productivity. Table 4 indicates three capital productivity indicators and its descriptions.

TABLE 4

THREE CAPITAL PRODUCTIVITY INDICATORS AND ITS DESCRIPTIONS

Indicators	Description
(1) Capital Productivity (CP) *Formula:* = Added Value / IT Equipments	This ratio indicates the degree of utilization of IT Equipments particularly ERP components.
(2) Capital Turnover *Formula:* = Total Output / IT Equipments	This ratio indicates the efficiency of capital utilization and of business strategy mechanism.
(3) Capital Intensity (CI) *Formula:* = IT Equipments / Total Employees	This ratio indicates whether an enterprise adopts a capital intensive or labour intensive policy.

ISBN : 978-602-97809-0-1

VI. FINDINGS

A. Introduction-Case A

Case A is a printing company located at Ampang/Hulu Klang area in Selangor. The company uses Pronto (which is based in Australia) as their ERP business solution. The Pronto system was purchased locally but the software originated from Australia. The cost of Pronto investment is approximately RM 400,000. As of December 2006, there are 30 users and 4 points of sales. The maintenance fee per year is RM 50,000. This system has been operational since June 2004.

1) ERP's Benefits : Productivity Indicators

The calculated productivity indicators for Case A are shown in table 5 and follows by explanation below.

TABLE 5

PRODUCTIVITY INDICATORS FOR THE PERIOD UNDER REVIEW

Ratio	Average 3 years Pre-ERP RM	Average 3 years Post-ERP RM	Variance
LCC	2.16	1.66	(23.1%)
LCE	32.70	61.12	86.9%
ULC	0.18	0.19	5.5%
LP	72.27	99.51	37.7%
LCE	223.38	332.76	49.0%
CP	13.71	9.25	(32.5%)
CT	41.16	30.76	(10.4%)
CI	5.06	10.81	113.6%

a) Competitiveness

As a whole, the company needs to address its employee costs contribution to the organization. The company needs to increase the productivity of their employees so that the increment in its labour cost could be justified. The ratios above show that:

- There was a jump in cost per employee from RM 32.70 prior to Pronto to RM 61.12 post Pronto implementation. Unfortunately, the increase in its labour cost did not commensurate with the value added created.
- There was a slight increase in ULC indicating that the company could be lacking skilled workers.

b) Labour Productivity

Based on the information supplied, there were no significant changes in the number of employees in the period under review. On average, about 388 employees were employed in Case A prior to the Pronto implementation and the number increased slightly to an average of 405 employees after Pronto implementation. Although total sales per year increased, the company was able to maintain the worker numbers as a result of the IT system being put in place. The LP ratio recorded an increase of 37.7% from RM 72.27 to RM 99.51 per employee. At the same time, the ratio for LCE also increased by 49.0%. These figures indicated that Case A was able to increase its employee productivity in terms of generating value-add to the products as well as the total output sold. However, the ratios are still below almost half the cost of employing a new employee. Efforts must be continuously made to enhance employee efficiency in the future by providing training and deploying more IT based system.

c) Capital Productivity

According to the ratios computed as shown in the Table 4.1, Case A underutilized its assets in generating value for them. Both ratios in CP and CT decreased 32.5% and 10.4% respectively post Pronto implementation. Even though as evidenced in the CI ratio, the company had invested 113.6% in capital, the company was somehow unable to utilize it to the maximum possible.

B. Introduction-Case B

Case B is listed on the Kuala Lumpur Stock Exchange's main board. It is a manufacturing company that sells its products locally and abroad.. Case B has always placed a strong emphasis on quality in all aspects of its operation, from producing manufacturing to the provision of service and support to its valued customers. Case B is fully committed to continuous evaluation and improvement

2) ERP's Benefits: Productivity Indicators

The figures below are derived from Case B's Annual reports for financial years 1999 to 2002. The first two years namely 1999 and 2000 represent the years for pre-ERP adoption and the remaining three years represent post-ERP adoption.

Based on the data in Table 6, the following explanation can be made on three productivity indicators namely competitiveness, labour productivity and capital productivity.

TABLE 6

COMPETITIVE INDICATORS RATIOS OF CASE B

Ratio	Average 2 years Pre-ERP RM	Average 3 years Post-ERP RM	Variance
LCC	3.25	3.02	(7.1%)
LCE	22.33	28.05	25.6%
ULC	0.13	0.13	0.0%
LP	72.51	84.59	16.6%
TOP	177.08	216.05	22.0%
CP	8.04	7.40	(7.9%)
CT	19.63	18.90	(3.7%)
CI	9.02	11.43	26.7%

a) Competitiveness

The post adoption ratio is lower than the prior ERP adoption figures. Even though, the added value for the company on the overall increased by 10.4%, the increase in percentage for labour cost is higher (18.7%). A low ratio indicated that Case B's value added creation did not commensurate with its labour cost. However, the increase in labour costs was also contributed by other external factors such as inflation and the living standards for the betterment of their employees especially over the long term.

ISBN : 978-602-97809-0-1

b) Labour Productivity

The two ratios as presented in Table 6 indicated that in terms of labour productivity, employees in Case B was more productive after ERP implementation even though the number of employees employed had declined from 792 to 746 employees.

c) Capital Productivity

The results shown in Table 6 indicated that even though the company made a huge capital investment which increased from RM 9.02 to RM 11.43 per employee, the company failed to fully utilize the potential of its assets. The percentage reduction for both CP and CT ratios which both recorded negative percentages needs to be addressed by the company. Efforts must be immediately taken to increase its asset utilization as well as its efficiency.

C. Introduction-Case C

Case C is listed on the Second Board of Bursa Malaysia. It was incorporated in Malaysia in 1983. The principal business of Case C is poultry farming which has been able to produce approximately 950,000 eggs per day, 4,100,000 broilers per annum and 1,000 metric tons of organic fertilizer per month.

3) ERP's Benefits: Productivity Indicators

Table 7 is derived from Case C's annual reports and subsequently the following rationalization can be made.

TABLE 7

COMPETITIVE INDICATORS OF CASE C

Ratio	Average 3 years Pre-ERP RM	Average 3 years Post-ERP RM	Variance
LCC	1.85	1.89	2.2%
LCE	16.01	18.29	14.2%
ULC	0.09	0.09	0.0%
LP	29.56	34.63	17.2%
TOP	169.18	213.13	26.0%
CP	6.28	6.96	10.8%
CT	35.94	42.82	19.1%
CI	4.71	4.98	5.7%

a) Competitiveness

The post adoption ratio is higher than the prior ERP adoption ratio. The increase in added value for the company is slightly higher than the increase in labour cost. Overall, there is a positive contribution of Case C's added value as compared to labour cost. The LCC ratio registered an increase by 2.2%. On average, there was a 14.2% increase in the labour cost per employee. The increase is in tandem with the yearly salary increment and other costs such as medical benefits, bonus, EPF contribution, etc. However, the ULC maintained at RM 0.09 showed that Case C was successfully able to optimize its manpower to generate sales for the company.

b) Labour Productivity

There is a favourable increase in labour productivity in Case C in the prior and post ERP adoption. Being a company that continuously strives to maximize the use of its resources through innovative means as stated in the annual report, productivity among the employees has shown a 17.2% increase from a ratio of RM 29.56 (pre-ERP) to RM 34.63 (post-ERP). The Prior ERP adoption figures show that total output per employee was only at an average of RM 169.18 ('000) but with ERP being put in place, Case C's output per employee jumped up to RM 213.13 ('000), recording an increased by 26.0%.

c) Capital Productivity

Post ERP implementation shows an upward trend recording a positive variance of 10.8%. This means that Case C is efficient in utilizing its IT based assets to generate its value chain in producing goods for customers. Looking at an improved post ERP ratio (RM 42.82) compared to the prior ERP ratio (RM 35.94), the management of Case C had achieved efficiency after ERP implementation in the area of capital utilization supported by a good strategy plan. As indicated in its annual reports, Case C continuously invested in automation and technology in order to improve its business processes and hence servicing customers better. As a result of their continuous investment in automation and technology, the capital intensity ratio had shown an increase from RM 4.71 (pre-ERP) to RM 4.98 (post-ERP).

D. Introduction-Case D

Case D which was incorporated in 1985, is today the largest aluminium products manufacturer in Malaysia and one of the largest in South East Asia. The company is listed on the main board of the Bursa Malaysia.

4) ERP's Benefits: Productivity Indicators

The figures in Table 8 are derived from Case D's annual reports for financial years 2000 to 2005. The first three years namely 2000, 2001 and 2002 represent the years for pre-ERP adoption and the remaining three years represent post-ERP adoption. Based on Table 8, the following explanation can be made.

TABLE 8

COMPETITIVE INDICATORS OF CASE D

Ratio	Average 3 years Pre-ERP RM	Average 3 years Post-ERP RM	Variance
LCC	2.94	2.74	(6.8%)
LCE	21.22	27.17	28.0%
ULC	0.08	0.08	0.0%
LP	62.42	74.51	19.4%
TOP	267.78	337.90	26.2%
CP	16.31	10.49	(35.7%)
CT	69.91	47.08	(32.6%)
CI	39.40	72.59	84.2%

a) Competitiveness

The aluminium business has a limited value chain. As a result, the post ERP LCC ratio decreased from RM 2.94 to RM 2.74 which is a 6.8% reduction from the Pre ERP adoption figures. In tandem with the reduction in LCC, the cost per employee rose from RM 21.22 (pre-adoption) to RM

27.17 (post-adoption). The increasing cost of obtaining local workers to work also contributed to this problem. However, the ULC still maintain at RM 0.08 per output. Nevertheless on the whole, the company's competitiveness in terms of labour had decreased and Case D should take corrective measures to overcome this.

b) Labour Productivity

Even though, the cost per labour increased as shown in Table 5.15, the productivity per employee had increased. A 19.4% increment was seen between the pre ERP adoption and the post ERP adoption. In line with the positive growth in labour productivity, the TOE also increased from RM 267.78 (pre-ERP) to RM 337.90 (post-ERP) registering an increased by 26.2%.

c) Capital Productivity

In terms of capital utilization, Case D failed to utilize the availability of its fixed assets judging from a reduction of 35.7% between pre and post ERP adoption figures. A negative variance was also recorded for CT which reduced from RM 69.91(pre-ERP) to RM 47.08 (post-ERP). Nevertheless, based on the calculated ratio, Case D has embarked on capital investment extensively in order to reduce its dependency on labour especially for the long term benefits. As shown above, a jump of 84.2% increment was recorded after Case D implemented their ERP system.

VII. CONCLUSIONS

As for objective benefit which is measured in the form of productivity indicators, the study showed mixed results. Of the three components, the labour productivity component had shown positive contribution whereas the remaining two components namely competitiveness and capital productivity had resulted in negative feedback. Generally, these indicators seem to show that the increase in labour cost was greater than the increase in the value-added created as a result of adopting an ERP system. These might be due to the companies failing to fully utilize all the modules in their ERP system. For example, in Case A and Case B, they only utilized the financial module of their ERP system fully as compared to other modules available in their ERP system. The findings from our previous survey [16] also revealed that 84.2% of companies utilized the financial module more than other modules available in their ERP system. We have to take cognizance of the fact that the financial module of an ERP system does not directly affect the output from the operations of the business activities such as supply chain and the actual manufacturing process are the reasons why ERP was adopted in the first place. The financial module for them is perhaps more towards providing the statistics and information and to assist in making expedient decisions. Another reason could be that in the manufacturing industry, not all end products are highly dependent on technology devices as in other sectors such as in the financial services sector.

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ISBN : 978-602-97809-0-1

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Proceedings

The International Conference on Industrial Engineering and Business Management 2010

CHAPTER 12 : Intelligent and Expert System (IES)

editor :
Arya Wirabhuana, Muchammad Abrori, Kifayah Amar

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ISBN : 978-602-97809-0-1

Machine Vision System for Automatic Grading of Pineapple Maturity Index

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Abstract - **Machine vision system is widely used in agriculture industry particularly in a sector that produce high production yield such as oil palm, corn and wheat plantation. Implementation of automation technology in any sector can contribute the increasing of productivity. As the machine is widely used in agriculture, we proposed a vision system technology to grade a pineapple index based on maturity colour processing. The system known to be replaced the manual grading by labour workers and will result better performance of index grading for pineapple export. According to Malaysia's Best standard produced by Federal Agricultural Marketing Authority (FAMA), pineapple maturity was graded into seven indexes and it is very important to ensure that the export quality meet the international standard which depending in which country the fruits are exported. Manually inspection of maturity index is known to be inefficient due to human factors. This may lead to misjudgement of maturity index and affect the quality of pineapple for export. On top of that, we present an automated pineapple maturity inspection using colour identification process which is based on image processing technique. The acquire image has been processed by using RGB filtering technique and we applied feature extraction method to mine yellowish colour of the fruits. The colour algorithm was successfully developed to represent unique features of indexes of pineapple and has been used as an input to the linear classification technique. More than 1000 images of each index as well as video recording image have been tested and we obtained a promising result above 90% accuracy. In the final stage, the yellowish colour algorithm has been integrated with the overall prototype systems which consist of conveyor, CCD camera and sorting bin.**

Keywords - **Machine Vision, Pineapple, Image Processing**

I. INTRODUCTION

Malaysia is one of the main pineapple exporters in the world together with Thailand, Philippine, Indonesia, Hawaii, Ivory Coast, Kenya, Brazil, Taiwan, Australia, India and South Africa [1]. Pineapple is the most significant among variety of fruits in Malaysia besides durian and mango. Only Philippine and Malaysia are the countries from the Asian continent that listed among eleven countries which have exported fresh pineapple for years. These two countries provide about 15% of the total of world fresh pineapple for export. Under East Coast Economic Region (ECER), Malaysian government has allocated 7,400 hectares supposed for pineapple development in Pekan Pahang which may help Malaysia regain its dominance as the world's top three pineapple producers as in the 1960s and 1970s [2].

The pineapple will be harvested during its firm and matured. The quality of pineapple is relying on the percentage of maturity and ripeness to suit the market demanding. For domestic market, pineapples should be harvested whenever its maturity closes to full ripeness, which is at the one-half yellow external surface colour. Fruit intended for the export market should be picked up at the quarter-yellow colour stage and will be necessary to expeditiously move the product from the field to the packaging house and then to the airport as soon as possible. For long distance transportation, it will be firmer and better if the fruits picked about less than one quarter yellow. The fruit grading process is according to size, condition and maturity must be done as soon as possible where it should be ideally packed for market within a day of harvest. So, the technology must be used to implement new device and application that can help to overcome this problem.

Traditionally, index of maturity inspections are done by labour workers by referring to its skin colour. Serious misjudgement frequently occurs at index of maturity two and three due to very little differences between these two indexes. Requirement for index two needs all scales of green with tinge of yellow between the scales at the base, the bracts are dry and whitish while index three required one to two scales are yellowish green at the base [3]. Therefore, it requires a very experienced worker to conduct pineapple maturity grading. Labour shortages and lack of overall consistency in the process resulted in a need to search for automated solutions, especially to meet the quality requirement. In order to automate the index of maturity testing, a non-destructive test using colour identification is seen as a potential solution.

Recently, many research projects have been ran to develop non-destructive fruit quality inspection grading either by using machine vision image processing or artificial intelligent which used to focus on fresh fruits such as papaya [4], apple [5], pineapple [6], star fruit [7], olive [8], oil palm fruit bunch [9], mango [10] and so forth. With the computing cost become cheaper nowadays, it is possible to develop an affordable vision based system to test the maturity of pineapple according to its colour [11, 12, 13].

II. METHODOLOGY

In image processing analysis, there are a few step must be taken to analyse the acquired data. Generally the main part of processing is data acquisition, pre processing, processing, classification and decision. In this project, we are intending to analyse the colour of pineapple that contributes to the decision of classification. The amount of yellowish on the pineapple surface can be used as a guide to determine its maturity .There are 7 indexes that used to classify the maturity of pineapples but in this research, only index 2 until 7 are considered. Index 1 is negligible because it is for immature fruit and should not harvest at the plantation.

Figure 1 shows the overall process of system development of pineapple maturity index classification. Data are collected from one of the pineapple orchards at Simpang Renggam, Johor and Pekan, Pahang, Malaysia. Total of 1000 images of pineapple at different angle was taken as a database to develop the system.

A. Data Acquisition

Database development that consists of pineapple image is the important stage to ensure reliability of the system. We have to ensure that the acquired data must cover all the possibilities of real time system implementation. The lack of data collection would affect the system efficiency. In this paper, digital camera with 5 megapixels resolution has been used to capture the still images and video recording images. The lowest resolution used to record the image which will make the processing of image not consume much time.

The second stage in image analysis is to apply pre processing technique. To guarantee that only a good image can be process in the next stage, filtering technique was used to produce a good and clean image. Next, colour processing method has been used to identify the percentage of yellowish of pineapple. The percentage of yellowish can be extract using morphological measurement whereby only the desired value is produce which is can be use at the final stage of classification.

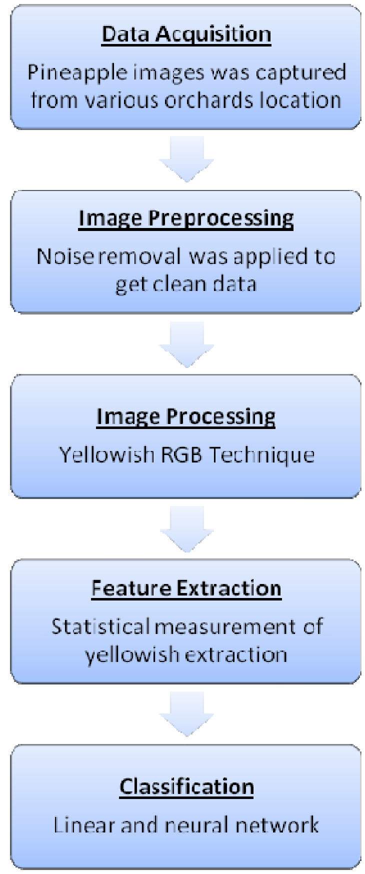

Fig. 1 Process of pineapple maturity index inspection

B. Pre processing and Colour measurement

The key task of pre processing is to improve the image in ways that can increase the chances of success of the subsequent processes [14]. It will process raw data to prepare for another processing procedure and transform all the data into a format that would be more easily and effectively processed for analysis. In pineapple maturity index, the yellowish increases which begin at peduncle and end at top as the maturity increases (*fig 2*). Therefore maturity index levels are recognizing through these features. Images are represented as RGB format and yellowish are identified based on pixel value of colour component as shown in table 1.

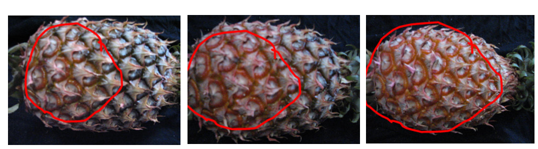

Fig. 2 Yellowish increases as index increases

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TABLE I GROUP PIXEL VALUE OF COLOR COMPONENT

Colour	Digital image representation
Red	90 -110
Green	60-80
Blue	40-60

Figure 3 shows the detail steps of colour processing images. Firstly, the pineapple images has been analysed to define its RGB pixel values. The output of RGB must be in form of matrix to make sure that it can be used in neural network application.

Fig. 3 Step of colour processing

The pineapple images will be store in different folder for different index which from index 2 until index 7. All the pictures are classified by each index to use them for data training. Every picture in each index will be processed to get sum of pineapple yellowish colour pixels. One feature that can be extracted to discriminate the pineapple classes is by processing its colour. All the classes can be differentiated by analysing its components of colours. By referring to the concept of RGB, image is a combination of gray values with three arrays that represent red, green and blue.

The pixel value which is not in red has been removed from the image. Morphological method was applied to the gray images so that the index of pineapple can be distinguished.

C. Feature Extraction

In image processing analysis, any technique applied will produce an output in a form matrix value. The values either in gray scale or integer numbers represent the method used. Normally, the output that produced by the technique are difficult to analysis due to the large data obtained.

Besides, normally digital image have a disturbances (noise) and need to remove. These are due to the illumination and reflectance. Illumination is the amount of source light incident on the scene being viewed [11]. Major illumination comes from random noise (movement of electron) inside fluorescence light and camera flash especially while capture data at laboratory. Reflected light tends to be soft and to have a colorcast (created because the light picks up the color of the object from which it is reflected). The softness of the light is a result of two primary factors. First, the reflected surface is often quite large and close to the image. Second, the surface of the reflecting object is often very rough.

On top of that, a feature extraction technique must be introduced to minimize the number of data and noise so that it will contribute more efficient to the classification measurement. In our study morphology has been used to implement feature extraction strategy. Morphology eliminates unnecessary data and noise using region filling technique. Morphology is a non-linear process used to manipulate binary images. It process image based on shape. Morphological operations apply a structuring element to an input image, creating an output image of the same size. In a morphological operation, the value of each pixel in the output image is based on a comparison of the corresponding pixel in the input image with its neighbors. There are four basic morphological operations, which are erosion, dilation, opening and closing. Erosion and opening operation are chosen to achieve the desired outputs. The erosion technique changes every object pixel that is touching a background pixel into a background pixel, hence make the objects smaller. Morphology filter widely use in machine vision to removes unwanted features [3, 9].

The erosion of A(image) by B(structuring element) is the set of all structuring element origin locations where the translated B has no overlap with the background of A. Mathematically erosian is defined as;

$$A \Theta B = \{ z \mid B_z \cap A^c \neq \emptyset \} \qquad (1)$$

In order to smooth the object's border, opening operations is the best to removes small islands and thin filaments of object pixels. Opening morphology are done using

$$A \circ B = (A \ominus B) \oplus B \qquad (2)$$

where Θ and denote erosion and dilation, respectively [12]

III. RESULT AND DISCUSSION

Overall process to analyse yellowish of pineapple is started with data acquisition, pre processing and colour analysis, feature extraction and classification. In order to determine colour content of pineapple, we analyse RGB component and choose the best threshold value to represent maturity index. Table 2 shows the pixel values that represent colour of RGB. Pixels with a value out from threshold (table 1) remain maintains, while pixels with a value in range of threshold are set to logic 0. This process will allow the desired features and remove others. Measuring of pixel value is a part of feature extraction process. Morphological analysis is a process to convert pixel value from gray level to logical value. The output of morphological analysis is shown in figure 4. Colour processing technique has been used to remove the entire colour except yellow and morphological analysis was applied to the output of yellowish colour to produce only black and white values.

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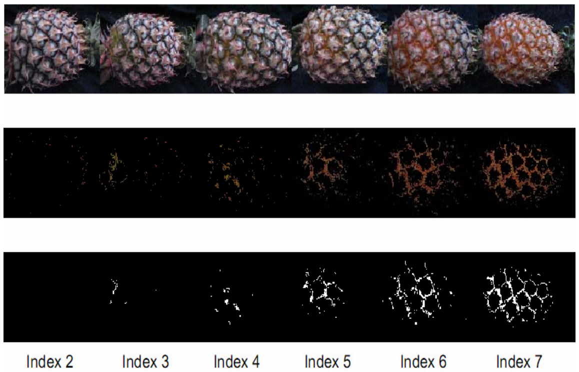

Fig. 4 Morphological process

Morphological analysis which is produced black and white values shown significantly different between each indexes. Measurement of BW values has been recorded and used as an input to classification tools. From the figure 4, it is clearly seen that each index of pineapple can be classify based on morphological measurement.

As mentioned above, the pineapple fruit can be classified in three classes supposed for export, local market and not for market. All these classes can be distinguished by looking at the total of yellowish colour. Fig 5 shows the graph of pixel values of index 2. From the graph we found that the sum of pixel value is in range of 400 pixels.

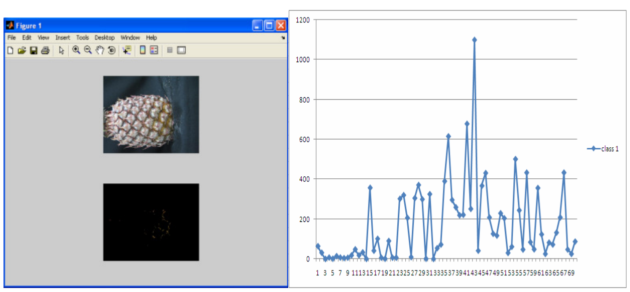

Fig. 5 Histogram of gray level of index 2

Fig 6 shows the graph of pixel values for index 5. We can see that, the average number of sum pixel value is between 400-800 pixels.

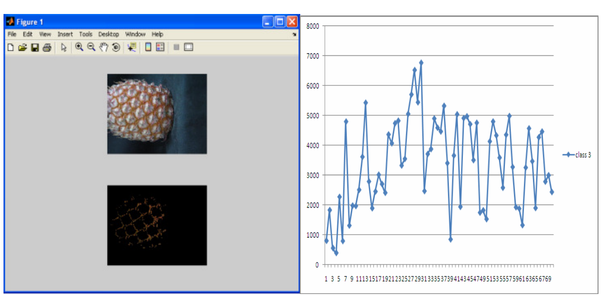

Fig. 5 Histogram of gray level of index 5

For this class, it is unsuitable either for export or local market. The texture of the flesh will be flaccid, less desirable flavour due to excess sugar content coupled with decreased acidity. Not suitable for export because fruit will be more susceptible to bruise damage at the full yellow stage.

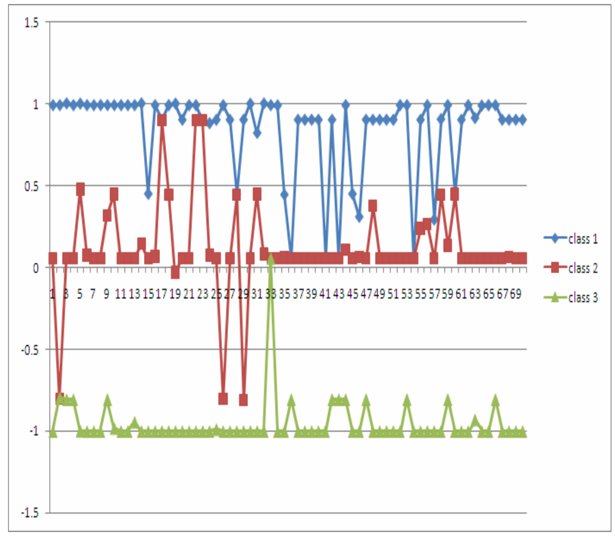

Fig. 7 Pixel value of morphological image of each class

Measurement of all class on its pixel value has been done and shown in Fig 7. From the plot graph, we found that each class has fall in three different groups. The feature vector of BW values has been used to train neural network and established the weightage as shown in table 3 aThe ranges of each class are decided based on average number of data in each area. Although there are a few data in class one are less than 0.5 but the range is set as greater than 0.5 because the number of data in class two are greater than the number of data in class one when Y< 0.5. Same as class one, the range value for class two and three also based on the number of data that consist in the range. This is important to make sure that the result more accurate.

TABLE 2 RANGE OF NEURAL NETWORK WEIGHTAGE

CLASS	OUTPUT NETWORK (Y)
1	Y > 0.5
2	Y > -0.7 && Y < 0.5
3	Y< -0.7

Another method of classification is using linear equation. Threshold value has been chosen for classification at each index as listed in Table 3. These values are obtained from measurement total number of pixel at each sample. The lowest and highest numbers of yellowish pixel at each index are considered as threshold value.

TABLE 3 PIXEL MEASUREMENT OF MATURITY INDEX

Index	1	2	3	4	5	6	7
Total number of pixel	<30	30-80	80-250	250-500	500-800	800-950	950>

More than 1000 images from different angle used to test the accuracy of developed system. We used classification neural network for measuring class accuracy and linear equation with fix threshold for index class. Table 4 shows the accuracy of each index.

TABLE 4 ACCURACY OF EACH INDEX

Index	% Accuracy
1	85
2	83
3	89
4	88
5	89.1
6	85
7	88.3

From the result shown in table 4, more than 80% correct classification was achieved for each index. The critical index misjudgment is at index two and the most accurate result is index five. These misjudgements happened because of wrong classify samples by expert during data collection. Index two is the hardest part to recognize by expert due to low level intensity of yellowish. Low quality of the image will affect the results. Moreover, total numbers of pixel for some samples are fall between the indexes and causing misclassification.

The system is intended to wrong classify due to too many index. Based on advice from expertise, the indexes can be grouping into three main categories which is group 1 is export, group 2 for local market and last group is not good. We class the pineapple based on group by using threshold linear equation and the result has been shown in Table 5. It is shown that the classification result is more than 90% correct classification.

TABLE 5 ACCURACY OF EACH GROUP CLASS

Group	Index	% Accuracy
Group 1	1,2	94
Group 2	3,4,5	95.1
Group 3	6,7	97.4

IV. CONCLUSIONS

Pineapple Maturity Inspection using colour identification has been successfully develops with more than 80% accuracy. In real implementation, the index of pineapple can be group into 3 main categories which is for local, export and rejected. The classification performance has been increased when it is measure by group. More than 90% correct classification has been achieved for the system testing in group of class index.

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

Reversible Wavelet Based Watermarking for Checking Image Authenticity

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***Abstract* – This paper presents the reversible watermarking technique based on wavelet transformation. The purposes are to protect the image from illegal modification and to check image authenticity. The embedded watermarked is located in the last bit of difference of pixels pairing. It is intended for minimize the changes of watermarked image. For the reversibility, the original pixel value that experienced changes in the value stored in the virtual border. The authentication is needed in the watermark reading to guarantee the originality of image.**

***Keywords* – reversible watermarking, wavelet transformation, virtual border**

I. INTRODUCTION

Digital image, like digital data, have some characteristic, including: easily to copied, easily distributed and changes that are not easily perceived by some human visual system [1][3]. Digital watermarking techniques can be used to protect digital image especially related to information hiding, issues of ownership and copyright and the issue of forgery [2].

Mohanty in his paper [4], classified the watermarking methods into various categories. According to working domain, watermarks can be applied in spatial domain and frequency domain. The most simplified method of watermarking in the spatial domain is LSB (Least Significant Bit) [1]. This method replaces the image's LSB with watermark data. This image's LSB is identic with the last bit of pixels value. In the frequency domain, watermark can be embedded in the transform domain. First, image is transformed in the frequency domain. Then, bits of watermark are embedded in the coefficient of transformation (i.e. coefficient of DWT, FFT, or DCT). Based on both of these methods, it has been shown that the frequency domain methods are more robust than the spatial domain methods.

Based on robustness of watermarking methods, it can be divided into two categories, fragile watermarking and robust watermarking. The using of these methods depends on the objectives. If we want to protect the authenticity of image, we use fragile watermarking. If we want to add the copyright or ownership in the image, we can use robust watermarking that can counter the non-malicious attack and malicious attack.

In this paper, we propose the fragile watermarking in the frequency domain, especially using LSB of wavelet transform coefficient, to protect the image authenticity. The reversibility can be obtained from adding virtual border, that has been introduced by trichili er al [5], to store the original pixels value and its coordinate that have changes after watermarking. PSNR is used to compute the peak signal-to-noise ratio between two images. The unit is decibels (dB). It is often used to measure quality of original image and compressed image [6]. The higher the PSNR, the better the quality of image. Before computing the PSNR, it needs to calculate Mean Square Error (MSE). It represents the cumulative squared error between the compressed and the original image. The lower the value of MSE, the lower the error [6]. When the two images are identical, the MSE will be equal to zero, resulting in an infinite PSNR [7].

II. WAVELET TRANSFORM

A wavelet is a mathematical function [8][9] used to divide a given function or continuous-time signal into different frequency components and study each component with a resolution that matches its scale[10]. A wavelet transform is the representation of a function by wavelets. The wavelet are scaled and translated copies (known as "daughter wavelets") of a finite -length or fast-decaying oscillating waveform (known as the "mother wavelet")[11].

The discrete wavelet transform (DWT) is commonly used for watermarking purposes. The basic idea of DWT for one-dimensional signal briefly described. The original signal is denoted by $x[n]$ is split into two parts, the low pass filter is denoted by $g[n]$ and high pass filter is denoted by $h[n]$. This splitting is called decomposition. The edge components of the signal are largely confined to the high frequency part. The low frequency part is split again into two parts of high and low frequencies. [12].

This decomposition to further increase the frequency resolution and the approximation coefficents decomposed with high and low pass filters is continued until the desired level is reached. The maximum number of levels depends on the length of the signal [10]. Figure 1 shows the decomposition is represented by a binary tree with nodes

ISBN : 978-602-97809-0-1

representing sub spaces with different time frequency localization.

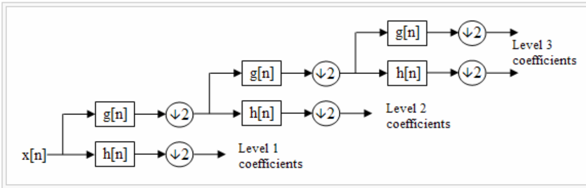

Fig 1. DWT for one-dimensional signal

At each level in the above diagram the signal is decomposed into low and high frequencies. Due to the decomposition process the input signal must be a multiple of 2^n, where n is the number of levels [13]. The outputs of the high pass and low pass filters are called DWT coefficients and by these DWT coefficients the original image can be reconstructed.

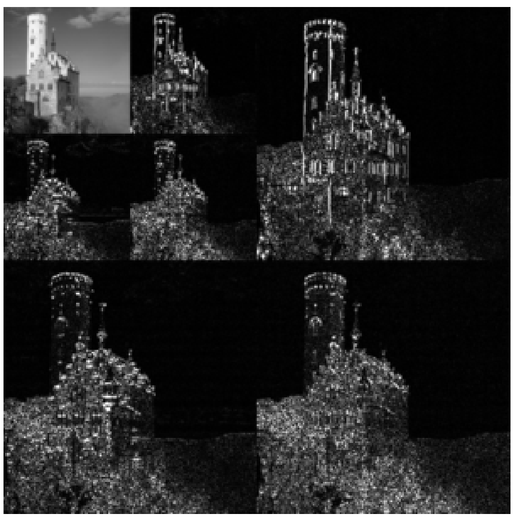

Fig.2 2D Discrete Wavelet Transform [13]

Figure 2 shows an example of the 2D discrete wavelet transform that is used in JPEG2000. The original image is high-pass filtered, yielding the three large images, each describing local changes in brightness (details) in the original image. It is then low-pass filtered and downscaled, yielding an approximation image. This image is high-pass filtered to produce the three smaller detail images, and low-pass filtered to produce the final approximation image in the upper-left[13].

A watermark can be applied using this wavelet transform. In the wavelet transform, especially haar wavelet filter, there are the average and the difference calculation [14]. We can use the difference to embed a watermark. A bit of watermark can be stored in MSB (Most Significant Bit) or LSB (Least Significant Bit). It is a fragile watermarking, so it will be used to authenticate the image.

III. PROPOSED TECHNIQUE

The reversible wavelet based watermarking that we propose is a watermarking technique based on wavelet transform. It uses the difference of virtual border as a location to save the data changes. Data changes are the original value and coordinate of pixels that have changes after watermark embedding. Virtual border is a mirror of a horizontal line border image. Authentication is done by comparing the extracting data from pixel pairs with the hashing of original image.

A. Embedding Watermark

Initial step of embed watermark image begins with making a virtual horizontal border as a place to store data changes. Before making a virtual border, the original image will be hashing using MD5. The result is a message digest of original image that will be converted into binary as a payload.

Figure 3 shows the flowchart of the method we use to embed watermark.

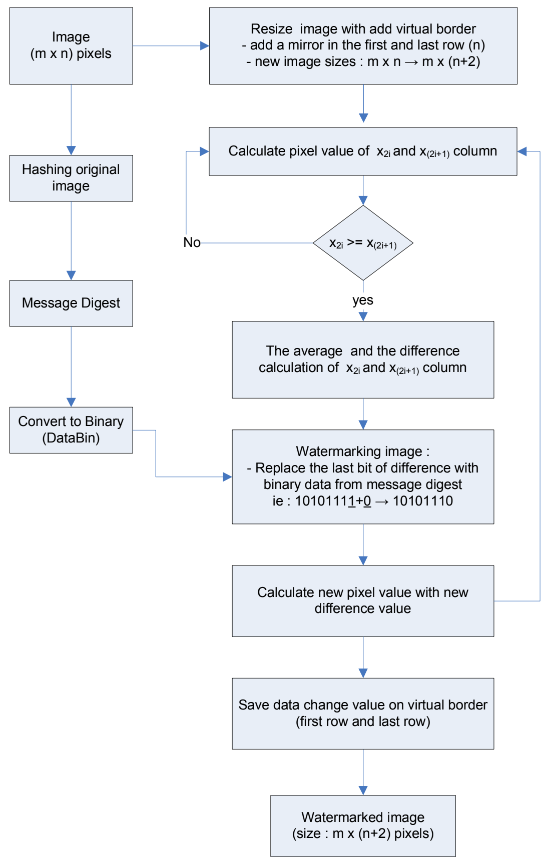

Fig.3 The flowchart of embedding watermark

The next step is to create a virtual horizontal border. Assumed that image has size m x n pixels. While added mirrors on the first and last row, the size of the image will be increased to m x (n +2) pixels.

Next, compute the average and difference of pixel pairs ($x_{2i}, x_{(2i+1)}$). In the Haar Wavelet filter, define the average and difference as,

$$l = \left\lfloor \frac{x_{2i} + x_{(2i+1)}}{2} \right\rfloor,\ h = x_{2i} - x_{(2i+1)} \quad (1)$$

where $x_{2i} \geq x_{(2i+1)}$,

$$x_{2i}, x_{(2i+1)} \in Z, 0 \leq x_{2i}, x_{(2i+1)} \leq 255 \quad (2)$$

and $1 \leq i \leq p$, where *p* is size of the payload.

After obtaining the average and difference of pixels pairs, the watermark will be embedded at the last bit of differences. To embed the payload, we use the LSB (Least Significant Bit) method and replace the last bit difference with the payload $b = \{b_1, b_2, ..., b_p\}$, where $b_i \in \{0,1\}$.

There are only two possibilities of the new difference *h'* values are: equal or changed. For example: we have a difference 10101001 and payload ("0" or "1"). The chances of new difference are "10101000" or "10101001". So, the range of new difference *h'* is $0 \leq h' \leq 255$. The value of *h'* is defined as

$$h' \begin{cases} h+1 & \rightarrow \quad lastBit = 0, payload = 1 \\ h & \rightarrow \quad lastBit = payload \\ h-1 & \rightarrow \quad lastBit = 1, payload = 0 \end{cases} \quad (3)$$

Based on the formula (1), (2) and (3), the transformation for new pixel (x2i) and new (x2i +1) is

$$(x_{2i})' = l + \left\lfloor \frac{h'+1}{2} \right\rfloor,\ (x_{2i+1})' = l - \left\lfloor \frac{h'}{2} \right\rfloor \quad (4)$$

Watermarking simulations are presented in table 1. This table shows a testing algorithm using a variation of some values.

TABLE 1
SIMULATION OF WATERMARKING USING VARIOUS VALUES

x1	x2	diff (h)	binary diff	data (b)	New diff	(x1)'	(x2)'
255	0	255	1111 1111	0	1111 1110	254	0
255	1	254	1111 1110	1	1111 1111	255	0
255	255	0	0000 0000	1	0000 0001	255	254
255	254	1	0000 0001	0	0000 0000	254	254
1	1	0	0000 0000	1	0000 0001	2	1
1	0	1	0000 0001	0	0000 0000	0	0
0	0	0	0000 0000	1	0000 0001	1	0
0	0	0	0000 0000	1	0000 0001	1	0
160	145	15	0000 1111	0	0000 0000	159	145
80	70	10	0000 1010	1	0000 1011	81	70

Where x1=(x_{2i}), x2= ($x_{(2i+1)}$), (x1)'=new (x_{2i}), (x2)'= new ($x_{(2i+1)}$)

B. Reversibility

Reversibility image obtained through the storing of the change of pixel data. Changes of data are stored by storing the coordinate of pixels and the original pixels value using the following format:

posX+"1010"+posY+"1010"+posK+"1011"+ pixelVal (5)

PosX, *posY*, *posK* and *pixelVal* in the form of a string. *PosX* and *posY* are pixel coordinates in the *X* axis and *Y* axis. *PosK* is RGB components of pixels (1:Red, 2:Green, 3:Blue). *PixelVal* is the value of the pixel at the position of *posX*, *posY* , *posK*.

Before the data changes are stored, every single char of the value of *posX*, *posY* and *posK* will be converted into 4-bits binary, except for *pixelVal* will be converted directly into 8-bit binary.

As an example of the value of each:

posX = 20, *posY*=115, *posK*=3, *pixelVal*=254

Using the format (5), conversion to binary :

0010 0000 1010 0001 0001 0101 1010 0011 1011 11111110

For easy restoring and data reading, at the end of the binary data will be added 4-bit binary (1111) as a sign of completion.

C. Reading a Watermark

We can read the watermark by extracting data from the LSB of horizontal border differences. There are five steps to read watermark and authenticate it :

1. Read changed data that stored in the virtual border.
2. Restore the value of the original pixel in accordance with the data stored in the virtual border.
3. Calculate the difference of pixel pairs and get the image signature from the last bit of these differences (LSB).
4. Erase the virtual border and hash it using MD5. It will cause image size reducing. Without horizontal border line (eliminate the first row and last row), the image size becomes m x n-2 pixels.
5. Authenticate the result of step 3 and 4, if authenticating is succeed, restore the original image into an image file.

The flow diagram of inverse reversible watermarking above can be seen in figure 4. This advantage of this methods is the

ISBN : 978-602-97809-0-1

change of image size, although it is small (only increase 2 rows).

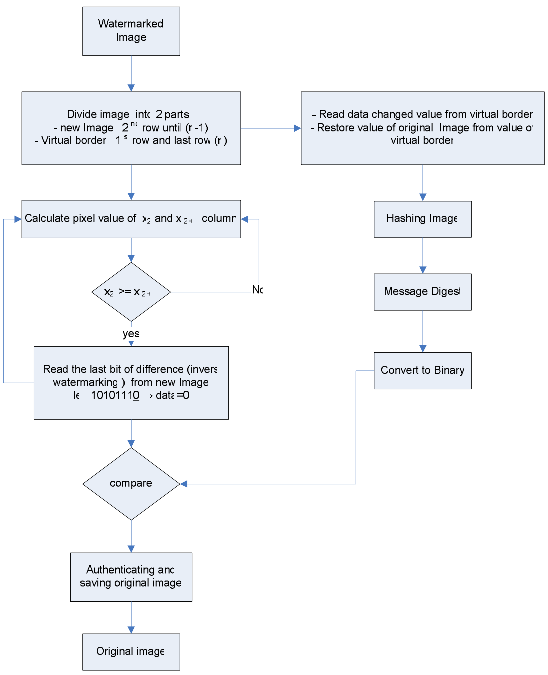

Fig.4 The flow diagram of inverse reversible watermarking

IV. IMPLEMENTATION

The implementation of this watermarking technique was built using Java[TM] Technology development tools. There are several classes that used in this application included Graphical User Interface (GUI). The watermarking class is *WaveletWatermarking.java*, the function of wavelet watermarking is shown below:

```
private void waveletWatermark() {
   // Make virtual border
   // Copy the first and last row
   newImage = new byte[width+1][height+3][4];
   for (int j = 0; j <= height; j++) {
      for (int i = 0; i <= width; i++) {
         for (int k = 0; k <= 3; k++) {
            newImage[i][j+1][k]=dataRGB[i][j][k];
         }
      }
   }
   for (int i = 0; i <= width; i++) {
      for (int k = 0; k <= 3; k++) {
         newImage[i][1][k]=dataRGB[i][1][k];
         newImage[i][height+2][k]=dataRGB[i][height][k];
      }
   }
   // Wavelet based watermarking
   for (int j = 2; j <= height+1; j++) {
      for (int i = 1; i <= width/2; i++) {
         for (int k = 1; k <= 3; k++) {
            if (dataLength > 0) {
            // calculate the difference of column i and column i+1 per
band(3 bands:R,G,B)
            // Only positive integer that will be proceeded
               x2iVal =  (newImage[2*i-1][j][k] & 0xff);
               x2i1Val=  (newImage[2*i][j][k] & 0xff);
               if((x2iVal-x2i1Val)>=0) {
                  hDiff = x2iVal  - x2i1Val;
                  mean = (x2iVal+x2i1Val)/2;
                  // Watermarking
                  // inserting message digest using LSB
                  String binaryDiff =Integer.toBinaryString(hDiff);
                  char tempBin =strDataBin.charAt(strDataBin.length()-
dataLength);
                  String newDiff =
binaryDiff.substring(0,binaryDiff.length()-1)+tempBin;
                  if ((mean + (Integer.parseInt(newDiff,2)+1)/2)<=255){
                     x2iNew=mean + (Integer.parseInt(newDiff,2)+1)/2;
                     x2i1New=mean - (Integer.parseInt(newDiff,2))/2;
                  } else {
                     x2iNew=mean + (Integer.parseInt(newDiff,2))/2;
                     x2i1New=mean - (Integer.parseInt(newDiff,2)+1)/2;
                  }
                  // Store the data changed into virtual border
                  if (x2iVal!=x2iNew) {
                     dataChanged=storeDataChangedBinary( 2*i-1, j-1,  k,
x2iVal);
                  }
                  else if(x2i1Val!=x2i1New){
                     dataChanged= storeDataChangedBinary( 2*i, j-1,  k,
x2i1Val);
                  }
                  newImage[2*i-1][j][k] = (byte) x2iNew;
                  newImage[2*i][j][k] = (byte) x2i1New;
                  dataLength--;
               }
            } else{
               bStatus = true;
               break;
            } if (bStatus) break;
         } if (bStatus) break;
      }
   }
   // data changed addition with "1111" for indexing the end of data
   dataChanged=dataChanged+"1111";
   if (dataChanged.length() > width*6) {
      System.out.println("The changes are too large, Please use the
bigger image!");
   } else {
      // insert data changed in the last bit of virtual border
      boolean statData = true;
      for (int i = 1; i <= width; i++) {
         for (int c = 1; c <= 3; c++) {
            if ((6*(i-1)+2*(c-1))>=dataChanged.length()){
               statData = false;
               break;
            } else {
               sTemp = Integer.toBinaryString(newImage[i][1][c] & 0xff);
               char tempTop = dataChanged.charAt(6*(i-1)+2*(c-1));

newImage[i][1][c]=(byte)Integer.parseInt(sTemp.substring(0,sTemp.length()-
1)+tempTop,2);
               sTemp =Integer.toBinaryString(newImage[i][height+2][c]
& 0xff);
               char tempBot = dataChanged.charAt(6*(i-1)+2*(c-1)+1);

newImage[i][height+2][c]=(byte)Integer.parseInt(sTemp.substring(0,sTemp.l
ength()-1)+tempBot,2);
            }
         } if (!statData) break;
      }
   }
}
```

ISBN : 978-602-97809-0-1

From codes above, the first step is the making of virtual border. Next, the difference and mean of pixel pairing are calculated. Watermark is embedded in the last bit of differences. It will produce a new difference. The new value of pixel pairing will be calculated with this new difference. While calculating the new pixel value, an original pixel value is stored and will be embedded in the last bit of virtual border.

Inverse of reversible watermarking has some steps, first is reading the watermark. Next are creating new image that has size width x height-2 (back to original image size), reading data from virtual border, and restoring the original image. The result of this function is an array of original image and a watermark in the hexadecimal format. The codes are shown below:

```
//1. Read Watermark start from row 2 - row (height-1)
for (int j = 2; j <= height-1; j++) {
   for (int i = 1; i <= width/2; i++) {
      for (int k = 1; k <= 3; k++) {
         x2iVal =  (dataRGB[2*i-1][j][k] & 0xff);
         x2i1Val=  (dataRGB[2*i][j][k] & 0xff);
         if((x2iVal-x2i1Val)>=0) {
           hDiff = x2iVal  - x2i1Val;
           // save the last bit of each difference
            String hDiffTemp = Integer.toBinaryString(hDiff);
            hDiffEnd = hDiffEnd +
hDiffTemp.substring(hDiffTemp.length()-1);
            countMsg++;
            if (countMsg == 128) {
               bStatus = true;
               break;
            }
         } if (bStatus) break;
      }if (bStatus) break;
   }if (bStatus) break;
}
//2. Restore Digital Image
//a. create new Image from dataRGB, back to original size  (w x(h-2))
newImage = new byte[width+1][height-1][4];
for (int j = 0; j <= height-2; j++) {
   for (int i = 0; i <= width; i++) {
      for (int k = 0; k <= 3; k++) {
         newImage[i][j][k]=dataRGB[i][j+1][k];
      }
   }
}
//b. Read virtual border and restore Original Image
for (int i =1; i<=width; i++) {
   for (int k=1; k<=3; k++) {
      String lsbTop = Integer.toBinaryString(dataRGB[i][1][k] &
0xff);
      extractData = extractData + lsbTop.substring(lsbTop.length()-1);
      String lsbBtm = Integer.toBinaryString(dataRGB[i][height][k] &
0xff);
      extractData = extractData + lsbBtm.substring(lsbBtm.length()-1);
      if (extractData.length()==4 && !extractData.equals("1111")
&& !boPixVal) {
         if (extractData.equals("1010")) {
            if (count==1) {
               posX=sTemp;  extractData=""; count++;
            }else if (count==2) {
               posY=sTemp;extractData="";count++;
            }
            sTemp = "";
         } else if (extractData.equals("1011")
&& !extractData.equals("1111") && !boPixVal) {
            if (count==3) { posK=sTemp;extractData="";}
            boPixVal = true;
         } else {
               sTemp = sTemp +
Integer.toString(Integer.parseInt(extractData,2));
               extractData="";
            }
         }else if (extractData.length()==8 && boPixVal) {
            pixVal = Integer.parseInt(extractData, 2);
            extractData = "";
            boPixVal = false;
            sTemp=""; count=1;
            // Restore the original pixel value into watermarked image

newImage[Integer.parseInt(posX)][Integer.parseInt(posY)][Integer.parseInt(p
osK)]=(byte)pixVal;
         } else if (extractData.length()==4 && extractData.equals("1111")
&& !boPixVal) {
            boExit = true;
            break;
         }
      }if (boExit) break;
   }
   // Convert watermark into hexadecimal
   for(int i=0; i<16; i++) {
      strBin = hDiffEnd.substring(i*8, (i+1)*8);
      int intHex = Integer.parseInt(strBin, 2);
      strHex = Integer.toHexString(intHex);
      if (strHex.length()==1) strHex = "0"+ strHex;
      sDataBin = sDataBin + strBin;
      strDataHex = strDataHex + strHex;
   }
   // Result of watermark reading
   watermark = strDataHex;
```

V. RESULT

The original images used in this paper are in the RGB color format and in the "png" file format. The images are downloaded form any links shown in the table 2. Majorities are medical images. The size of watermarked image will be increased 2 point in height. It is caused by adding virtual border as embedding media. Image signature is gained from hashing image using standard hash function in the java™ technology. We use MD5 for experiments. The output of this function is 128 bits of message digest.

TABLE 2

IMAGES SOURCE

No	Filename	Source
1	Bone	http://en.wikipedia.org/wiki/File:Nl_bone_scan2.jpg
2	Petct	http://en.wikipedia.org/wiki/File:Nl_petct.jpg
3	Abnl	http://en.wikipedia.org/wiki/File:Abnl_petct.jpg
4	Saddle	http://en.wikipedia.org/wiki/File:SADDLE_PE.JPG
5	Keosys	http://en.wikipedia.org/wiki/File:Viewer_medecine_nucleaire_keosys.JPG
6	Brain	http://gallery.hd.org/_c/brain_scan/brain-scan-orig-DHD.jpg.html
7	Mri	http://en.wikipedia.org/wiki/File:Brain_Mri_nevit.svg

No	Filename	Source
8	Fetal	http://gallery.hd.org/_c/medicine/_more2008/_more04/sonogram-human-foetal-fetal-ultrasound-scan-at-10-weeks-mono-2-ANON.jpg.html
9	Head	http://en.wikipedia.org/wiki/File:Head-3D.jpg
10	Waterfall	http://www.travelblog.org/Wallpaper/pix/waterfall_desktop_background-1600x1200.jpg
11	Wind	http://commons.wikimedia.org/wiki/File:Windbuchencom.jpg

The example of original image (saddle), original image with horizontal virtual border, and watermarked image are shown in figure 5, 6 and 7. They are resized from original size for publication needed.

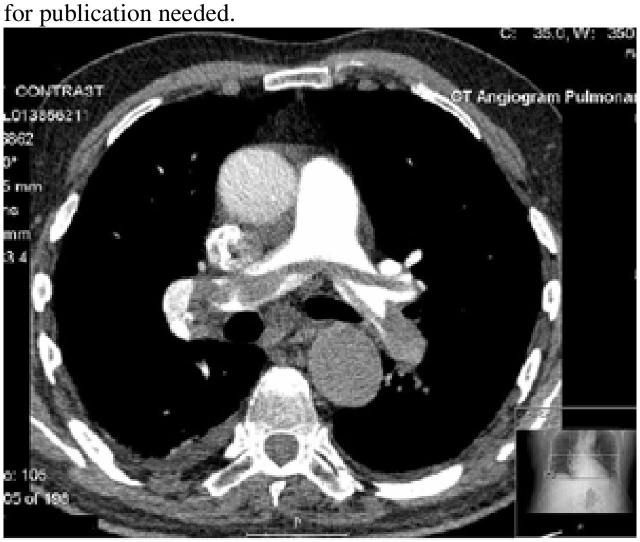

Fig. 5 The original image “saddle”

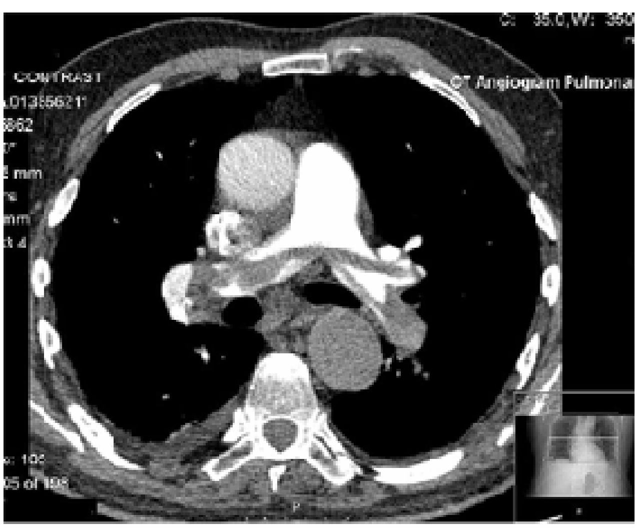

Fig. 6 Original image with virtual border

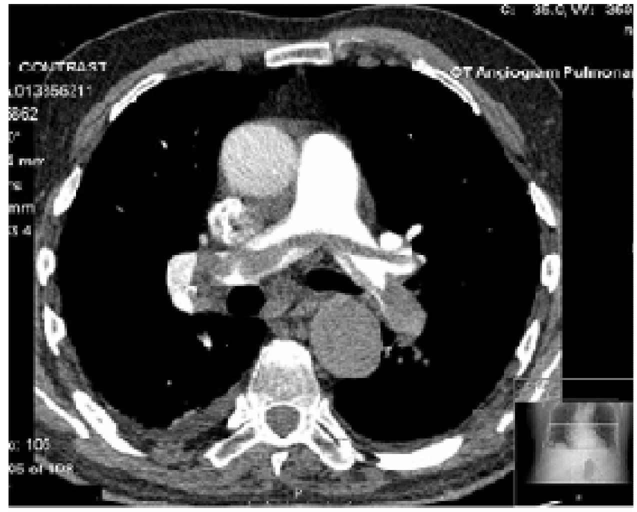

Fig. 7 Watermarked image

The PSNR of original images with virtual border and watermarked images are shown in the table 3. There is a sample image that can not be embedded. It is happen because the size of changed data is too large and the image size, especially the image width, is too small. The changed data is formed by coordinate pixel and its value in the binary form. The maximum space to store it in the virtual border is 6 x image width. We assume that each pixel in the virtual border can store 3 bit, and an image has 2 row of virtual border. For example, image waterfall with virtual border has size 400x302. Row 1 and row 302 are virtual border that has 400 pixels for each row. The maximum space can be calculated as 400x2x3=2,400 bits. If the changed data has size more than 2,400 then it will not be accommodated and causes the watermarking failed.

TABLE 3.

THE PSNR OF WATERMARKED IMAGE AND ORIGINAL IMAGE

No	Filename	Size1*	Size2**	sumOfDiff	PSNR
1	bone	593x600	593x602	1154	77.8064
2	petct	606x599	606x601	992	78.5503
3	abnl	694x599	694x601	1334	77.8527
4	saddle	721x600	721x602	1448	77.6696
5	keosys	800x500	800x502	1130	78.4091
6	brain	432x538	432x540	1206	75.7673
7	mri	446x599	446x601	1262	76.1735
8	fetal	931x624	931x626	1241	79.6195
9	head	640x496	640x498	1202	77.137
10	waterfall	400x300	400x302	failed	failed
11	wind	400x301	400x303	1181	73.0145

VI. CONCLUSIONS

Reversible wavelet based watermarking can be used to prevent illegal modification of image. The using of difference of pixels pairing to embed image signature can make a small changes, so it can be used to watermark a sensitive image. Based on experimental results, the PSNR values are high, it means a good quality for the watermarked image. There is a sample image that can not be embedded. It is happen because the size of changed data is too large and the image size, especially the image width, is too small. The development of this method is still needed to increase the strength and watermarked image quality.

ACKNOWLEDGMENT

This work is financially supported by Researchers and Engineers Incentive Program, Ministry of Research and Technology Republic of Indonesia in fiscal year 2010 under contract no. 053/M/Kp/II/2010.

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ISBN : 978-602-97809-0-1

ANFIS as Tool for Bankruptcy Prediction: A Comparative Study with Logit Technique

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Abstract - **Adaptive Neuro Fuzzy Inference System (ANFIS) is integration of neural networks and fuzzy systems and has advantages of neural networks and fuzzy logic, simultaneously, however, this model has been applied in few bankruptcy prediction researches so far. This study demonstrates effectiveness of ANFIS in bankruptcy prediction task. The data set consists of 136 matched bankrupt and non-bankrupt firms in Tehran Stock Exchange (TSE) during 1997-2008 have been applied to build up an ANFIS and a Logistic regression (LR) models for estimating of bankruptcy. Moreover, we used T-test statistical feature selection method to select the variables for our analysis. The obtained models have been estimate with three different data set partitioning pattern. Examination of empirical results by various views of overall accuracy, type I and type II values indicates, the ANFIS model outperforms LR model in both training and testing samples, significantly.**

Keywords - **Bankruptcy Prediction; ANFIS; Logit Regression; Tehran Stock Exchange (TSE), T-test feature selection**

I. INTRODUCTION

Formal analysis on bankruptcy prediction has been started since 1932, and still continues to attract intense interest among academics, practitioners and regulators [1]. Incorrect decision-makings in financial institutions may cause financial distress and incur social costs affecting stakeholders such as shareholders, managers, workers, creditors and investors. The high individual, economic, and social costs could be motivating reasons for examining of bankruptcy prediction capability.

Since the pioneering financial ratio model conceptualized by Beaver [2], bankruptcy prediction models, such as the multivariate analysis technique by Altman (1968) [3], the linear probability model by Myer and Pifer (1970)[4], the Logit (i.e., logistic regression) model by Ohlson (1980)[5], the probit model by Zmijewski[6] have been much-developed. Two last mentioned models give a crisp relationship between explanatory and response variables of the given data set from a statistical view point and not assume multivariate normality (Tseng and Hu, 2010)[7].

In recent years, much attention is given to the choice of methodology for overcoming the short coming and restrictive assumptions of primitive statistical methods. Artificially intelligent expert system techniques which are very efficient for searching an unknown linear or non-linear pattern in a massive data set have been developed. One of the most popular of these techniques is artificial neural networks [8]. Many studies had been shown that artificial neural networks (ANN) are more accurate, adaptive and robust in comparison with traditional statistics models ([9], [10], [11], [12]). A review of applications of neural networks to predict bankruptcy can be found in [13]. In spite of ANN being good for modeling nonlinear systems they suffer from their inability to explain the steps used to make decisions and incorporate rules in their architecture [14].

Identification of specific factors or their combination that leads to unfavorable forecast is very important to managers. That is, managers can make more use of conventional or fuzzy interpretable IF THEN rules rather than neural networks [15].

Since introduction in 1965 by zadeh ~~(1965)~~[16], fuzzy set theory received considerable attention, not only in the scientific community but also in industry. Some researchers have been used fuzzy rule-based systems for bankruptcy prediction such as [17].

However, since fuzzy systems do not have much learning capability, it is difficult for human operator to tune the fuzzy rules and membership functions from the training data set.

Fuzzy modelling, along with other techniques, especially neural network, is recognize as powerful tools that can facilitate the effective development of models [18].

One of the ways to integrate neural networks and fuzzy systems is Adaptive-Network-Based Fuzzy Inference System (ANFIS) which proposed by Roger Jang in 1993[19]. ANFIS is the class of adaptive networks which are functionally equivalent to fuzzy inference and has advantages of neural network and fuzzy logic, simultaneously [19].

The objectives of ANFIS are as follows [19]:

(1) To integrate the best features of fuzzy systems (FS) and neural network (NN):

- From FS: Representation of prior knowledge into a set of constraints (network topology) to reduce the optimization search space,
- From NN: Adaptation of back propagation to structured network to automate fuzzy control parametric tuning.

(2) ANFIS application to synthesize:

- Controllers (automated fuzzy control tuning),
- Models (to explain past data and predict future behavior).

The advantage of ANFIS is that it is one of the best tradeoffs NN and FS, providing

- Smoothness, due to the fuzzy control interpolation,
- Adaptability, due to the NN back propagation.

One important feature of the ANFIS is that is adaptable; the membership function parameter can adapt and change within the learning procedure.

Although this effective approach was first introduced in early 1993s, it has been applied to bankruptcy prediction just in few studies so far.

Kumar and Ravi [20] applied ANFIS model within ensembles created model. A set of seven classifiers was applied: ANFIS, support vector machine (SVM), four types of RBF networks, and MLP. The majority voting rule has been used to aggregate ensemble members. Their results indicate that ANFIS, Semi-Online RBF2 and MLP are the most important classifiers among the seven classifiers employed in their paper, as they figured in the best ensemble combinations.

The correct classification rate of ANFIS model has been compared with Altman Z-score by Purvinis et al in 2008. They showed the relation between bankruptcy forecast and considered financial ratios is complicated and nonlinear. As they had expected ANFIS outperformed Altman Z-score model. Their proposed ANFIS model showed that percentage of right failure and success predictions is 80%.

Considering advantages of ANFIS than statistical, neural network and fuzzy system and applying ANFIS in few studies for bankruptcy prediction domain so far, more examination about ANFIS is looked necessary. The contributions of this research are documented as the following. First, this study decides to apply ANFIS structure for problem of bankruptcy prediction on the Tehran Stock Exchange (TSE) data set. Moreover, we compare performance of ANFIS model with logistic regression (LR) which is widely used statistical method for binary classification to demonstrate reliability and effectiveness of ANFIS model on Tehran data. Second, feature selection as a preprocessing step in prediction process, aims at filtering out superfluous and/or irrelevant features from the original data [21]. In this study, T-test selection method as variables selection is applied. The variables are selected by T-test method performs stably and provides higher prediction accuracy rather than other statistical feature selection methods [21]. Therefore, T-test method is applied for selecting predictive variables in this study.

Prediction performance of obtained ANFIS and LR models are compared with performance evaluation measures such as prediction accuracy, Type I and Type II errors.

The remaining parts of this paper have been organized as follows. Section 2 describes architecture of ANFIS and logistic regression model. Empirical results and their analysis are presented in sections 3. Finally, section 4 provides a summary and conclusion.

Description of proposed models

Adaptive Neuro-Fuzzy inference system (ANFIS)

Several types of FIS have been proposed in the literatures which are due to the differences between the specification of the consequent part and the defuzzification schemes [22]. One of these types is the so called Takagi and Sugeno FIS (1985), in which the consequent variable of each rule is defined as a linear combination of input variables [23]. The Adaptive neuro-fuzzy inference system (ANFIS) is a multilayer, network- based neural fuzzy system. For illustrating the system, we assume the fuzzy inference system consists of five layers of adaptive network with two inputs *x* and *y* and output z which is shown in Fig. 1.

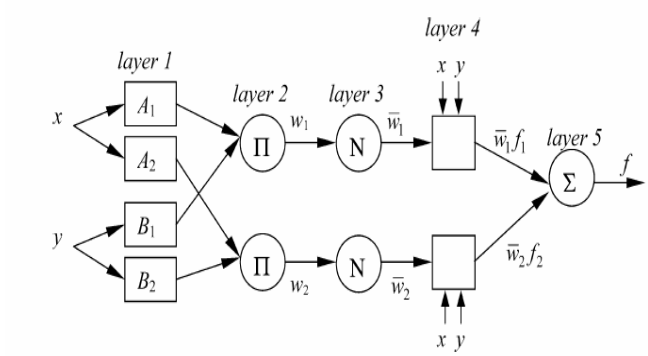

Fig. 1. Schematic diagram of ANFIS

For the first-order TSK fuzzy model, a typical rule set with two fuzzy if-then rules is the following:

$$\text{Rule1: If } x \text{ is } A_1 \text{ and } y \text{ is } B_1, \text{ then } f_1 = p_1 x + q_1 y + r_1 \quad (1)$$

$$\text{Rule2: If } x \text{ is } A_2 \text{ and } y \text{ is } B_2, \text{ then } f_2 = p_2 x + q_2 y + r_2 \quad (2)$$

The entire system architecture consists of five layers, namely, fuzzification layer, product layer, normalized layer, de-fuzzification layer and total output layer.

[Layer1]: Every node i in this layer is an adaptive node with a node function

$$O_{1,i} = \mu A_i(x) \text{ , i=1,2} \quad (3)$$

$$O_{1,j} = \mu B_{j-2}(y) \text{ , j=3,4} \quad (4)$$

Where x (and y) is the input to node i and Ai (and Bj) is a linguistic label (such as “small” or “large”) associated with this node. O1,i is then the membership grade of a fuzzy set A (= A1,A2, B1 and B2). Gaussian parameterized membership function is usually used as the input membership function which guarantees a smooth transition between 0 and 1:

$$\mu A(X) = \exp\{-(\frac{x-c_i}{a_i})^2\} \quad (5)$$

Where $\{a_i, c_i\}$ is the parameter set.

[Layer 2]: The output of this layer is the product of all the incoming signals and represents the firing strength of a rule:

$$O_{2,i} = \omega = \mu A_i(x) \times \mu B_i(y) \text{ , i=1,2} \quad (6)$$

[Layer 3]: The outputs of this layer are the normalization of incoming firing strengths:

$$O_{3,i} = \overline{\omega} = \frac{\omega_i}{(\omega_1 + \omega_2)} \text{ , i=1,2} \quad (7)$$

[Layer 4]: Every node i in this layer is an adaptive node with a node function.

$$O_{4,i} = \overline{\omega}_i f_i = \overline{\omega}\,(\mathrm{p}_i x + q_i y + r_i) \quad (8)$$

Where $\overline{\omega}$ is a normalized firing strength from layer 3 and $\{p_i, q_i, r_i\}$ is the parameter set of this node. Linear parameters in this layer are referred to consequent parameters.

[Layer 5]: The single node in this layer computes the overall output as the summation of all incoming signals:

$$O_{5,i} = \sum \overline{\omega}_i f_i \quad (9)$$

It can be observed that there are two adaptive layers with square nodes in this ANFIS architecture which have namely the first layer and the fourth layer. In the first layer, there are two modifiable parameters $\{a_i, c_i\}$ which are related to the input membership functions. These parameters are the so-called premise parameters. In the fourth layer, there are also three modifiable parameters $\{p_i, q_i, r_i\}$ pertaining to the first-order polynomial. These parameters are so-called consequent parameters.

1) *Hybrid Learning Algorithm*: It is observed that given the values of premise parameters, the overall output can be expressed as linear combinations of the consequent parameters [19]. More precisely, the overall output of the ANFIS model can be written as follow equation :

$$f = \sum f_i = \frac{w_1}{w_1+w_2} f_1 + \frac{w_2}{w_1+w_2} f_2 = \overline{w_1} f_1 + \overline{w_2} f_2$$
$$= (\overline{w_1})\, p_1 + (\overline{w_1})\, q_1 + (\overline{w_1})\, r_1 + (\overline{w_2})\, p_2 + (\overline{w_2})\, q_2 + (\overline{w_2})\, r_2 \quad (10)$$

The above-mentioned nonlinear and linear parameters in premise and consequent parts are adjusted by a hybrid learning algorithm, based on a collection of process data. One of the hybrid learning algorithms, which Jang [19] proposed, includes the Gradient Descent Method (GDM) and the Least Squares Estimate (LSE). Each epoch of the hybrid learning procedure is composed of a forward pass and a backward pass.

In the forward pass, functional signals go forward till layer 4 and consequent parameters are optimized by the LSE, under condition that premise parameters are fixed. In the backward pass, the error rates propagate backward and the premise parameters are updated by the GDM.

A. Logistic Regression Model

The logistic regression is a statistical model to distinguish two groups based on some distinguishing variables and has been used in studies of classification, especially in bankruptcy prediction domain ([24], [25]). In our study, the logistic regression model essentially estimates to the probability of belonging to the two groups, the dependent value is a dummy, with 0 representing non- bankrupt firms and 1 representing bankrupt firms. The logistic regression with a dichotomous dependent variable can be expressed in terms of logit or probabilities form [26]. From the logistic regression model, the estimated value of the dependent variable can be interpreted as the predicted probability of an event occurring, which lies between 0 and 1 [26].

In this study, the estimated value of the dichotomous dependent variable was defined as the predicted probability of being a bankrupt firm or P (B). When expressed in logit form, the ‘‘odds’’ is defined as the ratio of the probability of going bankrupt to not going bankrupt or P(B)/(1 - P(B)). When expressed in logit form, the model is specified as a linear function of the firm’s independent variables.

$$Log\left[\frac{P(D)}{(1-P(D))}\right] = \beta_0 + \beta_1 X_{i1} + \ldots + \beta_n X_{in} \quad (11)$$

Where P (B) is the probability of going bankrupt for the ith firm; β_0 is an intercept; X_1-X_n are the potential variables; β_1–β_n are the coefficients of the *n*th potential variables. Eq. (1) can be transformed into a specification of the logistic regression model of event probability. By solving P (B) through the Eq. (1), the predicted probability of bankruptcy is described as:

$$P(D) = \frac{1}{[1+e^{-y}]} \qquad (12)$$

Where *e* is the base of the natural logarithm; $y = \beta_0 + \beta_1 X_{i1} - \dots + \beta_n X_{in}$.

II. Application and Discussion

A. Sample selection

The used dataset in this study is from non financial firms that were or still are listed on the TSE. The financial institution have special and different operating and laws, therefore they are excluded from our dataset. Besides, those firms with missing at least one financial ratio value are also eliminated. The considered sample includes 68 bankrupt firms from 1997 through 2008. Since this study decides to use matched paired data construction, the 68 healthy firms are collected within the same time period and year and industry with selected bankrupt firms. Therefore, the considered sample is consists of 136 firms. This study decides to estimate the bankruptcy prediction model with the financial data of one year prior to financial distress.

By investigating on 37 industry branches of TSE, the textile, machinery & equipment and non-sugar products industries are the critical industry and have 16, 13 and 9 percent of total bankrupt companies, respectively.

Section Headings

B. Selection of initial financial ratios

The 25 financial variables which have more extensive usage among bankruptcy prediction literature are selected as initial variables. These deduced variables are more frequent variables used in studies that are examined in Kumar ' reviews researches[27]. Table 1 represents the definition of 25 initial financial ratios. T-test method demonstrates 11 predictive variables have the significant level of Sig. less than 0.01 which are labelled with star symbol in Table 1.

TABLE I

FINANCIAL RATIOS USED IN THIS STUDY

#	Variables	#	Variables
1	EBIT/Total asset*	14	Sales/equity
2	Net income/total assets*	15	Total debt/equity*
3	Net income/Sales*	16	Total debts/total assets*
4	Cash/total assets*	17	Current assets/current debts*
5	Current assets/total assets	18	Quick assets/current debts*
6	Quick assets/total assets	19	equity/total asset*
7	Working capital/total assets	20	Cash/current debts*
8	Size	21	Current debts/total debts*
9	retained earning/total asset	22	long term debt/equity
10	sales/total assets	23	net income/ gross profit
11	sales/Cash	24	cash/ total debt
12	sales/Working capital	25	sales/ quick asset
13	sales/Current assets		

C. Estimation ANFIS and LR prediction models

Since, the size of training and testing patterns may influence the prediction ability of models and for more comprehend comparing models, three data partitions are accomplished. The considered three data partitions by a random sampling procedure are:

a. 90/10 partition: "training" (122 sample: 61 bankrupt and 61 healthy) and "testing" (14 sample: 7 bankrupt and 7 healthy).
b. 80/20 partition: "training" (109 sample: 55 bankrupt and 54 healthy) and "testing" (27 sample: 13 bankrupt and 14 healthy).
c. 70/30 partition: "training" (96 sample: 48 bankrupt and 48 healthy) and "testing" (40 sample: 20 bankrupt and 20 healthy).

It is necessary to pay attention to this subject that the observations used to train the network ought to mix from bankrupt and healthy firms in the random order. Because, this cause significant unlearning occurs [14].

There are two methods for generating network structure of ANFIS which are grid partition and subtractive clustering techniques [19]. We choose the grid partition technique for estimating T-test-ANFIS models. We set 2 Gaussian Bell shape membership functions for each variable. Error Tolerance creates a stop criterion after training data error remains within this tolerance. For the best result, leave 0 if you do not know how your training error is going to behave.

The classification of a firm is determined by a cutoff value which is set to balance Type I and Type II errors. A firm with a predicted value greater than this cutoff value is considered as bankrupt, otherwise a healthy firm (Lin, 2009). We assume the costs of Type I error and Type II errors are equal and the value of cut-off is 0.5. It means that if the estimated output over 0.5 then the firm would be predicted to be a bankrupt firm.

ANFIS and LR models are estimated for three partitioning data pattern and average performance of them are reported in next subsection. The statistical results shows that estimated LR models are meaningful, in spit of some financial ratio's coefficient are not significant in achieved regression equation.

D. Performance comparison

For detailed comparison between applied models in this study, prediction accuracy, Type I, Type II error performance measures which are popular in bankruptcy prediction researches are used. The average classification performances of different classification methods in three data partition patterns are represented for both training and test sample, separately in Table 2. The value in each parenthesis is standard deviation corresponding to individual classification results.

Based on the results from table 2, we can conclude that ANFIS model outperforms LR model in both training and test samples in average. As shown in table 2, ANFIS models with 94.47% and 91.81% prediction accuracy perform better than LR models in classification firms into bankrupt and non-bankrupt groups. Meanwhile, it has smaller type I error and type II error than LR models.

TABLE 2

AVERAGE PERFOREMANCE OF CLASSIFICATION MODELS (STDEV): IN PERCENTAGE

Data set	Models	Prediction accuracy	Type I Error	Type II error
Training	ANFIS	94.47(0.85)	8.58(0.58)	3.1(1.2)
	LR	81.27(0.93)	21.68(2.89)	15.78(1.0)
Testing	ANFIS	91.81(1.57)	14.52(14.3)	8.09(7.33)
	LR	76.75(9.3)	16.15(19.9)	32(14.8)

The schematic comparison between obtained models performance on train and hold-out sample have been shown in Fig 2. The follow depicted graphs show superiority of ANFIS model to LR models in all prediction performance measures point of view.

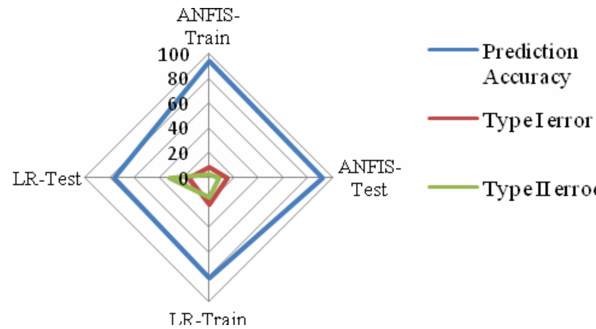

Fig. 2 Graphical Performance of classification models on train and test data

III. CONCLUSION

Both Fuzzy theory and neural network theory have been used to develop bankruptcy prediction models but both of them have merits and shortages. Neural network theory easily map non-linear input and output relationships, show excellent learning ability, but can not show results and learning phase clearly. Fuzzy theory is the clear and qualitative inference process, but lacks adaptability to environmental changes and learning ability. Adaptive-Network-Based Fuzzy Inference System (ANFIS) is a model that combines the advantages of neural network and fuzzy logic system.

As few studies examined applying ANFIS model for bankruptcy prediction, so far. Thus, there are many potential fields of further research about this method. In this study we endeavor to apply ANFIS model for bankruptcy prediction and comparing this model with Logit model. Meanwhile, we Focus on preprocessing feature selection procedure using T-test method.

The dataset including 136 Iranian companies listed on Tehran Stock Exchange (TSE) has been applied for experimental case. By evaluating performance of the prediction models with prediction accuracy, Type I error and Type II error, we conclude ANFIS model is superior to LR model.

Some suggestions for future studies are such as: developing a more accurate ANFIS model by examining on pattern and number of membership functions, using checking data. Aggregating ANFIS model with other statistical or artificial intelligent techniques in order to improve prediction accuracy. More focus on the obtained ANFIS rules, and develop the early warning systems as decision support system and so on.

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ISBN : 978-602-97809-0-1

A Genetic Algorithm for Capacitated Balanced Allocation Problem with Multiple Products

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Abstract - **In today's competitive business environment, importance of supply chain integration in on time delivery of products and services for customer has been increased. In this among, distribution centers (DCs) play an important role to increasing efficiency and effectiveness of supply chain networks. Optimal utilization of DCs has a significant effect on reducing costs and increasing service level in whole supply chain. One of the existing approaches in effective utilization of DCs is balanced allocation of customers that can improve performance of supply chain. In this paper, firstly an integer programming model is developed to express balanced allocation of customer with attention of multiple needed products. Then problem by genetic algorithm is solved and with using a series of numerical experiments efficiency of proposed algorithm is examined.**

Keywords — **Balanced allocation, Supply chain network, multiple products, Genetic algorithms.**

I. INTRODUCTION

With Growth concepts relating to supply chain, such as globalization, information technology and integrated supply chains, structure and traditional functions of distribution systems as warehouses to storing inventory has changed and necessity of the presence of an integrated system in supply chain more than ever has been deduced. Also, with increase in information exchange and changes in customer demand characteristics, competition between companies has increased. In this regard, the level of integration between supply chain members such as suppliers, manufacturers, distributors and customers can be directly related to the success of the whole chain [1], [2]. The most important goals of a distribution system is improve customer service level and reduce overall supply chain costs. To achieve these goals, should the level of utilization of any of the facilities in distribution network, given existing capacity constraints increase as much as possible. Developments in technologies and diversity in products cause to manufacturers have continuous expansion in the number of their DCs and storage capacity of them. Growth in warehousing capacity can be contrary to such purposes, unless the planning to develop the capacity of DCs done in a way that additional costs not impose to the system and services be conducted in a desirable level. Hence, customers allocation planning in the distribution networks must be done in a manner that don't cause extra workload and over capacity utilization in some DCs and also poor utilization in other DCs [3]. For achieve this purpose, one way is to allocate different customer demands to DCs base on their costs so that assigned cost to each DC in compare with other DCs equitably be balanced. Balanced allocation of customers to DCs is an efficient and suitable way to utilize supply chain network and it helps to managing of the customer demands and satisfaction of customers.

Such a problem comes up when the number of DCs in a supply chain is more than one. Herein, for an optimal allocation, different parameters can be considered. Profit, cost and transit time are the most important items that they can be pointed. In this paper, cost as an important factor and efficacious in performance of supply chain networks is considered.

In this study, we consider a multi products supply chain network that a number of DCs distribute produced products of manufacturers among multiple customer sites. Main objective of model is finding a suitable deployment of customers and DCs with attention to different types of demand in a manner that shipping costs between DCs and customers become minimized and each DC in the network has an equal workload. The most emphasis of this problem is on the importance of degree of balance between DCs. Because the balancing between DCs may redound to an on time supply chain with a low stock out and late delivery also a high order fill rate and utilization rate. The rest of this paper is organized as follows: The literature review and background of this paper is represented in section 2. In section 3 we describe problem in details and develop mathematical model and following this, a genetic algorithm is applied to solve problem. Problem testing and Computational results for evaluate of algorithm briefly is shown in section 4. Finally, section 5 concludes paper and explains possible future research work.

II. LITERATURE REVIEW

Balanced allocation of customer to multiple DCs has a little attention by practitioner and researchers but with increase in complexity of supply chains need for a seamless supply chain network, more than past is comprehended. The balanced

ISBN : 978-602-97809-0-1

allocation problem conceptually is similar to political districting problem. Political districting problem intends to fragment country to a number of electoral districts. Each electoral districts served by an official elected and total population that assign to each district is equal [4]. This problem attempts to design electoral districts as to be neutral as possible base on many criteria such as integrity, contiguity, population equality and compactness. Many exact and approximate algorithms have been developed to solve political districting problem [4] – [6].

Zhou et al. defined balanced allocation problem as a star spanning forest in such a way that each DC is considered as a root node and their allocated customers are leaf nodes that in follows of this, all DCs and their allocated customers construct a star spanning forest [3]. This kind of representation topologically shows an undirected graph and is a specific kind of mini-max spanning forest problems. The mini-max spanning forest problem (MMSFP) consists of a set of mutually disjointed trees and it is related to finding best spanning forest such that the maximum tree cost in this forest be minimized. Many heuristic algorithms were developed for solving MMSFP [7] – [9].

In the traditional location problems, aim is finding location of facilities such a way that associated parameters become optimal [10]. In contrary with this kind of problems, balanced allocation, not follow locating issues because of location of facilities is considered to be fixing and only utilization of them is investigated. Aim of a balanced allocation problem is finding best allocation of customers to DCs such a way that: 1) assigned cost of each DC becomes minimum 2) degree of balance become maximized. Hence, classic problems such as minimum spanning tree problem that only follows to optimize a single parameter such as cost can't meet the goals of balanced allocation problem. In this regard, heuristics algorithm such as greedy algorithms or polynomial time algorithm proposed by [11] and [12] are not suitable to solve a balanced allocation problem.

Zhou et al. [3] proposed a tree based genetic algorithm by define balanced allocation problem as a star spanning forest problem. In their study important factor such as diversity of demands and capacity constraints of DCs haven't seen. In an analogous research paper, Min et al. [13] studied balanced allocation problem with attention to capacity constraints by genetic algorithm. They produce multiple solutions as "satisficing solution" for decision makers. Chan and Kumar [14] investigated balanced allocation problem with optimizing the total transit time in a supply chain with a new formulation. They utilized a multiple ant colony optimization technique with aim of each DC gain equal workload and total transit times become minimized.

III. PROPOSED MODEL

In this section, we firstly describe model and present an integer formulation as mathematical model, then develop a genetic algorithm to solved proposed model.

A. *Mathematical model*

Capacitated balanced allocation problem (CBAP) with multiple products can be shown as a graph. In undirected graph $G = (V, U, E)$, with considering a set of nodes V as $m \times n$ customer demands (n customer sites and m products for each site), a set of nodes U as s DCs and a set of edges E as arcs between customer demands and DCs, each DC and its allocated customer demands is representing a star spanning tree. Different customer demands are considered as leaf nodes and DC is their root node. Following this representation, all DCs and their allocated customer demands construct a star spanning forest composed of l separated star spanning trees $T_1, T_2, ..., T_l$ that represent a solution for CBAP. Whereas each DC has a finite capacity, problem is redefined as finding best-capacitated star spanning forest with attention to balancing. Fig.1 shows a general representation of a supply chain network with multiple DCs and multiple customer sites that each of them has a series of needed products. It is noticeable that shown arcs between DCs and customer demands represents all possible states to allocating customers to DCs but for a solution of CBAP only one arc is connected to a customer demands.

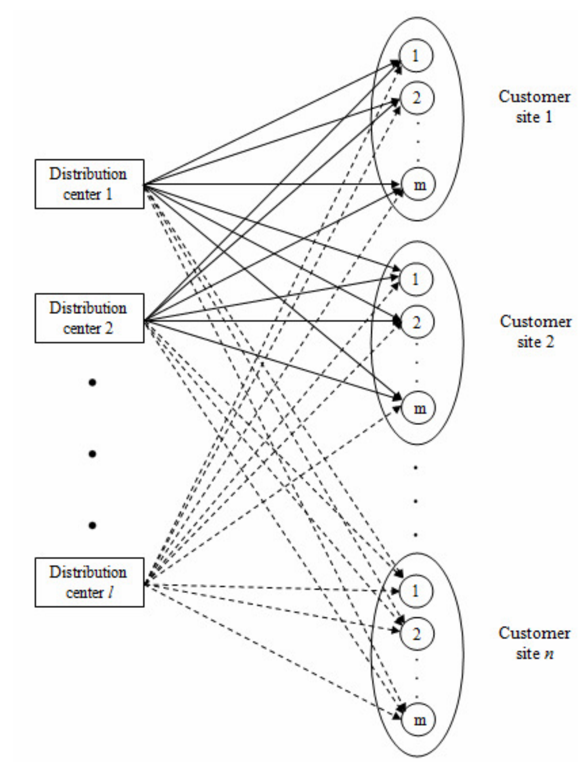

Fig. 1 A supply chain network with multiple DCs and multiple customer sites

As shown in Fig 1, relevant to each arc between customer sites and DCs there is a cost that is shown by c_{ijl} and indicates unit cost per volume of needed product i at customer site j that

 Proceedings of ICIEBM 2010, Yogyakarta - Indonesia

ISBN : 978-602-97809-0-1

is shipped to DC l. Demand quantity of product i at customer site j is D_{ij}. Also f_i is volume of product i. x_{ijl} is a binary variable that is equal to 1 if needed product i at customer site j is assigned to DC l and otherwise it is equal to zero.

The mathematical model of capacitated balanced allocation customers with different demand types is defined as an integer programming model as follows:

$$\min \max_{l=1,2,\dots,s} \sum_{i=1}^{m}\sum_{j=1}^{n} c_{ijl} x_{ijl} f_i D_{ij} \tag{1}$$

Subject to:

$$\sum_{l=1}^{s} x_{ijl} = 1, \quad i = 1,2,\dots,m \quad j = 1,2,\dots,n \tag{2}$$

$$\sum_{i=1}^{m}\sum_{j=1}^{n} x_{ijl} f_i D_{ij} \le w_l, \quad l = 1,2,\dots,s \tag{3}$$

$$x_{ijl} = 0 \text{ or } 1, \quad i = 1,2,\dots,m, \quad j = 1,2,\dots,n, \quad l = 1,2,\dots,s \tag{4}$$

In this model have assumed that all customer demands must be allocated to the DCs and further more there are not any distinction between customer demands to allocate to a specific DC and vice versa. The objective function, equation (1), minimizes the sum of shipping costs, in a way that total shipping costs at each DC be same as others as equitable as possible. Constraint (2) guarantees that each demand in concern of a specific customer, assigned to only one DC. Constraint (3) is related to DCs capacities and ensures that total demands of customers are assigned to a DC do not exceed the given capacity. Since this formulation is similar to a generalised assignment problem formulation, CBAP is categorised in NP-complete problems.

B. *Genetic algorithm*

Many heuristics and meta-heuristic algorithms have been developed to solve NP-complete optimization problems. Despite the multiplicity of these methods, the genetic algorithm still has a particular popularity. Solving many real world problems ensure robustness of genetic algorithms.

1) Representation of chromosome

One of the most important issues in solving problems by mete-heuristic algorithms is permutation encoding. It is because of significant impact on the efficiency and effectiveness of the algorithm. Dependent nature of various problems, encoding practices also differ. For representation of candidate solution, we use a simple and efficient method that covers all solution space. For this purpose, in a distribution network with m products, n customers and s DCs, the vector of a candidate solution is encoded as follows: Since there are $m \times n$ different customer demands, a vector as length of $m \times n$ represent our chromosome, so that each element of this vector has an integer value between 1 and s that is represents a DC. It indicates that customer demand in this vectorial position is assigned to shown DC. For example Fig 2 shows a candidate solution for a distribution network with 2 products, 3 customer sites and 3 DCs.

1	2	1	2	1	2
2	3	3	2	1	1

Fig. 2 An example of a chromosome

2) Fitness function

The fitness value determines the respective goodness of a chromosome and intends to select strong chromosomes as survivals for next generation. Because of large solution space in this problem, we should to define a kind of fitness function to avoid selecting infeasible solution. Hence, choice of fitness function has important influence on computational efficiency and accuracy of algorithm. Due to capacity constraints related to the DCs, some obtained solution during the algorithm may be infeasible. In this regard, for prevent of creating and accepting infeasible, must be a penalty value assigned to fitness value of these solutions. Following terms show the method of calculating fitness value for each candidate solution:

$$f = \max f_l \quad , l = 1,2,\dots,s \tag{5}$$

$$f_l = F_l(x) \,.\, P_l(x) \tag{6}$$

$$F_l(x) = \sum_{i=1}^{m}\sum_{j=1}^{n} c_{ijl} x_{ijl} f_i D_{ij} \tag{7}$$

$$P_l(x) = \begin{cases} 1)\ \delta + \dfrac{\left(\sum_{i=1}^{m}\sum_{j=1}^{n} x_{ijl} f_i D_{ij} - w_l\right)}{w_l}, \\ \qquad \text{if } \sum_{i=1}^{m}\sum_{j=1}^{n} x_{ijl} f_i D_{ij} > w_l \quad , \forall l, \\ 2)1, \\ \qquad \text{if } \sum_{i=1}^{m}\sum_{j=1}^{n} x_{ijl} f_i D_{ij} \le w_l \quad , \forall l. \end{cases} \tag{8}$$

This kind of formulation is regular among researchers, and intends to conduct solutions to feasible solution area. Because type of objective function operator is min-max, according to equation (5), lower fitness value is related to a stronger chromosome. Considering the multiplicity constraints in this problem, to avoid selecting infeasible solutions, we consider a

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penalizing coefficient. This coefficient is a greater than one parameter and ensures that chromosome related to an infeasible solution, get a poor fitness value and it reduce the chance of selection in next generation for these chromosomes. Equation (8) is developed to calculate penalization ratio for each situation according to relative degree of objection value, and penalty coefficient that is shown with δ and is a greater than one amount. Equation (6) give penalized shipping costs by multiplying penalizing ratios and shipping cost obtained by equation (7) for each DC.

Since this model aim to attain balanced solutions with regard to capacity constraints, we need to penalize unbalanced solutions to changes the solutions direction towards capacitated balanced solutions. For this purpose, an imbalance penalty should to gain and multiply in obtained value in equation (6). Final fitness value for evaluate candidate solutions can define by equation (9).

$$f^{'} = IP(x)\,.\,f \tag{9}$$

Where $IP(x)$ is imbalance penalty that is given by equation (10) so that β is imbalance scale and calculates by equation (11). γ is a coefficient to control the rate of imbalance penalty that is between 0 and 1. This control coefficient helps to avoid penalizing solutions with a great imbalance ratio. Because it can deteriorates a solution that is capable to be a good solution in the next step of algorithm.

$$IP(x) = 1 + \gamma.\beta \tag{10}$$

$$\beta = \left(F_{\max}(x) - F_{\min}(x)\right) / F_{mean}(x) \tag{11}$$

In equation (11), $F_{\max}(x)$ is maximum value of shipping costs between all DCs, $F_{\min}(x)$ is minimum value of shipping costs and $F_{mean}(x)$ is the mean of shipping costs for all DCs. When a solution is completely balanced, it means β is equal to zero. Accordingly, imbalance penalty not impose any penalty to this chromosome. Inversely, an imbalance solution makes a positive value for β and with considering chosen value of γ it burdens a greater than one imbalance penalty to the solution and it deteriorates the goodness of fitness value.

3) Selection operators

The main goal of selection operators is choosing better chromosomes and emphasize on fitter solutions. For achieve this goal, several issues should be taken into consideration; how to choose chromosomes in the population for creating offspring and how many offspring should be created and how chromosomes are selected as population in next generation [15].

Parent selection

Select chromosome from the population as the parent is arbitrary. In this paper, parent selection is done by roulette wheel selection rule. Base on fitness value, each chromosome has a probability to be selected. Using this rule, chromosomes with higher fitness value have more chance to select. This selection procedure ensures strong survivals.

Survivor selection

For a good exploration and prevent premature convergence, ($\lambda + \mu$)-selection strategy that proposed by [16] is chosen as survivor selection scheme. Base on this scheme, after producing λ offspring from μ parents, for next generation, μ best and different chromosomes within $\lambda + \mu$ parents and offspring are selected as the next population.

4) Crossover and mutation

Crossover is process of taking two parent chromosomes from mating pool and producing offspring by combination of them with aim of finding better solutions. In this paper, we use a uniform crossover that it firstly produces a random binary mask of the same length as the chromosomes and then swap relative genes material of parent chromosomes according to generated binary mask. This crossover result a good exploitation of solution space [17].

After crossover, we perform an exchange mutation. For exchange mutation, one parent randomly selects from mating pool then two different arbitrary genes of the parent chromosome choose and swap the allele values [15].

5) Repairing process

In addition penalty function in fitness evaluation, we need an operator to repair produced solutions to accelerate algorithm in finding best solution. In this regards, a repairing operator after producing new solutions in both simulated annealing and genetic algorithm is used that is described as below:

In a candidate solution, S_l as a set of customer demands assigned to DC l is considered. If total customer demands assigned to distributor l is more than its capacity, *i.e.* $\sum_{i=1}^{m}\sum_{j=1}^{n} x_{ijl} f_i D_{ij} > w_l$, one customer demand assigned to this distributor is randomly selected then assign one of those distributor that have sufficient capacity to satisfy randomly selected customer demand. If number of distributors that have sufficient capacity to fulfil customer demand is more than one, one of them randomly selected. This procedure continues for all over utilized distributors until total customer demands of all distributor not exceed their capacity constraints and obtained solution become feasible as much as possible.

Such repairing process not only change produced infeasible solutions to feasible ones, but it can help to finding solution with better fitness value in the feasible solution.

6) Termination criterion

In this paper, Algorithm is terminated after a constant number of generations.

ISBN : 978-602-97809-0-1

IV. PROBLEM TESTING AND RESULTS

In this study, for examination of effectiveness of proposed algorithms a number of numerical experiments are tested. Varying problem sizes and parameters associated with proposed balanced allocation problem are generated to investigate efficiency and robustness of algorithm. Parameters related to problem are number of products, number of customers, and number of DCs and volume of products. Since there are totally $m \times n$ different customer demands and total number of DCs are s, all potential solutions of problem is equal to $s^{m \times n}$ that are sum of feasible and infeasible solutions. In this regard, with increase in the size of this mentioned problem parameters, solution space exponentially increases. Herein we choose these parameters such a way that different size of problem be tested to computationally investigate algorithm in compare to each other. For this purpose, these experiments have been categorized in four groups as shows in table 1. In each group, four instances have performed with choosing a set of randomly generated parameters as described in table 2.

TABLE 1.

CLASSIFICATION OF TESTED PROBLEMS

Category	Number of demands ($m \times n$)	Number of DCs
Very small	20-40	3-4
Small	40-60	5-6
Medium	60-80	7-8
Large	80-100	9-10

TABLE 2.

DIFFERENT RANGES OF PARAMETERS FOR NUMERICAL EXPERIMENTS

Parameter	Range of generated values
Shipping cost	U(20, 50)
Product volume	U(5, 20)
Demand quantity	U(100, 500)
Number of products	[3, 10]
Number of customers	[8, 17]

The proposed algorithm is coded by Matlab 2008a and run on a personal computer with a Core 2 Dou 2.2 GHz CPU and 2.5 GB of memory. For verify algorithm we have applied LINGO 8 to solve problems. LINGO is a modelling language to develop and solve mathematical models and allows practitioners to express complex problems in a straightforward manner. For nonlinear optimization LINGO uses Branch and bound (B&B) algorithm as primary solver [18]. B&B is a well known algorithm for solving NP-Hard combinatorial problems that enumerate all solution space to finding best solution. In large scale problems, enumeration of all solution space is impossible and it may lead to a local optimum solution [19]. Hence using meta-heuristic algorithms can help to find solutions that are more desirable.

Results of proposed genetic algorithm for degree of balance as the most important output, indicate that in all problems, obtained results by genetic algorithm is better than results of LINGO. These comparative results for GA and LINGO are shown in Fig 3.

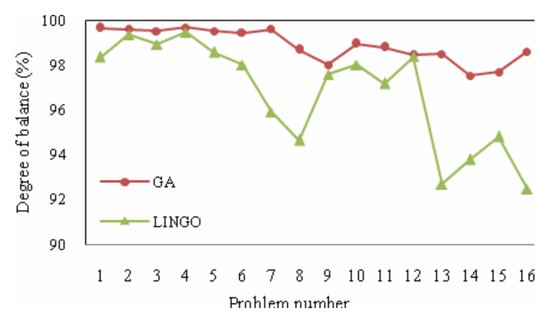

Fig.3 Degree of balance for different problem size

As described earlier, apart from degree of balance, assigned cost of each DC is another important parameter of a balanced allocation problem. Obtained results of average cost of each DC for different solved instances are shown in Fig 4.

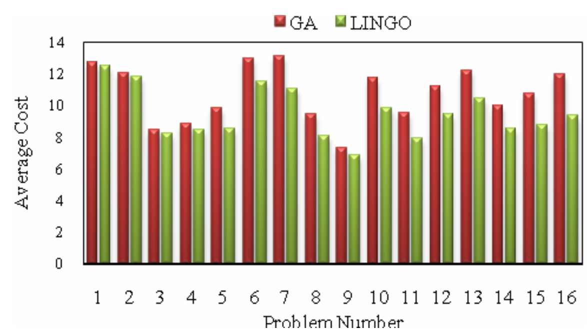

Fig. 4 Average cost of each DC for different problem size

V. CONCLUSIONS

Balance allocation of customer to multiple DCs is one of the strategic decision issues in the supply chains. Use of this allocation strategy has a significant effect in reducing shortages, loss sales and delivery lead times. Increase in order fill rate and utilization rate of DCs are another advantages of balanced allocation of customers in enhance performance of supply chains. Capacitated balanced allocation problem is known to be a NP-Complete problem. In this paper we develop a balanced allocation problem with considering multiple products that is an efficacious parameter in modelling of supply chain. After this, a genetic algorithm has developed to solve this problem. Obtained results shown the efficiency of proposed algorithm. As the future works, may use another algorithms similar to SA, TS and HS can improve the results. Also the model can develop by considering multiple transportation mode and difference between DCs. Another important parameter like transit time beside shipping cost can considered in a multi objective model.

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Automatic Door Access System using Small Embedded Single Board Computer

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Abstract **– Safety and security are major and important factors in any industrial, office, or any secured facility. Unauthorized access in room or facility containing sensitive or confidential materials, or high risk facility may lead to undesired things such as patents stealing, documents stealing, misused facility, etc. This research implements an automatic door access system using embedded single board computer. Automatic door access system leads to safer work environment and provides more reliable protection from any unauthorized access. The advantage of this system than using conventional or manual door lock is that more specific access can be implemented and any security measures like alarm system or other safety mechanism can be added to the system, providing more reliable protection and specific access for user. In this research, contactless smart card is used for user identification. The developed system shows that the system is working as expected. The system can identify multiple users each with different card. More specific access such as access by day, hour, even minute can be implemented. Alarm is used for indication if the door is unlocked or any forced attempt is happening. Future works will include the development of multiple access checkpoints using one single board computer and supervisory system to monitor all access checkpoints.**

Keywords **— Automatic door lock, embedded, single board computer, smart card, security, safety, access checkpoints.**

I. Introduction

Safety and security are major and important factors for sustainable operation in any industrial, office, or any secured facility. Premises containing sensitive or confidential materials, or high risk facility requires access limitation means to avoid patents and documents stealing, misused facility, damaged machinery, and others. Safety and security management cannot work effectively without the support of technology. This research considers the development of an automatic door access system using embedded single board computer for safety and security technology. Previous research has been done on smart card for door access system using Desktop PC [5]. In this research, single board computer is used for its low power consumption and low cost. The advantage of using this system than conventional door lock is that more specific access can be implemented such as access by day, hour, even minute. The single board computer used in the system is small enough to be installed integrated within the premises anywhere required. The system can be introduced with other types of additional security measure such as alarm system or any other safety mechanism, providing more reliable protection. In this research, contactless smart card is used for user identification. Biometric technology such as iris or fingerprint scanner can also be used to replace smart card for identification. Future works will include adding biometric technology for ID confirmation, controlling multiple access checkpoints using one single board computer, the development of supervisory system for monitoring access checkpoints, and so on.

II. Single Board Computer

There are many types of single board computer available on the market. In this research, Mini2440 single board computer is used for the implementation. Mini2440 is a practical low - cost ARM9 Single Board Computer (SBC) with a very high performance/cost ratio [2]. With the Samsung S3C2440 microprocessor and the use of professional layout and quality peripheral chips, this SBC is very robust [2].

The Mini2440 uses a four - layer board design with gold immersion processing, and has high quality equal - length bus routing in timing critical areas [2]. The production environment and quality control are the same as those of modern high-speed motherboards [2]. Fig.1 below shows Mini2440 [2].

Figure 1. Mini2440.

Fig.2 below shows Mini2440 size compared with another mobile device [4].

Figure 2. Size of Mini2440 compared to a mobile device.

Mini2440 has the following specifications [2][3]:

– Processor - Samsung S3C2440A, 405MHz (Max 533Mhz)
– RAM On - board 64M SDRAM 32bit data bus clock frequency up to 100MHz
– 128Mbytes (64Mbytes) NAND Flash, 2MBytes NOR Flash with installed BIOS.
– LCD interface 3.5 inch with touch screen capability.
– 1 10/100M Ethernet RJ - 45 interface (DM9000 network chip)
– 3 serial ports - one configured for RS - 232, COM0
– 1 USB Host, 1 USB Slave B - type interface
– 1 SD card storage interface, no size limit
– 1 channel stereo audio output interface.
– 1 built in microphone, 1 microphone input.
– 1 2.0mm pitch 10-pin JTAG interface
– 4 User LEDs
– 6 User buttons (with connection to GPIO connector and 8 pin user connector)
– 1 buzzer PWM control
– 1 adjustable resistor for A/D test
– 1 I2C bus AT24C08 chip for I2C Bus test, holds 256 bytes.
– 2.0 mm pitch 20-pin camera interface
– Power interface (5V), with power switch and indicator light
– Dimension 100mm x 100mm

With those specifications, Mini2440 has more computational strength than microcontroller with has approximately equal processing strength with PC in terms of data communication and processing, but smaller than any Desktop PC, notebook, or embedded PC in common.

III. CONTACTLESS SMART CARD

Many options can be chosen for user identification, from access code, biometric, smart card, and other means. In this research, contactless smart card is used for identification. Smart card is a plastic card with size almost equal to credit card, which has silicon chip inside for data storage. Contactless smart card uses microcircuit and Radio Frequency Identification (RFID) to exchange information [7]. So, physical contact between card and the reader is not required.

Basically, there are two types of smart card, contact and contactless smart card. Compared to contact smart card, contactless smart card does not require physical contact for data transaction. The card can be read by the reader without taking it out from purse, wallet, or anything making it more convenient and faster to use [6]. Because no physical contact required, contactless card has longer lifespan than contact card [5]. There are several types of card that can be used. In this research, Mifare 1K and 4K cards are used. Fig.3 below shows image of Mifare contactless smart card. This type of smart card shown in Fig.3 is available and can be found easily on the market.

Figure 3. Mifare card

IV. SYSTEM DESIGN

Designed system provides access limitation to ensure safety and security of the corresponding protected room or facility. The system will scan every card that is being used to request access. The system checks if the card is registered as user or not and checks for access status of the corresponding user. If the card is registered and access time is within the allowed access time, the system will unlock the door and the door remains unlocked until the user entered the room or facility. Fig.4 below shows the block diagram of the system [5]. The application is designed using C language. The application is implemented in open source operating system (OS) Linux Qtopia.

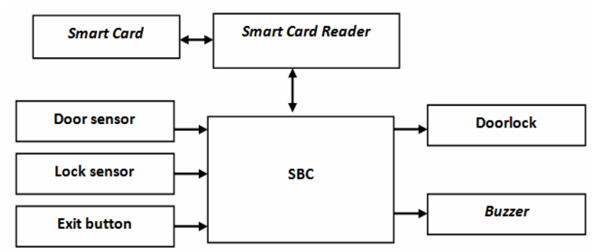

Figure 4. System block diagram

Smart card is used as key to unlock the door. Each card has its own unique serial number which is different in each card. This serial number is used to differentiate each user. User information (names, social security number, ID number, and other) can be saved in the card for better identification. In this research, the system acquires serial number from presented card and compares with the registered number in system's database. If the card is registered and the user logs in within the allowed access time, the system will unlock the door, allowing the user to get in the room or facility.

Smart card reader is used as data exchange media between SBC and card. When a card is present, the reader will scan the card and send the card information and contained data to the SBC. In this research, contactless smart card reader from ACS is used [1].

Door sensor is used to check whether the door is opened or closed. Lock sensor is used to detect whether the door is locked or unlocked. Exit button is located inside the room or the facility. The button is used to unlock the door if the user inside the room wants to exit the room.

Buzzer is used as indicator. If the door is unlocked or the door is breached, the buzzer will turn on with unique pattern which is different for every possible conditions.

SBC is used for data processing and lock control. SBC sends and receives data and responses from smart card. Data and responses are then processed by the SBC to determine access status of the corresponding user. SBC will also check and acquire data from sensors and control the door lock.

To control the door lock, any form of electronic lock can be used. In this research, car central lock is used. The central lock contains solenoid which is used as lock actuator. The lock is controlled by the SBC through lock driver circuit.

The door prototype used in this research is a push/pull type door which the dimension is 50cm x 30 cm. Fig.5 shows the prototype of the door [5].

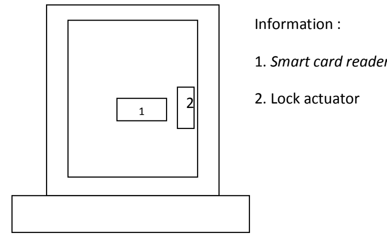

Figure 5. Door prototype

Lock mechanic is put inside the door. Smart card reader is put in front of the door. Exit button is put behind the door or inside the room. The door sensor is put underneath the door and the lock sensor is put inside the door near the lock lever.

The application is developed in Linux operating system, which is open source and freely distributed. The graphical user interface or display is simple but gives enough information to the user.

The algorithm of the developed application has flowchart which is explained in Fig.6 below.

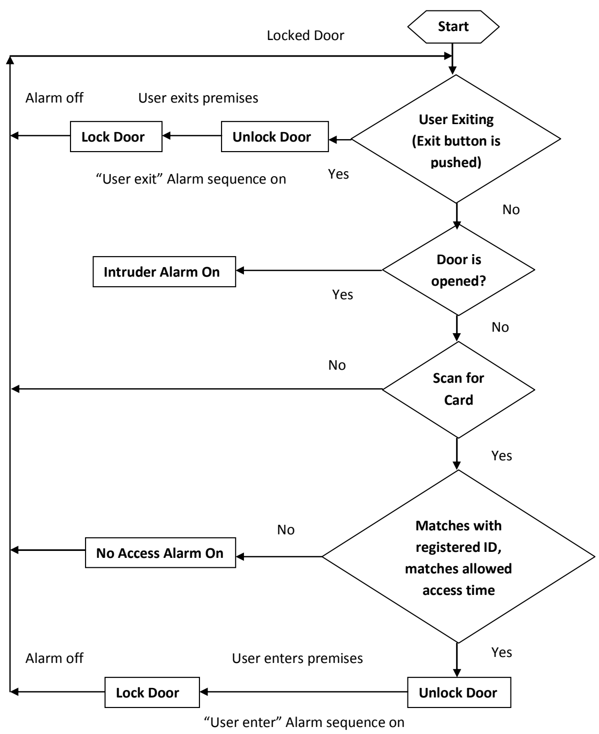

Figure 6. Application flowchart

Application works:

1. In default state, the door is closed and locked. The application scans the exit button state whether a user is about to exit the room. If the exit button is pressed, the door is unlocked. After the user exits the room and closed, the door will be locked automatically.

ISBN : 978-602-97809-0-1

2. If no user is exiting the room, the application scans for a card continuously. If a card is present, the application checks the serial number contained within the card whether it is registered in the database or not. If the card is registered as a user, the application checks for allowed access time of the corresponding user.
3. If the card is registered and the user logs in at the allowed access time, the door will be unlocked so the user can access the premises or facility. After the user enters the facility and closes the door, the door will be locked automatically.

If the door is forcedly opened in the default state (closed and locked), the "intruder" alarm will on. The alarm itself has several beeping mode. When a user is entering the facility or exiting the facility, the alarm will on with its own beeping sound according to the corresponding event.

V. System Test Results

To test the system, three cards used for identification are registered in the database. Two of them are Mifare 1K cards, and one of them is Mifare 4K card which is a university student ID. The cards are given call signs "ID1", "ID2", and "ID3", each has its own authorized access time. One unregistered Mifare 1K card, give call sign "ID4" is also used to represent "unknown identification". Table 1 below explains the description of each card with each corresponding owner or user.

TABLE 1

CARD DESCRIPTION

No	Card Type and SN	Identification and Access Time
1	Mifare 1K (ID1) 8C7E044C	Name : Bendot K.D
		ID Number : 39876
		Access Time : 12AM – 7 PM
2	Mifare 4K (ID2) D42DD353	Name : Udayanto D.A
		ID Number : 31690
		Access Time : 3PM – 11PM
3	Mifare 1K (ID3) 6CE6643C	Name : Viktor Troska
		ID Number : 31445
		Access Time: 8AM – 5 PM
4	Mifare 1K (ID4) unknown	Unknown Identification

The application is executed in SBC. Fig.7 shows the application start up in SBC.

```
## SMART CARD DOOR ACCESS SYSTEM v1.0b ##
##   Developed by Mas'Ud Uday Atmojo ##
##      mas_ud@mail.te.ugm.ac.id     ##

Reader Has Been Connected!


Please Tap Your Card on to the Reader!

█
```

Figure 7. Application start up

At start up, the application is checking for card availability continuously. If any card is detected, the application will scan for its serial number and compare it with the registered card database.

First, ID3 card is presented near the reader. The application scans the card and displays the result shown in Fig.8 below. The application confirms the card is registered and unlocks the door. While the door is still unlocked until the user enters and the door is closed, "User Enter" alarm sequence is on as an indicator. This condition is the same with ID1 logging in at authorized access time except for the user identification data.

```
A Card Has Been Detected!
Analyzing Card Data.......
61 10
Analyzing COMPLETE!


###### Card Data ######

Target number : 01
Tag Type : 10
Sens_Res : 00 04

Mifare 1K ID CARD Detected!



###### END CARD DATA ######

##### USER ID #####

Name               :Viktor Troska
NIM                :31445
Access time        :Everyday after 8AM until 5 PM
User logged in at  :Wed Jul 28 14:01:01 2010


################# ACCESS STATUS ################

YOU ARE AUTHORIZED FOR ACCESS!

##### END #####

UNLOCKING DOOR
You can open the door now!
The door has been unlocked!
Door is still closed!
You may open the door now!
█
```

Figure 8. ID3 accessing in.

After the user enters and closes the door, the system will lock the door automatically. The application writes the log data inside the SBC containing user who logs in. After that the system will continue to its default state checking card availability. Fig.9 below shows the application state after ID3 logs in.

```
Mifare 1K ID CARD Detected!


###### END CARD DATA ######

##### USER ID #####

Name             :Viktor Troska
NIM              :31445
Access time      :Everyday after 8AM until 5 PM
User logged in at :Wed Jul 28 14:01:01 2010


################ ACCESS STATUS ###############

YOU ARE AUTHORIZED FOR ACCESS!

##### END #####

UNLOCKING DOOR
You can open the door now!
The door has been unlocked!
Door is still closed!
You may open the door now!
Door has been opened!
Please close the door immediately!
Door has been closed!
Locking process initiating!
LOCKING DOOR INITITATING

## SMART CARD DOOR ACCESS SYSTEM v1.0b ##
##   Developed by Mas'Ud Uday Atmojo ##
##      mas_ud@mail.te.ugm.ac.id     ##


Please Tap Your Card on to the Reader!
█
```

Figure 9. Application status after ID3 user enters

Next, ID2 card is presented near the reader at unauthorized access time. The application scans the card and displays the result shown in Fig.10 below. The application confirms the card is registered but keeps the door locked because ID2 user is logging in at unauthorized time. “No access” alarm is on.

```
###### Card Data ######

Target number : 01
Tag Type : 10
Sens_Res : 00 02

Mifare 4K ID CARD Detected!


###### END CARD DATA ######

##### USER ID #####

Name             :Udayanto Dwi Atmojo
NIM              :31690
Access time      :Everyday after 3 PM until 11 PM
User logged in at :Wed Jul 28 14:06:31 2010


################ ACCESS STATUS ###############

YOU ARE NOT AUTHORIZED FOR ACCESS RIGHT NOW!
UNALLOWED ACCESS TIME!
UNAUTHORIZED ACCESS!

## SMART CARD DOOR ACCESS SYSTEM v1.0b ##
##   Developed by Mas'Ud Uday Atmojo ##
##      mas_ud@mail.te.ugm.ac.id     ##


Please Tap Your Card on to the Reader!

█
```

Figure 10. Unauthorized access for ID2

After ID2 fails to log in, the application will back to its default state, scanning for card availability.

Next, unknown identification ID4 card is presented near the reader. The application scans the card and displays the result shown in Fig.11 below. The application denies the authorization request from ID4 because ID4 card is not registered in the system’s database. Because ID4 is not authorized, “no access” alarm is on.

```
Analyzing COMPLETE!


###### Card Data ######

Target number : 01
Tag Type : 10
Sens_Res : 00 04

Mifare 1K ID CARD Detected!


###### END CARD DATA ######

##### USER ID #####

UNKNOWN ID!
UNAUTHORIZED ACCESS!

## SMART CARD DOOR ACCESS SYSTEM v1.0b ##
##   Developed by Mas'Ud Uday Atmojo ##
##      mas_ud@mail.te.ugm.ac.id     ##


Please Tap Your Card on to the Reader!

█
```

Figure 11. Unknown ID access unauthorized.

When a user inside the room or facility wants to exit the room, the user must press the exit button provided. After the exit button is pressed, the system will unlock the door, making the user inside can exit the room. Fig.12 below shows the application status when the exit button is pressed by a user inside the room.

```
## SMART CARD DOOR ACCESS SYSTEM v1.0b ##
##   Developed by Mas'Ud Uday Atmojo ##
##      mas_ud@mail.te.ugm.ac.id     ##


Please Tap Your Card on to the Reader!

User exiting!
Unlocking Door now!
UNLOCKING DOOR
Door has been unlocked!
You may open the door now!
Door has been opened!
Please close the door immediately!
Door has been closed
Commence locking process!
LOCKING DOOR INITITATING

## SMART CARD DOOR ACCESS SYSTEM v1.0b ##
##   Developed by Mas'Ud Uday Atmojo ##
##      mas_ud@mail.te.ugm.ac.id     ##


Please Tap Your Card on to the Reader!

█
```

Figure 12. Application status when a user exits the room

After the user exits the room and the door has been closed, the system locks the door and the application will back to its default state, scanning for card availability.

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When a user logs in or attempts to log in, the identification of the user is recorded in the log report inside the system. The log report contains user identification and log in time. Fig.13 below shows the log generated by the system.

```
User Logged in: Wed Jul 28 14:01:01 2010
 NAME   : Viktor Troska
 NIM    : 31445

Attempted User Log In: Wed Jul 28 14:04:15 2010
 NAME   : UNKNOWN ID
 NIM    : UNKNOWN

User Attempted Log in: Wed Jul 28 14:04:55 2010
 NAME   : Udayanto Dwi Atmojo
 NIM    : 31690
UNALLOWED ACCESS TIME

User Attempted Log in: Wed Jul 28 14:04:59 2010
 NAME   : Udayanto Dwi Atmojo
 NIM    : 31690
UNALLOWED ACCESS TIME

User Attempted Log in: Wed Jul 28 14:06:31 2010
 NAME   : Udayanto Dwi Atmojo
 NIM    : 31690
UNALLOWED ACCESS TIME

User Attempted Log in: Wed Jul 28 14:07:39 2010
 NAME   : Bendot Kurugan Daging
 NIM    : 39876
UNALLOWED ACCESS TIME

User Logged in: Wed Jul 28 14:09:03 2010
 NAME   : Bendot Kurugan Daging
 NIM    : 39876

User Logged in: Wed Jul 28 14:17:36 2010
 NAME   : Bendot Kurugan Daging
 NIM    : 39876
```

Figure 13. Log report generated.

The log itself is saved in the SBC and may be observed at anytime.

Temporarily, no detailed comparison has been made between the designed system and existing automatic door access system. But the system is expected to have high performance at competitive price compared to the existing similar products on the market.

VI. Conclusions

To make safety and security more reliable, an automatic door access system using SBC is designed. Instead using conventional key, contactless smart card is used to access the corresponding room or facility.

The result shows that the design is working well as expected. The system can recognize card user by comparing the presented card's serial number with the available database and reject a log in request if unauthorized user attempts to log in or unregistered card is used to access the room or facility.

Using sensors installed in the door, system can detect the door status and perform automatic lock-unlocking procedure.

In the future, the system will be developed furthermore by improving the reliability, replacing the identification mean using biometric, adding supervisory system to monitor multiple access checkpoints, and so on.

Acknowledgment

The author would like to say thanks to Mr. Dayasakti Nawa Kartika who had given helpful suggestions and supports in implementing this research, and to Mr. Mudiono who had given permission to improve his research, and also to all our family, friends, and colleagues in Gama Cendekia and Department of Electrical Engineering and Information Technology for all the supports, motivations, and the inspirations. May Allah Blesses us everywhere where go and everything we do.

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Genetic Algorithm for a Dynamic Inbound Ordering and Shipping, and Outbound Dispatching Problem with Delivery Time Windows

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***Abstract* - This paper considers a single-product problem for inbound ordering and shipping, and outbound dispatching at a third-party warehouse, where the demand is dynamic over the discrete time horizon. Each demand must be delivered into the corresponding delivery time window which is the time interval characterized by the earliest and latest delivery dates of the demand. Ordered products are shipped by a container and the freight cost is proportional to the number of containers used. Also it is assumed that related cost functions are concave and backlogging is not allowed. We propose a genetic algorithm (GA) for efficiently solving the large-sized real problems. We compare the performance of the proposed GA with the optimal solution using CPLEX package through simulation experiments. This paper simultaneously provides the effective decisions for ordering, shipping, and dispatching plan to minimize total costs which include ordering, shipping, and inventory holding costs.**

***Keywords* – – dynamic demand, lot sizing, shipping, dispatching, delivery time window, genetic algorithm, third-party logistics**

I. INTRODUCTION

For the couple of decades, the reduction of transportation cost and warehousing cost have been two important issues to enhance logistic efficiency and demand visibility in a supply chain. The logistic alliances and specialized Third-Party-Logistic (TPL) providers have been growing to reduce the costs in industry. In a dynamic planning time period, the issue of transportation scheduling for inbound ordering and shipping of products to TPL warehouse by proper transportation modes at right time and the issue of lot size dispatching control including inventory control to the customers have become significantly important for production and distribution management.

In this paper, a warehouse purchases a single product to deliver a number of demands of the product. Ordered product is shipped by a container and the freight cost is proportional to the number of containers used. The warehouse purchases the product and uses a freight container as a transportation unit to ship into the warehouse, and delivers its purchased (or manufactured) product in the warehouse to retailers, which may lead to the managerial decision problems including lot-sizes and dispatching size for each demand, container types used, loading policy in containers, and the number of containers are used. Furthermore, each demand must be delivered into the corresponding delivery time window which is the time interval characterized by the earliest and latest delivery dates of the demand. Thus, this provides us with a motivation to simultaneously investigate the optimal lot-sizing, inbound shipment scheduling, outbound dispatching problem.

The dynamic lot-sizing model (DLSM) has stemmed from the work of Wagner and Whitin [1]. The majority of DLSMs have not considered any production-inventory problem incorporating transportation activities. Several articles have attempted to extend the classical DLSM incorporating production-inventory and transportation functions together. Lee [2] considered DLSM allowing multiple set-up costs consisting of a fixed charge cost and a freight cost, in which a fixed single container type with limited carrying capacity is considered and the freight cost is proportional to the number of containers used. Lee *et al.* [3] extended the works of Lee [2] by considering multiple heterogeneous vehicle types to immediately transport the finished product in the same period it is produced. It is also assumed that each vehicle has a type-dependent carrying capacity and the unit freight cost for each vehicle type is dependent on the carrying capacity. Lee *et al.* [4] considered a dynamic model for inventory lot-sizing and outbound shipment scheduling in the Third-Party Warehousing domain. They presented a polynomial time algorithm for computing the optimal solution. Lee et al. [5] was the first paper that studied the DLSM with time windows. They developed two polynomial time algorithms for the case of a backlogging allowed the case of a backlogging being not allowed. Jaruphongsa et al. [6] studied a single item, two-echelon DLSM with delivery time window. Hwang and Jaruphongsa [7] developed a polynomial time algorithm based on untraditional decomposition principle. Wolsey [8] proposed polynomial time algorithm considering both production and delivery time windows. Hwang [9] developed an improved algorithm by the model of Lee et al. [5]. Hwang and Jaruphongsa [10] studied a lot-sizing model for major and minor demands in which major demands are specified by time windows while minor demands are given by periods.

This paper analyzes a dynamic inbound ordering and shipment scheduling, and outbound dispatching problem for a single product that is transported from a supplier to TPL warehouse by common freight containers and delivered to retailers in a supply chain. It is assumed that each order is not allowed to split to ship in the different periods and shipped immediately in the same period and the total freight cost is proportional to the number of containers used. Delivery can be split within the time window. Further, no backlogging is allowed. The main objective of this study is to simultaneously determine the lot-sizes and the shipment schedule that minimize the total cost which consists of ordering, inventory holding, and freight costs.

II. MODEL FORMULATION

The following notations are defined to formulate the problem:

- T = length of periods,
- t = period index ($t=1,2,\cdots,T$),
- M = number of demands,
- i = demand index ($i=1,2,\cdots,M$),
- W = carrying capacity of a container,
- S_t = ordering cost in period t,
- h_i = unit inventory holding cost of demand i from period t to period $t+1$,
- F = unit freight cost of container in period t,
- x_t = amount of ordering and shipping to a warehouse by container in period t,
- I_t = amount of inventory at the end of period t,
- d_{ti} = amount of demand i in period t, and
- d_i = amount of delivery for demand i,

The objective of the problem is to determine (x_t, d_{ti}) for $t=1,2,\cdots,T$ and $i=1,2,\cdots,M$ such that the demands over given horizon must be satisfied at the minimum total cost. In this paper, ordering and procurement cost is a fixed-charge cost in one of concave functions and freight cost is a fixed cost depending on the volume of a container and the number of containers. The ordering and procurement cost and freight cost are as follows:

$$K_t(x_t) = S_t\delta(x_t) + px_t + F\lceil x_t/W \rceil \tag{1}$$

where, $\lceil a \rceil$ is an integer value no less than a and $\delta(\cdot)$ is 0-1 integer variable. Therefore, the T-period problem can be formulated in a mathematical program as follows:

$$(P) \quad \text{Min} \quad \sum_{t=1}^{T} K_t(x_t) + h_t I_t \tag{2}$$

$$\text{s.t.} \quad x_t + I_{t-1} - \sum_{k=1}^{M} d_{kt} = I_t,\ t=1,\ldots,T \tag{3}$$

$$\sum_{t=E_k}^{L_k} d_{kt} = d_k,\ \ k=1,\ldots,M, \tag{4}$$

$$d_{kt} \ge 0,\ \ k=1,\ldots,M;\ t=E_k,\ldots,L_k, \tag{5}$$

$$d_{kt} = 0,\ \ k=1,\ldots,M;\ t=1,\ldots,E_k-1, \tag{6}$$

$$d_{kt} = 0,\ \ k=1,\ldots,M;\ t=L_k+1,\ldots,T, \tag{7}$$

$$I_0 = I_T = 0, \tag{8}$$

$$x_t \ge 0,\ I_t \ge 0,\ \ t=1,\ldots,T, \tag{9}$$

The constraints (3)-(9) define a closed and bounded convex set, and the objective function is concave, so that it attains its minimum at an extreme point of the convex set. The mixed integer model P can be represented by a network model as Fig. 1. Lee [11] developed an algorithm with the complexity of $O(M^2T^3)$ using dynamic programming. However, the proposed algorithm requires the constraint that the container capacity must be $W \ge \max\{d_i, i=1,2,\ldots,M\}$. In practice, however, the amount of demands is more than the container capacity. In this case, we expect that the complexity become hard as (T, M, d_i), where $i=1,\ldots,M$ increases so that the mixed integer programming cannot provide an optimal solution within reasonable CPU time. Hence, we focus on heuristic algorithm using a genetic algorithm to obtain near-optimal solutions.

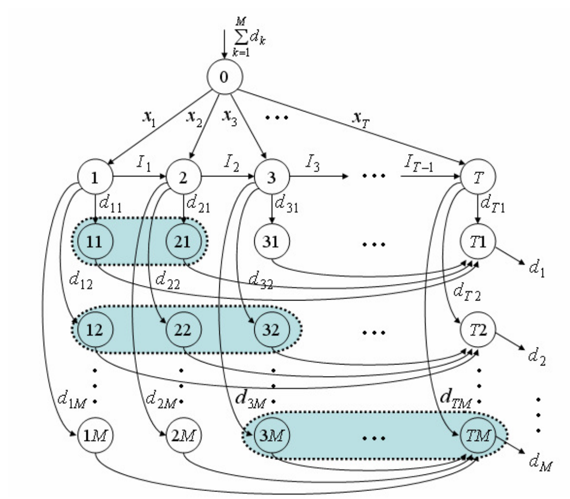

Fig.1 Network representation of the model P

III. GENETIC ALGORITHM

The genetic algorithms, which have been widely used in various areas for three decades, are stochastic search

ISBN : 978-602-97809-0-1

algorithms based on the mechanism of natural selection and natural genetics. Generally speaking, the genetic algorithm is applied to large spaces to be exhaustively searched [12].

A. Representation and initialization

The proper representation of a solution plays a key role in the development of a genetic algorithm. Since we have a set of two decision variables $(\mathbf{X},\mathbf{D})$ to represent, we first initialize dispatching amount $(\mathbf{D})$ and then we initialize the purchasing amount $(\mathbf{X})$ using the zero-one-two encoding, in which the purchasing amount $(\mathbf{X})$ is represented by 0, 1, or 2.

1) Initialization $(\mathbf{D})$: Vigaux and Michalewicz [13] proposed two-dimensional real representation at the linear transportation problem and showed a good performance. Since the dispatching amounts of d_{ti} have two dimension such as planning horizon and demand, we adopt two-dimensional real representation to initialize the dispatching amount $(\mathbf{D})$. The procedure of initial chromosome for the dispatching amount $(\mathbf{D})$ is as follows:

begin
  $\pi \leftarrow \{1,2,\dots,TM\}$
  $u_k \leftarrow d_k$, for $k = 1,\dots,M$
  repeat
    select a random number i from set π;
    calculate corresponding row and column;
      $k \leftarrow \lfloor (i-1)/T+1 \rfloor$;
      $t \leftarrow \lfloor (i-1) \bmod T+1 \rfloor$;
    assign dispatching amount d_{tm} as follow;
    if $E_k \le t \le L_k$
    $d_{kt} \leftarrow rand[0,u_k]$;
    else
    $d_{kt} \leftarrow 0$;
    end if
    update u_k and π as follows;
    $u_k \leftarrow u_{ki} - d_{kt}$;
    $\pi \leftarrow \pi / \{i\}$;
  until(π becomes empty)
end

2) Initialization $(\mathbf{X})$: Once the dispatching amount $(\mathbf{D})$ is initialized, $\sum_{k=1}^{M} d_{kt}$ can be found. Then we can initialize purchasing amount $(\mathbf{X})$ to avoid non-negative inventories $(\mathbf{I})$. We represent a chromosome for purchasing amount using the zero-one-two encoding encoding. In their representation, the string of T digits (where T is the number of periods). Each digit may take the value of 0, 1, or 2. The question of how many future periods to cover with an order is explicitly answered by the zero-one-two encoding where a value of one or two in any digit indicates that an order should be placed in the period corresponding to that digit for its demand and inventory and the demand in all subsequent period with a code of zero. One indicates an order quantity that the inventory in the previous period and the demands in the current and subsequent periods with a code of zero covered by the order. Two indicates an order quantity that is the closest integer multiple of W higher than the inventory in the previous period and the demands in the current and subsequent periods with a code of zero covered by the order. The zero-one-two encoding can avoid the infeasibility of the offspring having negative inventories. Because the zero-one-two encoding impose the optimality properties by Lee [11], we expect good solution performance.

Fig.2 describes a decoding process of the zero-one-two encoding of a chromosome of '200101' for the demand of 4, 3, 6, 9, 11, and 5 for the periods from one to six, respectively. Since W is 5, the first gene of the chromosome is 2 and two consecutive genes are 0, the purchasing amount at the first period, x_1, the closest integer multiple of W higher than the total demand to cover the demands of the first three periods and the previous inventory in the previous level. Thus, x_1 is 15 the closest integer multiple of 5 of higher than demands, 4, 3, and 6 at the period 1 to 3. And x_2 and x_3 are 0 because they are already covered by x_1. The gene at period 4 is 1 and one consecutive gene which has 0 is followed by the 1. Thus, x_4 has 22 including 2, the inventory in period 3 and 20, the total demand to cover demand 9 and 11 at period 4 and 5. And x_5 equals to 0, because it is already covered by x_4. Finally, x_5 equals to 5 including 0 an inventory at period 4 and a purchasing amount 5 at period 5.

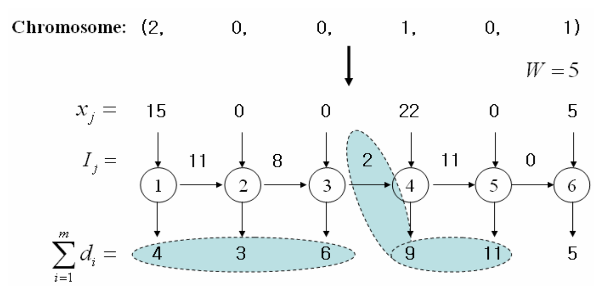

Fig. 2 Decoding process of the zero-one-two chromosome

3) Repairing $(\mathbf{X})$: There are still the possibility for an infeasible solution due to the imbalance between total purchasing amount and total demand by excessive purchasing, even if the zero-one-two encoding prevents negative inventory during planning periods,. Ozdamar and Birbil [14] proposed a backward repair pass, in which each positive lot size is checked from last period if inventory level at the last period is positive. If the inventory at the last period is positive, the minimum between the lot size in the current period and its inventory level is deduced from the lot size and update

ISBN : 978-602-97809-0-1

inventories at the subsequent periods. If the inventory at the last period is still positive, then the lot sizes of prior periods are deduced and inventories at the subsequent periods are updated so as to retract inventory in the last period completely. Hence, the backward repair pass prevents excess purchasing amount by eliminating positive inventory at last period.

B. Objective and fitness function

Once the a set of decision variables $(\mathbf{X},\mathbf{D})$ and depending variable $\mathbf{I}$ is determined based on the $(\mathbf{X},\mathbf{D})$, we can obtain the objective function value defined by the model P in Section II. Since all of the problems under consideration are minimizing problems, however, we have to convert the objective function values to fitness function values of maximization form. We use the simplest procedure to get the fitness value for a chromosome (i,e, F_i) from the objective function value of the chromosome (i.e., Z_i) and the maximum objective function value among the population (i.e., $Z_{\max}$) as follows:

$$F_i = Z_{\max} - Z_i \tag{9}$$

C. Reproduction, crossover and mutation

A simple genetic algorithm that yields good results in many practical problems is composed of three operations: reproduction, crossover and mutation. Reproduction is a process in which individual chromosomes are copied according to their fitness function value. We use the easiest and the most popular method that is referred to as roulette wheel reproduction where each current string in the population has a roulette wheel slot sized in proportion to its fitness. The crossover operator takes two chromosomes and swaps a part of their genetic information to produce new chromosomes. The crossover in the dispatching amount $(\mathbf{D})$ is described as follows:

begin

Select two chromosomes $D_1 = (d_{kt}^1)$ and $D_2 = (d_{kt}^2)$. The crossover is performed in three steps:

Step1. Create two temporary matrices $P = (p_{kt})$ and $Q = (q_{kt})$ as follows:
$p_{kt} = \lfloor (d_{kt}^1 + d_{kt}^2)/2 \rfloor$ and $q_{kt} = (d_{kt}^1 + d_{kt}^2) \bmod 2$.

Step2. Divides matrix Q into two matrices Q_1 and Q_2 such that
$Q = Q_1 + Q_2$,
where, $\sum_{t=1}^{T} q_{kt}^1 = \sum_{t=1}^{T} q_{kt}^2$, for $\forall k$.

Step3. Then we produce two offspring of D_1^* and D_2^* as follows:
$D_1^* = D + Q_1$ and $D_2^* = D + Q_2$

end

The crossover in the purchasing amount $(\mathbf{X})$ used one-cut-exchange which is the easiest and the most classical crossover method. Mutation produces spontaneous random changes in various chromosomes. For the mutation of the dispatching $(\mathbf{D})$, the entire amount in a selected period within the time window moves to a period in the *common time window*, in which it is co-periods in the time windows of multiple demands. By locating dispatching amounts in different demands to the common time window, the probability that larger amount can be ordered and delivered at the same period increases. As results, inventory cost and purchasing cost can be reduced by the mutation. The detailed mutation procedure in the dispatching $(\mathbf{D})$ is described as follows:

begin
repeat
select a random real value r from $[0,1]$.
if $r \le P_M$,
Step 1. select a random integer number b from $[1, M]$.
Step 2. find $[E_b, L_b]$ at row b in $\mathbf{D}$ and change $E = E_b$ and $L = L_b$ and choose a moving position s from a common time window $[E, T]$.
Step 3. construct a common window
while ($n \le N$)
Step 3.1 select a random p from $[1, M]$
Step 3.2 find $[E_p, L_p]$.
Step 3.3
if $[E, L]$ and $[E_p, L_p]$ has a common period, update $E = \max(E, E_p)$ and $L = \min(L, L_p)$.
end if
Step3.4 increase n by 1.
end while
Step 4. select a random period e at row b from $[E, T]$
Step5. remove d_{bs} from period s to e at row b and add it into d_{be}.
end if
until (the repeating number equals TM)
end

The mutation in the purchasing amount $(\mathbf{X})$ used a random change among 0, 1 or 2. Adopting the elitist strategy, two best chromosomes are excluded from the crossover and mutation procedure and they are directly copied to the next generation. The detailed procedure to generate the next generation is as follows:

Step 1. Copy two best chromosome sets to the next generation.
Step 2. Select two chromosome sets by the roulette wheel method from N number of $(\mathbf{X},\mathbf{D})$.
Step 3. Select a random number from [0, 1]. If the number is less than a given crossover probability, generate two chromosomes of $\mathbf{D}^*$ given $\mathbf{X}$ by the crossover of $\mathbf{D}$, or copy the two chromosomes directly, otherwise.

ISBN : 978-602-97809-0-1

Repeat this step until *N-2* number of $(\mathbf{X}, \mathbf{D}^*)$ is constructed, where $\mathbf{D}^*$ is a new chromosome of dispatching amount.

Step 4. Select two chromosome sets by the roulette wheel method from *N-2* number of $(\mathbf{X}, \mathbf{D}^*)$ and 2 Elites of $(\mathbf{X}, \mathbf{D})$.

Step 5. Select a random number from [0, 1]. If the number is less than a given crossover probability, generate two chromosomes of $\mathbf{X}^*$ given $\mathbf{D}^*$ by the crossover of $\mathbf{X}$, or copy the two chromosomes directly, otherwise. Repeat this step until the next generation chromosome set $(\mathbf{X}^*, \mathbf{D}^*)$ is constructed, where $\mathbf{X}^*$ is a new chromosome of purchasing amount.

Step 6. Repeat ***Step 4*** and ***Step 5*** until 50 generations are found.

Step 7. For *N-2* number of $(\mathbf{X}^*, \mathbf{D}^*)$ from ***Step 6*** excluding the two elites, if a random number from [0, 1] is less than 0.5, perform mutation $\mathbf{X}^*$, or perform mutation $\mathbf{D}^*$ in $(\mathbf{X}^*, \mathbf{D}^*)$, otherwise.

Step 8. Generate N number $(\mathbf{X}, \mathbf{D})$ in next generation including 2 elites and *N-2* number of $(\mathbf{X}^*, \mathbf{D}^*)$. And repeat ***Step* 2** to ***Step* 8** until 300 generations are found.

IV. COMPUTATIONAL RESULTS

To analyze the performance of the proposed heuristic algorithm, the following experimental conditions were designed:

(1) set $T = 10, 12, 14, 18$ and $M = 25\%, 50\%, 75\%$ of each T, respectively.,

(2) set the size of time window, $TW = 30\%, 40\%, 50\%$ of each T, respectively,

(3) demands were generated from a normal distribution $N(\mu_k, \sigma_k)$, where μ_k was generated from a uniform distribution $U(300,900)$ and σ_k was equally likely selected from μ_i and $\mu_i / 5$,

(4) $h_t = 1$ and $S_t = TS\overline{\mu}/2$ was assumed without loss of generality and $TS = 1,3,6$ where TS denotes EOQ time supply,

(5) Set $W = 100, 200, 300$ and respective unit freight cost was selected as follows: $F = iW$, $i = 1, 2, 3$

(6) Crossover probability and mutation probability of a chromosome set $(\mathbf{X}, \mathbf{D})$ are $P_C = 0.25$ and $P_M = 0.05$.

GA heuristic coded using C++ and run on a laptop computer with an Intel(R) Core(TM)2 Duo CPU 2.4GHz and 3066 RAM. To find an optimal solution, CPLEX 6.0.2 package was used. Four replications were performed for each combination of input parameters. Total 432 times of instances were tested in both CPLEX and GA heuristic. Due to the limitation of a computer performance, the optimal solution was not obtained within 2 hours for many large-sized test problems having more than or equals to 14 periods. So, CPLEX package was modeled and run so as to find the best solution within 1,000,000 node limits. However, GA found a best solution no more than 3 minutes. For many small-sized test problems having less than or equals to 12 periods, the optimal solution was found. To obtain the performance of the heuristic, the average percent gap between the best solution and the heuristic solution was computed as follows:

$$(Z_H - Z_B)/Z_B \times 100 , \tag{10}$$

where $Z_B =$ objective value of the best solution and $Z_H =$ objective value of the heuristic solution.

Tables 1, 2, and 3 present the average percent gap between the best solution and the heuristic solution in time window size of 30%, 40%, and 50% of each period's length. The negative value of the average percent gap implies that the heuristic solution is better than the best solution on the average. In an average sence, the heuristic offers good solution within 0.55%, 0.07%, 1.16% in comparision with the best solution for given test problems with different time windows. The results show that GA become more efficient as T and M increases and F decreases under a given W keeping the economy of the compution time.

TABLE I
AVERAGE GAP FROM THE BEST SOLUTION FOR 30% TIME WINDOW

M	W	F	T=10	T=12	T=14	T=18
25%	100	100	0,00	0,52	0,00	1,71
		300	0,00	0,00	0,00	0,00
		600	0,00	0,17	0,00	0,00
	200	200	0,00	0,00	4,28	0,09
		600	0,00	0,38	1,76	-0,36
		1200	0,12	0,00	0,38	0,31
	300	300	0,41	0,00	4,77	0,82
		900	0,00	0,00	1,22	0,32
		1800	0,25	0,00	-0,11	0,16
50%	100	100	0,73	1,47	3,99	3,15
		300	0,00	0,33	0,00	0,84
		600	0,04	0,10	-1,40	-1,40
	200	200	0,30	1,28	-0,59	-0,59
		600	1,19	0,64	0,36	0,36
		1200	-0,34	0,00	1,35	1,35
	300	300	0,00	0,00	0,70	0,70
		900	0,39	1,35	2,20	2,20
		1800	0,92	-0,39	-0,87	-0,87
75%	100	100	0,00	0,14	3,25	3,34
		300	0,00	2,91	0,33	1,62
		600	0,02	0,13	0,43	-0,73
	200	200	0,00	0,00	0,00	2,13
		600	0,93	1,43	0,69	3,44
		1200	0,00	0,70	-2,07	-2,14
	300	300	0,00	0,84	4,29	6,99
		900	0,52	0,00	1,76	0,68
		1800	0,00	-0,29	0,11	-8,24
					Ave.	0.55

TABLE II
AVERAGE GAP FROM THE BEST SOLUTION FOR 40% TIME WINDOW

M	W	F	T=10	T=12	T=14	T=18
25%	100	100	0,00	0,54	2,65	0,00
		300	0,00	0,00	0,00	0,00
		600	0,00	-0,98	-0,39	0,60
	200	200	0,00	0,00	0,00	5,67
		600	0,00	0,00	0,68	0,00
		1200	0,00	0,00	1,40	0,17
	300	300	0,00	0,00	0,19	0,00
		900	0,00	0,00	0,00	0,00
		1800	0,00	0,00	-0,51	0,97
50%	100	100	0,00	3,71	0,00	1,41
		300	0,88	0,51	1,83	-0,27
		600	0,00	0,94	-0,46	-0,51
	200	200	0,00	0,00	4,45	0,80
		600	0,00	0,00	0,00	-0,26
		1200	-0,25	0,28	-0,91	-2,05
	300	300	0,00	4,46	2,64	0,00
		900	-0,37	0,00	0,10	0,34
		1800	-0,20	0,10	-1,87	1,34
75%	100	100	0,00	0,28	3,11	0,00
		300	0,00	-0,38	0,00	0,18
		600	1,93	0,99	0,52	-0,65
	200	200	1,85	2,72	0,00	0,30
		600	0,00	1,43	0,59	0,35
		1200	0,21	0,83	1,21	-15,53
	300	300	0,74	0,00	5,21	0,00
		900	0,45	0,77	0,33	0,00
		1800	0,00	0,56	-1,39	-26,46
					Ave.	0.07

TABLE III
AVERAGE GAP FROM THE BEST SOLUTION FOR 50% TIME WINDOW

M	W	F	T=10	T=12	T=14	T=18
25%	100	100	0,00	0,00	0,00	0,00
		300	0,00	0,07	0,00	1,78
		600	0,00	0,00	0,50	1,44
	200	200	0,00	0,00	0,00	3,23
		600	0,00	0,00	1,35	-1,03
		1200	0,00	0,03	0,42	-0,14
	300	300	0,00	0,00	0,00	2,82
		900	0,00	0,00	0,00	2,90
		1800	0,00	0,00	0,00	0,88
50%	100	100	1,43	0,00	2,13	4,39
		300	0,63	1,65	0,61	6,26
		600	0,00	2,25	0,48	3,35
	200	200	4,42	1,70	1,81	4,94
		600	0,00	1,66	1,65	2,90
		1200	0,00	1,41	4,35	-0,63
	300	300	1,39	0,00	2,86	5,34
		900	0,72	1,10	3,64	1,31
		1800	0,59	0,10	1,22	4,25
75%	100	100	1,85	2,73	4,82	3,62
		300	1,85	6,67	1,34	2,39
		600	0,00	1,74	1,80	-10,17
	200	200	0,70	3,31	3,79	2,88
		600	3,13	3,73	3,60	-0,09
		1200	1,72	-0,49	0,14	-8,23
	300	300	5,25	3,32	2,40	1,44
		900	1,72	-0,67	-0,05	2,53
		1800	0,07	0,53	0,85	-9,34
					Ave.	1.66

V. CONCLUDING REMARKS

This paper analyzes a dynamic inbound ordering and shipment scheduling problem for a single product that is transported from a supplier to TPL warehouse by common freight containers in a supply chain. Since the large-sized problem cannot find an optimal solution using the conventional optimization solvers or dynamic programming algorithm within a limited time, we proposed GA heuristic. To evaluate the performance of the heuristic, we present the computational results from a set of simulation experiment. The results show that in an average sense, the GA offers a good solution within 0.59% in comparison with the best solution for given test problems. Further research will be consider a dynamic inbound ordering, and shipment scheduling, and delivery problem with a concave-type dispatching cost for multi-products that are transported from a supplier to TPL warehouse by heterogeneous freight containers in a supply chain.

ACKNOWLEDGMENT

This work was supported by the Korea Research Foundation Grant funded by the Korean Government (MOEHRD, Basic Research Promotion Fund) (KRF—2008-313-D01222).

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ISBN : 978-602-97809-0-1

ISBN : 978-602-97809-0-1

A Fuzzy Multi-Objective Linear Program for solving Capacitated Lot sizing Problem in a Mixed assembly shop

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Abstract **-This paper develops a fuzzy multi-objective linear program (FMOLP) model for solving the bi-objective capacitated lot sizing problem(CLSP). The proposed model attempts to simultaneously minimize total cost consist of total production variation cost, inventory cost, backlog cost and total setup cost while maximize the resource utilization. According to the structure of the mixed assembly shops, a multi product model with multi item that should be produced during multi level has been designed. Based on the vagueness and imprecision of the real case, the demand of the products was considered as fuzzy number that have a same membership function during planning horizon in each period. A three phase Fuzzy Multi-Objective Programming algorithm has been applied to solve the problem. To evaluate the performance of the proposed methodology, 24 random problems in three case have been designed and solved. The results show the capability of the proposed model for CLSP.**

Keywords **-CLSP, Fuzzy Multi-Objective Linear Program, Mixed assembly shop**

I. Introduction

The capacitated lot-sizing problem (CLSP) is a standard formulation for big bucket lot-sizing problems with a discrete period segmentation and deterministic demands. The standard CLSP can be described as follows: multiple products have to be produced. A deterministic, discrete demand volume for every product is given for predefined periods. Producing a product consumes recourse capacity, which is scarce. When changing from one product to another, setup costs accrue. Generally, The objective is to find an optimal production plan that minimizes production variation cost, setup, backlog and inventory costs and delivers optimal lot-sizes and production periods for each product.

The CLSP is classified based on different criteria that considered by researcher during recent years such as setup, level, item, period, demand. In fact, research on lot sizing started with the classical economic order quantity (EOQ) model ([1]-[2]). The assumptions for the EOQ model are a single-level production process with no capacity constraints, which makes the problem become a single-item problem. The demand for that item is assumed to be stationary, i.e. demand occurs continuously with a constant rate. The EOQ model is a continuous time model with an infinite planning horizon. The optimal solution is easy to derive. Since these assumptions appear to be very restrictive, other models have evolved according to mentioned criteria.

Based on the planning horizon, we consider finite or infinite. The planning horizon is the time interval on which the master production schedule extends into the future. In addition, In terms of time period terminology, lot sizing problems fall into the categories of either big bucket or small bucket problems. Here, we consider a Big bucket problem, is those where the time period is long enough to produce multiple items in finite planning horizon which can find in works of [3]-[5].

According to the structure of the mixed assembly shop, in which the raw materials after processing by several operations change to end products, the multi level CLSP model has been considered. References [3], [6]-[7] extended the multi-level CLSP model and applying heuristic approach to tackle the complexity of such problem. In the old CLSP model, the researcher assume the demand is constant during planning horizon while in this work demand would be changed over time. However, problems with dynamic demands are much more complex than problems with static demands. Minneranalyzes the problem of the replenishment of multiple products to satisfy dynamic demands when the warehouse capacity or the available inventory budget is limited ([8]). References [9] proposed a dynamic programming algorithm to deal with the dynamic lot-sizing model for major and minor demands in which major demands are specified by time windows while minor demands are given by periods where cost structure is concave.

By considering more criteria CLSP become so difficult, various solution techniques have been proposed to solve them. In the past decade, meta-heuristics such as tabu-search([10], [11]), genetic algorithms ([12]-[14]), and simulated annealing,([15]-[17]) have become popular and efficient tools for solving hard combinatorial optimization problems ([18]).

Here, a new mixed integer model of CLSP has been developed which is tried to find the optimal lot sizes of both assembly components and end products in shop with mixed assembly products (Multi-item and multi-product). The planning horizon is finite and divided into h predefine periods (multi-period). We called the multi-level, multi item, multi product, multi period CLSP as M-PPIL/CLSP. At the end of each period, the demand's of the customer should be satisfied. If the lot size of a product is more than the demand, the inventory holding cost is accrued while if the lot size is less than demand the backlog would be happened. Due to the structure of the mixed assembly shops, the model is considered as a multi level with multi item in each level. By viewing the literature, we cannot find a model which have the all aspects of such problems although many researcher work on various CLSP model. In [19] addressed scheduling of lot sizes in a multi-plant, multi-item, multi-period, capacitated environment with inter-plant transfers that a real-world problem in a company manufacturing steel rolled products. Other group of researcher work on different problem as follow a) dynamic multi-level multi-item capacitated lot sizing problem such as [16], [15] b) multi-item capacitated lot-sizing problem with setup times, safety stock and demand shortages; [20], [21].

Based on the vagueness and imprecision of the real case, the demand of the products was considered as fuzzy number. During recent years, fuzzy set theory has been used to model systems that are hard to define precisely. As a methodology, fuzzy set theory incorporates imprecision and subjectivity into the model formulation and solution process. Fuzzy set theory represents an attractive tool to aid research in production management when the dynamics of the production environment limit the specification of model objectives, constraints and the precise measurement of model parameters ([22]). [23]applying fuzzy set theory to solve the CLSP with fuzzy capacity. His model is the well-known CLSP heuristic of [24], which is modified to deal with fuzzy capacity, Meaningful and practical interpretations of fuzzy lot size are provided through the use of fuzzy integrals and possibility theory. In addition some researcher work on other type of imprecision such as stochastic model. [25]present a model of a multi-level capacity-constrained system when external demand is stochastic and used Expected Net Present Value instead of traditional total cost objective. Although [26] derived an appropriate number of production runs and lot sizes for multi-products with fuzzy demands. Three lot size algorithms with fuzzy demands were compared in the work of [27]. [28]also incorporated fuzzy demands into a part-period balancing lot-sizing algorithm.

Fuzzy set theory helps to improve crisp models and provides more robust and flexible models for real-world complex decision problems, especially those involving human aspects. In the last decade, many fuzzy programming techniques such as fuzzy multi objective interactive fuzzy multi-objective decision making have been developed for solving multi-objective decision-making problems. Applying FST into multi objective has the advantage of better representation of real situations in which decision maker is not able to exactly establish the target value associated with each objective.

Fuzzy set theory (FST) presented by [29] has been found other extensive applications in various fields. [30]first introduced fuzzy sets into an ordinary LP problem with fuzzy objective and constraints. Chanas presented an Fuzzy linear programming (FLP) model for solving transportation problems with crisp cost coefficients and fuzzy supply and demand values. Moreover, they proposed the concept of the optimal solution of the transportation problem with fuzzy coefficients expressed as L–R fuzzy numbers, and developed an algorithm for obtaining the optimal solution. later, they designed an algorithm for solving the integer fuzzy transportation problem with fuzzy supply and demand volumes in the sense of maximizing the joint satisfaction of the fuzzy goal and constraints [31]. An evolutionary algorithm was applied to find a good fuzzy solution to the PSTP. Related studies on the use of fuzzy programming method to solve fuzzy DPD problems included [32]-[36].

In this paper for each of the objective functions of this problem, assume that the DM has a fuzzy goal such as 'the objective functions should be essentially less than or equal to some value'. Then, the corresponding linear membership function is defined and the minimum operator proposed by [37] is applied to combine all objective functions. Three phase fuzzy multi-objective programming algorithm has been applied to solved M-PPILCLSP.

II. CLSP IN A SHOP WITH MULTI ASSEMBLY PRODUCTS

A. *Shop with multi assembly products*

Shops, in which several assembly products are mounted simultaneously, are called Multi-Assembly Shops. In these shops, the raw material after being converted to sub-components by initial operations enters the main assembly line with different lot sizes. In such environments, many products with various sub-assemblies are assembled in different stages and then changed into final products ([38]-[39]).

It is possible that different products in an assembly processing use the same sub-component which in turn can use the same raw material. By considering the complexity of production scenario in multi-assembly shops and the relationship between the raw materials, sub-components and final products, a model is needed to determine the lot sizes of products in an assembly line [40]. The aim of this research is to develop a new mixed integer model of CLSP to find the optimal lot sizes of the end products. The structure of a shop with multi assembly products was shown in figure 1.

ISBN : 978-602-97809-0-1

One of the main aspects of such shop is the role of succeeding and preceding rule between levels while, if all operations of previous level not finished, the next succeed level cannot begin.

B. Assumption

1. The processing time and type of machine for each item is known.
2. An item cannot be processed (or assembled) simultaneously by more than one machine.
3. Several products are produced, each of which is assembled from two or more item.
4. The planning horizon is finite with fuzzy demand for each product.
5. The production system has been designed as multi level and in each level various item should be made to begin succeed level.
6. Production system in terms of number of products is a multi-item production planning that there are several end item should be organized.
7. The demands of end product are deterministic but changed during various periods (Dynamic demand).
8. There is existed machine capacity constraint.
9. Simple setup structure has been considered.

C. Notations:

The following notations have been used in this paper:

Indices:

i: End product, i=1,…,P

v: Item, v=1,…,V

l: level. l=1,…,L

j: Machine, j=1,…,J

h: period(Time bucket), h=1,…,H

Parameters:

C^{Sh}_{ilvj} : Setup cost of item *v* of level *l*, from end product *i* on machine *j* in period *h*

C_i^{Hh} : Holding cost of end product *i* in period *h*

C_i^{Bh} : Back order cost of product *i* in period *h*

$\tilde{d}_i^h$: Fuzzy demand of end product *i* at the end of period *h*

RT_{ilvj} : The rate of production item *v* at level *l* of end product *i* on machine *j*

t^h_{ilvj} : The processing time of item *v* at level *l* of end product *i* on machine *j* at period *h*

b_{ilv} : The number of item *v* at level *l* needed for producing product *i*.

ST_{ilvj} : Setup time of item *v* at level *l* of end product *i* on machine *j*

a^h_{ilvj} : The amount of resource *j* needed to produce one unit of item *v* of level *l* from end product *i* in period *h*

R_j : The accessible amount of resource *j*

λ_{ilvj} :1, If item *v* of level *l*, from end product *i is* need machine j,0 otherwise

Decision variable:

I_i^h : Inventory level of end product *i* at the end of period *h*

B_i^h : Back order level of end product *i* at the end of period *h*

Q_i^h : The lot size of end product *i* at period *h*

D. . The basic model of the capacitated lot sizing problem

1) M-PPIL/CLSP model

The objective of the multi product, multi period, multi item, multi level capacitated lot sizing problem (M-PPIL/CLSP) is to determine the lot-sizes that minimize the sum of setup, inventory holding, back order and production variable costs while maximize the utilization of the machine. The problem can be formulated a mixed integer program as follow:

$$\text{Min} \quad \sum_{h=1}^{H}\sum_{i=1}^{P}\sum_{l=1}^{L}\sum_{v=1}^{V} C^{Sh}_{ilvj} Y_i^h + \sum_{h=1}^{H}\sum_{i=1}^{P} C_i^{Hh} I_i^h + \sum_{h=1}^{H}\sum_{i=1}^{P} C_i^{Bh} B_i^h + \sum_{h=1}^{H}\sum_{i=1}^{P}\sum_{l=1}^{L}\sum_{v=1}^{V} C^{Ph}_{ilv} Q_i^h b_{ilv}$$

(1)

$$\min \sum_{h=1}^{H}\sum_{l=1}^{L}\sum_{j=1}^{J}\left(R_j - R_{lj}^h\right) \qquad (2)$$

S.t

$$I_i^{h-1} - B_i^{h-1} + Q_i^h = I_i^h - B_i^h + d_i^h \quad \forall i, h \geq 2,3,...,H \qquad (3)$$

$$Q_i^1 - I_i^1 + B_i^1 - d_i^h = 0 \quad \forall i \qquad (4)$$

$$I_i^H = B_i^H = I_i^0 = B_i^0 = 0 \quad \forall i \qquad (5)$$

$$\sum_{i=1}^{P}\sum_{v=1}^{V} b_{ilv}.Q_i^h.a^h_{ilvj}.\lambda_{ilvj} \leq R_j \quad \forall h,l,j \qquad (6)$$

$$Q_i^h \leq M.Y_i^h \quad \forall i,h \; (7)$$

$$Y_i^h = \{0,1\} \quad \forall i,h \; (8)$$

In this model, Eq. (1) and 2 represents the objective function which minimizes the total of setup, holding, backorder and variable production costs, while the second objective maximize the resource utilization. Eq.(3)-(5) are the typical material balance constraints which ensure the demands of products are supplied. Eq. (6) are the capacity constraints, the overall consumption must remain lower than the available capacity. Eq.(7) and (8) guarantee that , whenever . Constraint (8) shows are binary variable.

2) fuzzy constraints

Due to the vagueness and imprecision of the customer's demand, constraints (3) and (4) would be replaced by two fuzzy constraints (9) and (10). These material balance constraints shows that the demand of the customers would be satisfied based on the fuzzy membership function which was identified by customers.

$$I_i^{h-1} - B_i^{h-1} + Q_i^h - I_i^h + B_i^h \cong \tilde{d}_i^h \quad \forall i, h \geq 2,3,...,H \qquad (9)$$

$$Q_i^1 - I_i^1 + B_i^1 \cong \tilde{d}_i^1 \quad \forall i \qquad (10)$$

III. THREE-PHASE FUZZY LINEAR PROGRAMMING METHODOLOGY

In this section, the general multi-objective model for M-PPIL CLSP is presented and then by applying three-phase fuzzy linear programming methodology, the CLSP model has been solved. In each phase a new model has been created to model a single crisp objective function and improve the quality of the results.

A. *Phase 1:defuzzifing*

The fuzzy constraint has been shown as equation (11) in the fuzzy Multi-PPIL CLSP (FM-PPIL CLSP) model.

$$\tilde{g}_i(x)=\sum_{i=1}^{n} a_{ri}x_i \leq\sim \tilde{b}_r \quad r=1,2,...,h \qquad (11)$$

Where $\mu_{g_r}(x)$ is a fuzzy constraint with fuzzy parameters as right value in correspond equation. To modify the model, fuzzy constraint would be replaced by equation (12) when the equation (13) and (14) should be added to the objective function and constraint respectively.

$$\gamma_r \leq \mu_{g_r}(x) \qquad r=1,2,...,h, \ (12)$$

$$\sum_{r=1}^{h}\beta_r\gamma_r \qquad r=1,2,...,h, \qquad (13)$$

$$\sum_{r=1}^{h}\beta_r=1 \qquad r=1,2,...,h, \qquad (14)$$

where is called the membership function of constraints and are the weighting coefficients that present the relative importance among the fuzzy goals and fuzzy constraints. The new model of the FM-PPIL CLSP would be obtained as follow:

Objective functions: Equation (1), (2) and (13)

Constraints: Equation (5) to (8), (12) and (14)

B. *Phase 2:FM-PPIL CLSP*

In this step, the [30] method has been used to transform the multi objective model of the FM-PPIL CLSP into the single objective model. Find a vector x written in the transformed xT = [x1, x2,…,xn] which minimizes objective function Zt with

$$Z_t=\sum_{i=1}^{n}c_{ti}x_i \qquad t=1,2,...,T. \qquad (15)$$

and constraints:

$$x\in X_d,\ X_d=\left\{x / g(x)=\sum_{i=1}^{n}a_{ri}x_i \leq b_r, \quad r=1,2,...,m,\ x\geq 0\right\} \qquad (16)$$

wherecki, ari and br are crisp or fuzzy values.

[30]has solved problems (15-16) by using fuzzy programming. He formulated the fuzzy program by separating every objective function Zt into its maximum Zt+ and minimum Zt – value by solving:

$$Z_t^+=\max Z_t,\ \ x\in X_a,\ Z_t^-=\min Z_t, \quad x\in X_d \ (17)$$

is obtained through solving the multi-objective problem as a single objective using, each time, only one objective and means that solutions must satisfy constraints.

Since for every objective function Zt, its value changes from toZt+, it may be considered as a fuzzy number with the linear membership function.

Assuming that membership function, based on preference or satisfaction is the linear membership for minimization goals (Zk) is given as follows:

$$\mu_{Z_t}(x)=\begin{cases}1 & \text{for } Z_t\leq Z_t^-,\\ \dfrac{\left(Z_t^+-Z_t(x)\right)}{\left(Z_t^+-Z_t^-\right)} & \text{for } Z_t^-\leq Z_t(x)\leq Z_t^+, \quad t=1,2,...,T,\\ 0 & \text{for } Z_t\geq Z_t^+.\end{cases}$$

Z_t^-, Z_t^+ are the subjectively chosen constants expressing the limit of the admissible violation of the t[th] inequalities constraints.

According to the [37], and the weighted additive model, [41] the new model of FM-PPIL CLSP would be obtained as equation (18) to (26):

$$\max\sum_{t=1}^{T}w_t.\lambda_t+\sum_{r=1}^{h}\beta_r.\gamma_r \qquad (18)$$

S.t.

$$\lambda_t\leq\mu_{Z_t}(x) \qquad t=1,2,...,T, \ (19)$$

$$\gamma_r\leq\mu_{g_r}(x) \qquad r=1,2,...,h, \ (20)$$

$$I_i^H=B_i^H=I_i^0=B_i^0=0 \qquad \forall i \ (21)$$

$$\sum_{i=1}^{P}\sum_{v=1}^{V}b_{ilv}.Q_i^h.a_{ilvj}^h.\lambda_{ilvj}\leq R_j \qquad \forall h,l,j \ (22)$$

$$Q_i^h\leq M.Y_i^h \qquad \forall i,h \ (23)$$

$$Y_i^h=\{0,1\} \qquad \forall i,h \ (24)$$

$$\lambda_t,\gamma_r\in[0,1] \quad t=1,2,...,T, \quad r=1,...,h, \ (25)$$

$$\sum_{j=1}^{p}w_j+\sum_{r=1}^{h}\beta_r=1 \quad w_j,\beta_r\geq 0, \ (26)$$

C. *Phase 3. MFM-PPIL/CLSP*

The aim of this step is to tackle the disadvantage of the proposed methodology which was discussed by some researches as [42] and [40]. The biggest disadvantage of the above model is that the results obtained by the ‘‘max–min’’ operator represent the worst situation and cannot be compensated for by other members, which may turn to be more appropriate using alternative reasonable characterization of the solutions. Indeed quite reasonably, it is much more desirable for a compensatory operator to be used to obtain a compromised solution ([42]).

So, in this step, the solution is enforced to get better from that calculate by the max–min operator in the previous step. The λ_t and γ_r which was obtained from step 2 has been considered as satisfaction degree, (for goals and constraints respectively) and added to the model as equation (33) and (34). The new objective function is formed to increased the distance between the obtained value of the λ_t and γ_r while, become closer to the better solution. The problem can be reformulated as follows:

$$\max \quad \frac{1}{T}.\sum_{j=1}^{p} w_j.\sum_{t=1}^{T}(\psi_t - \lambda_t)^2 + \frac{1}{R}.\sum_{r=1}^{h}\beta_r.\sum_{r=1}^{R}(\zeta_r - \gamma_r)^2 \quad (27)$$

$$\lambda_t \le \psi_t \le \frac{\left(Z_t^+ - Z_t(x)\right)}{\left(Z_t^+ - Z_t^-\right)} \qquad t = 1, 2, ..., T \; (28)$$

$$\gamma_r \le \zeta_r \le \frac{\left(d_r^+ - g_r(x)\right)}{\left(d_r^+ - d_r^-\right)} \qquad r = 1, 2, ..., R \; (29)$$

And constraints (26) to (31)

The following algorithm is employed to solve the MOFLP for the proposed FM-PPIL CLSP:

Step 1 . Identify customer's demand membership function.

Step 2. The new fuzzy constraints correspond to the demand added to the model and it be reformulated by equation (12) to (14). In this step the FM-PPIL CLSP would be constructed.

Step 3. Solve the tth objective function with an optimization technique, and set to the objective function value of the found minimum solution (the Lower bound of the).

Step 4. Determine the values of the other objective functions of the obtained sequence in the previous step and set =the maximum value among the obtained values (the upper bound of the).

Step 4: Repeat steps 2 and 3 for all the objective functions.

Step 5: Define the membership function of each goal, t=1,…,T.

Step 6: Formulate the weighted additive model of the FM-PPIL CLSP by equation (18) to (26) and obtained the value of the and .

Step 7:set the value of the and as satisfaction degree and form the modified model of FM-PPIL CLSP according to the equation (21) to (28).

IV. CONCLUSION

In this paper a new bi-objective model of capacitated lot sizing problem has been developed to adapt with mixed assembly products. According to the structure of the assembly shops a multi period, multi product, multi item, multi level CLSP was proposed and called as M-PPIL/CLSP model. The M-PPIL/CLSP model attempts to simultaneously minimize total cost consist of total production variation cost, inventory cost, backlog cost and total setup cost while maximize the resource utilization. A three phase Fuzzy Multi-Objective Programming algorithm has been applied to tackle with the vagueness and imprecision of the real case, which the demand of the products was considered as fuzzy number. Various problems with different dimension has been solved to validate the proposed methodology. The results shown that the three phase Fuzzy Multi-Objective linear Program algorithm has a better performance to deal with M-PPIL/CLSP.

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ISBN : 978-602-97809-0-1

Ontology Supported Intelligent Energy Management System in Buildings

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Abstract – **In recent years, energy consumptions in public and residential buildings have been rising and currently are representing a significant percentage of the whole energy consumption on earth. As stated by European Union, application of building automation systems is as important as thermal insulation and insulating glazing to improve energy efficiency in buildings. This paper describes an approach for improving energy efficiency in buildings by utilizing building automation systems. The goal of the approach is to develop an intelligent system that allows occupants to monitor and to control their energy consumption and also to detect their energy wasting points. An ontology based method for energy analysis that offers more intelligent mechanism is introduced in this paper. The method is an improvement of classical data-driven analysis, which is commonly used by existing energy management solutions.**

Keywords **– energy management, intelligent systems, ontologies, building automation system, data mining, knowledge-based system**

I. Motivation

A study observing building energy consumption held in 2007 shows that the public and residential buildings represent more than 40% of the whole energy consumption in European Union, of which residential use represents 63% of total energy consumption in buildings sector [1]. An improvement of energy efficiency in buildings is considered as important instrument to reduce EU energy import, which is currently about 48%. The energy efficiency improvement in buildings is also one of the methods to comply with the Kyoto Protocol in reducing carbon dioxide emissions.

The energy price has also been raising due to continuously increasing demand as well as the shortage of fossil energetic resource. These reasons force companies and private persons to organize their behavior in more energy-efficient way. There are many technical possibilities to improve energy usage efficiency. European Union has issued the Directive 2002/91/EC about overall energy efficiency of buildings. The directive aims to improve energy efficiency by taking into account outdoor climatic and local conditions, as well as indoor climate requirements and cost-effectiveness [2]. Based on the directive, a new DIN V 18599 “Energetische Bewertung von Gebäuden” describing integral calculation method of energy requirements for heating, acclimatization, and lighting has been published. Furthermore, in the future, energy savings in buildings can be increased by utilizing building automation systems. This kind of method is as important as the conventional thermal insulation of walls or insulating glazing to improve energy efficiency in buildings [3], [4], [5].

Modern building automation solutions for the private or business area offer a great potential for a comprehensive improvement of energy efficiency. Building automation systems that are composed by computer aided networked electronic devices are mostly used for improvement of the individual quality of life and safety. Building automation technology offers easy way to control and monitor the building conditions. However, the existence of building automation systems does not come along with an optimal usage of energy. They are applied for comfort and security reason preferentially, and do not lead to improvement in energy consuming behavior.

Recently low cost and low energy consuming building automation technologies have already been developed. Technologies such as *digitalSTROM* and *WPC* offer energy measurement and sensors by using small chips that consume less than 10 mW [6]. These chips communicate through power line communication (PLC). Therefore, modifications on walls and other building parts as well as extra wiring in the building are not necessary for the installation. By using these devices, extra energy consumptions of measuring devices can be avoided. Thus, the improvement of energy efficiency can be achieved.

In this paper we propose a framework of intelligent system for energy management in buildings by utilizing building automation systems. The framework uses knowledge-based approach in providing intelligent analysis based on the relations between energy consumption, activities and events in the building, building related information and surrounding factors, such as temperature and weather condition.

Each building automation technology may offer different functionalities, and has its own strength and weakness. For example, *digitalSTROM* offers better functionality in energy metering, but it does not offer occupancy sensor. On the other hand, other technologies such as *EnOcean* provide this. In order to achieve comprehensive energy management by taking into account as much as related conditions and factors, an integration of different building automation systems is required. Ontology can be used as generic model to facilitate the integration [7]. The ontology is not only used to describe functionalities of building automation systems, but also to represent states of building, and relations with user events and surrounding factors. In this paper, we introduce also method to generate the ontology components semi-automatically based on user events and building specific information.

This paper is organized as follows. In section II we discuss the state of the art and related works. Next we introduce the developed framework of intelligent energy management in section III. Section IV describes our approach in generation of ontology as the centre point of our intelligent system. In section V we give overview how the energy analysis is performed using ontological query. In section VI, we depict the system architecture of the developed framework. Finally we make our conclusion in section VII.

II. State of the Art and Related Works

In 2009 Electric Power Research Institute USA conducted research of electricity consumption feedbacks in household. They categorized feedback mechanism based on the information availability into standard billing, enhanced billing, real-time feedback, real-time plus feedback, etc [8]. The research showed that real-time plus feedback leads to the best improvement of energy conservation comparing to the other feedback mechanism, despite the higher cost of implementation. Real-time feedback allows users to monitor their energy consumption and/or control appliances in their home through building automation system (BAS) and home area network (HAN).

Ontologies are used to integrate different building automation systems. They are also utilized to support complex interoperation, generalization and validation tasks in building automation environment [9].

Ontologies represent knowledge in a particular domain. They are commonly created manually by experts from the corresponding domain. For example biology ontologies are created by biologist. However, a manual ontology creation is considered as a very time-consuming task. To overcome this problem, researchers have developed methods to generate ontology components in semi-automatic way. An example is the method developed by Maedche and Staab in the area of semantic web, which generates ontology from free text documents [10].

III. KEHL Software Framework

In this paper we propose a software framework, which considers different aspects of a building. The framework allows the users to have an integrated view of energy consumption in their apartment, office, as well as in entire building. With the help of building automation system, the energy consumption can be evaluated in different detail levels and quality, for instance, energy consumption per appliance, per group of appliances, per zone in the building, or per user event. These evaluations are carried out by considering the relation between rooms, appliances and user events. This means that the energy consumption can be evaluated based on activities or events that occurred in the building, for example in private building are breakfast, parties, working day, holiday, sleeping. Thus, occupants can get an exact overview of their behavior-specific energy consumption and can improve the energy efficiency significantly in their building. The improvement can be achieved by combining different functions such as energy monitoring, data analysis, as well as manual and automatic controlling using building automation system. Figure 1 represents the designed functional architecture of the framework whose main module~~s~~ is explained briefly in following sub sections. We named the developed framework as “KEHL-Framework” since the work described in this paper is part of our research project “KEHL-Kontrollierte Energie Haushalts Lösungen” (Solutions of Controlled Energy in Household), which is currently still ongoing.

A. 2D-Drawing Interpretation Module

A building plan is usually drawn in 2D using CAD software applications, such as *AutoCAD*. Unfortunately, 2D-drawings contains only geometrical information, for instance, lines, points, curves, circles, etc. They cannot describe any semantics of any building components contained in the drawing. We can still understand semantic of the drawing, because we already know the symbols representing certain

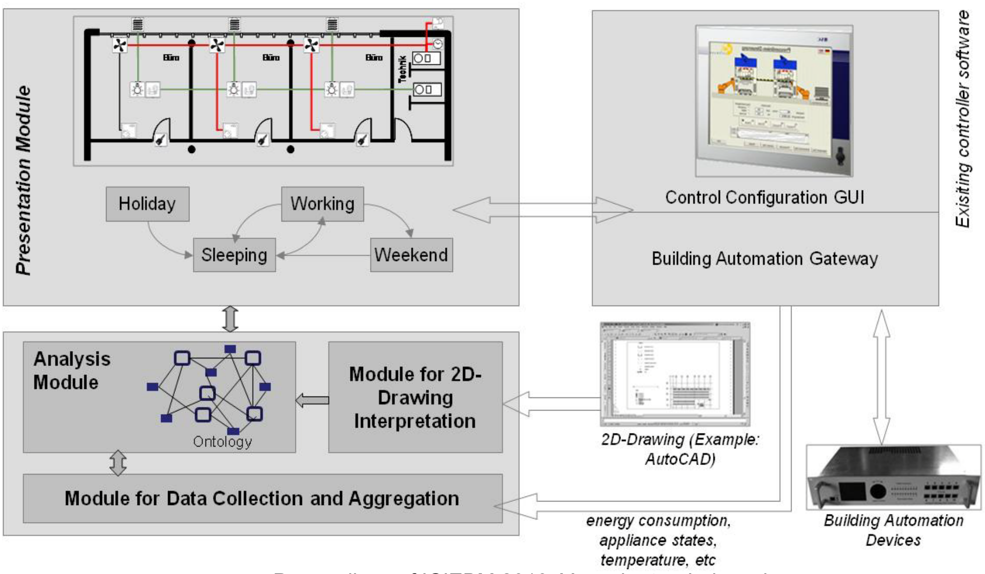

Figure 1. Functional Architecture of KEHL

building components or appliances, such as doors, walls, fridge, etc. FZI Research Center of Information Technologies has developed a method to interpret the semantic of 2D-drawings to support life-cycle management of building automation systems [11].

In this module we use configurable JavaScript based rules to interpret 2D-drawings semi-automatically. These rules define the relation between CAD-symbols and the semantics of building components and energy consuming appliances. The results of the 2D-drawing interpretation are stored as ontology individuals. This is explained further in section IV.

In existing energy analysis systems, users have to configure the system manually in order to perform energy consumption analysis for each room or appliances. Other configuration mechanism is through automatic discovery of appliances. But it has drawback that users have to relate the appliance to the building environment manually. The mechanism is dependent on a specific building automation technology as well. The interpretation of 2D-drawings helps users to configure the software framework, so they can have a model that represents their building layout with minimal effort.

B. Data Acquisition Module

This module is developed for collecting data from different building automation systems. It contains interface to communicate with different building automation logic control units or gateways via SOAP. The collected data, for instances, energy consumption and relevant sensor data, such as ~~ones~~ from contact sensor, occupancy sensor, and weather station, are aggregated and stored in a database. In order to allow visual representation of energy consumption data, we perform necessary data pre-processing such as removing erroneous values, data transformation, data selection and data conversion. The data are prepared to enable an energy consumption analysis in different criteria based on relation between rooms, appliances, time, and user events. This module provides data in such a form to enable the execution of data mining algorithm for finding the energy usage pattern.

C. Analysis Module

The analysis module evaluates energy consumption data that are collected and aggregated by data acquisition module, which then be presented in the presentation module. Through this module, energy consumptions can be related to device levels, room, and time, which in addition to that, can be combined with relation to user events and surrounding conditions.

In this module we consider two methods in energy analysis, i.e. data-driven analysis and knowledge-driven analysis. Data-driven analysis means analysis is conducted directly on the collected data by performing SQL-query, simple calculation, or visualization, for instance, energy consumption per time unit and each appliance. Knowledge-driven analysis is not conducted directly on the data, but by utilizing ontology that representing knowledge. The ontology is created manually by expert, and enriched with ontological elements generated from the data through ontology generation process. This is explained further in section IV and V.

D. Presentation Module

This module gives the users a visual overview of their energy consumption in the building related to the building environment and their behavior. Within the module, the energy consumption and other relevant information are presented intuitively. The energy consumptions in a building and in single rooms or appliances are visualized via a terminal or smart client placed in the building. At the same time the configuration and control of the building automation systems can be performed within the developed GUI.

IV. ONTOLOGY GENERATION

The knowledge base developed for KEHL framework is ontology containing concepts representing rooms, energy consuming appliances, building automation devices, environment parameters, events, and their relations. It is represented in *OWL (Web Ontology Language)*, a W3C specified knowledge representation language [12]. In our work, we use knowledge-driven analysis to find energy wasting conditions and to recognize energy usage anomalies in the building. We use it also additionally for identifying the operational state of an appliance and to identify appliance classes based on its energy consumption. Within KEHL framework, we develop three methods to generate the ontology components: 1) manual ontology generation by expert, 2) semi automatic through interpretation of 2D-drawings, and 3) semi automatic by using data mining algorithms.

A. Ontology Generation by Expert

The ontological classes as well as their attributes and relations representing building automation devices, for instances sensor and energy meter, building environments such as door, window, room, are created manually by experts. The ontology containing these hand-crafted elements is called base ontology. The base ontology contains only the ontological classes or *Tbox* components that describe the knowledge terminologically. It does not contain any ontological individuals or *Abox* components. These components own the validity for all buildings. The ontology does not contain any building specific information.

As occupants, we usually do not realize that our current energy usage leads to energy wasting. For instance, the light in balcony is still switched on, even though the sun rises already. In our work, we try to resolve this problem by modeling in the ontology the general situations in the building that lead to energy wasting. Thus, a computer supported reaction can be performed.

Energy wasting situations are modeled by experts in the base ontology. These situations are described in a rule representing language called *SWRL (Semantic Web Rule Language)*. SWRL is a language combined by OWL (Web Ontology Language) and RuleML (Rule Markup Language) that enables integration of rules in OWL ontology [13].

Here we provide examples of modelling energy waste situation with SWRL. We assume that a smart meter attached to an appliance can give information, whether the appliance is currently in use.

Example1. *Turning the heating appliance on and opening the window located in the same room leads to energy wasting.*

$$Window(?w) \wedge isAttachedTo(?cs,?w) \wedge ContactSensor(?cs) \wedge hasState(?cs,\text{"Open"}) \wedge Heater(?h) \wedge hasState(?h,On) \wedge SmartMeter(?sm) \wedge hasState(?sm,\text{"On"}) \wedge isAttachedTo(?sm,?h) \wedge Room(?r) \wedge isIn(?w,?r) \wedge isIn(?h,?r) \rightarrow EnergyWaste(?h) \quad (1)$$

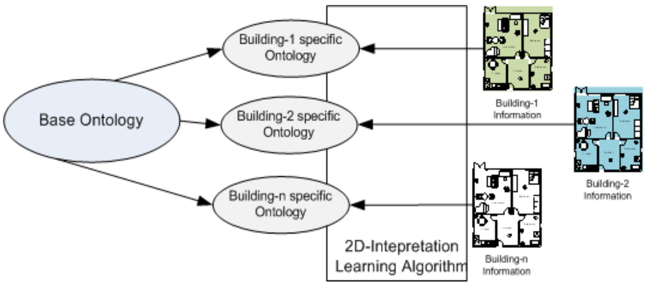

Figure 2. Enrichment of base ontology with building specific information.

B. Individual Generation through Interpretation of 2D-Drawings

By using this method, the base ontology is enriched with ontological individuals or *Abox* components from building specific information. The semantic information of building environments such as rooms, lightings, and appliances is obtained from geometrical data through interpretation of 2D-drawings. Then a search on ontological classes that corresponds to the resulted semantic information is performed in the base ontology. If the appropriate class is found, the module interpretation of 2D-drawings creates an ontology individual and associated relations e.g. `is_in` and `contains` representing the placement of the appliance in building environment. Figure 2 depicts the enrichment of base ontology resulting building specific ontology.

C. Semi Automatic Knowledge Acquisition through Data Mining Algorithm

In our work, data mining algorithms are used to indentify energy consumption patterns and their dependencies. Data mining is defined as the entire method-based computer application process with the purpose to extract hidden knowledge from data [14]. In KEHL framework we used different data mining procedures to generate knowledge for recognizing energy usage anomalies, determining classification of appliances based on their energy consumption, and identifying operation states of an appliance based on energy usage. We illustrate these procedures in the following sub sections.

1) Recognition of Energy Usage Anomalies

In this work, we relate the energy consumption with the behavioral occupant's pattern in the building. We aim to recognize energy consumptions that do not occur normally in the building. To perform this task, we have to know how energies are consumed normally regarding occupant events and surroundings. For example, normally when an occupant is currently sleeping and the outside temperature is comfortable, let us say greater than 20 degrees Celsius, total energy consumption in the building is low, for instance lower than 10 kWh. If in the same pre condition total energy consumption in building is more than 10 kWh, then it is considered as a usage anomaly.

It is difficult for users if they always have to log their activities. In our work we use simple sensors to recognize user activities automatically. Simple sensors can provide important hint about user activity. For instance, an occupancy sensor in a kitchen can strongly gives a clue whether somebody is currently cooking. Of course it should be combined with information of appliance states in the kitchen.

Rules representing normal energy consumptions are obtained through data mining classification rules algorithm. The algorithm is based on a divide-and-conquer approach. The created rule (2) shows the probability of 67% about how often it could happen if the event is sleeping while outside temperature is greater than 20 degree with total energy consumption lower than 10. This value is called confidence. The rule described in (2) represents a condition that normally occurs. The rule is transformed to (3), in order to represent an anomaly condition, by negating the consequent part of the rule.

$$Event = \text{"Sleeping"} \wedge OutsideTemperature \geq 20 \rightarrow TotalEnergyConsumption < 10\ (conf: 0.67) \quad (2)$$

$$Event = \text{"Sleeping"} \wedge OutsideTemperature \geq 20 \rightarrow TotalEnergyConsumption \geq 10 \quad (3)$$

Rules created by data mining algorithm are stored in ontology as SWRL. SWRL rule (4) represents the transformed rule (3), which is stored in ontology.

$$Event(?e) \wedge hasName(?e, \text{“Sleeping”}) \wedge OutsideThermometer\ (?ot) \wedge hasValue(?ot,?otv) \wedge swrlb{:}greaterThanOrEqual(?otv, 20) \wedge SmartMeter(?sm) \wedge hasValue(?sm,?smv) \wedge swrlb{:}greaterThanOrEqual(?smv, 10) \rightarrow UsageAnomaly(?e) \quad (4)$$

The rules resulted from data mining algorithm do not always have 100% confidence. Therefore we represent the rules as SWRL in order to enable verification by using rule editor provided in Presentation Module or using SWRL editor such as *Protégé*. The editor enables users to add, modify and delete the resulted rules.

2) Determining Classification of Appliances

Classification is the process of finding a set of models or functions that describe and distinguish data classes or concepts for the purpose of being able to use the model to predict the class of objects whose attribute is unknown [15]. The model is based on the analysis of a set of training data, i.e. data objects whose attribute is known.

In our work, appliances are classified based on their energy consumption by using classification algorithms, for instance *Naive Bayes*. Such a grouping finds out which devices

ISBN : 978-602-97809-0-1

consume more energy or if a household appliance works properly due to its energy demand. The grouping even allows the occupants to understand which of their activities need more energy. The resulted classes are transformed into ontological individuals of class `Energy_Cosumption_Class`. A relation `is_member_of` is added. It relates instances of appliance classes created by interpretation of 2D-drawings module and corresponding instances of class `Energy_Consumption_Class`.

3) *Generating Knowledge to Identify Operation States of Appliances*

In many cases an appliance consumes energy differently depending on its operational states. We are often not able to determine in which state our appliances consume more energy. Therefore we cannot react respectively, for example, to reduce or even to avoid in using appliances operating modes that consume more energy.

We use cluster analysis algorithm to recognize operation states of appliances, for instance, washing machine has operation states standby, water heating, washing and dry-spinning. Clustering algorithm analyses and puts data objects in certain clusters so that objects have high similarity to the other within a cluster but dissimilarity in comparison to objects in other clusters. In our case, we measure the similarity of energy consumption of an appliance.

V. Energy Analysis through Ontology Query

In knowledge base represented in ontology, all conditions of energy wasting and anomalies are represented as SWRL. Periodically data acquisition module requests real-time data from building automation gateway. These data contain states of all installed building automation devices. SWRL rules are used to decide whether these incoming data correspond to an energy waste or usage anomaly condition. We develop a rule engine based on *SWRLJessBridge* to support the execution of SWRL rules combined with *Protégé* API that provides functionality in managing OWL ontology.

First the attribute values of relevant ontological instance are set to values corresponding to incoming data. For example, if contact sensor attached to window gives a state “Open” then the attribute `hasState` of corresponding ontology instance of concept `ContactSensor` is set to “Open”. After that the rule engine executes the SWRL rules and automatically assign individuals to the ontology classes defined in the rule’s consequent. For example for rule (1) the instance of concept Heater is additionally assigned to `EnergyWaste` class and for rule (4) the instance of class Event to class `UsageAnomaly.`

SPARQL (SPARQL Protocol and RDF Query Language) is used to evaluate whether energy wasting condition or energy usage anomaly occurs. Which appliances cause the energy wasting can be retrieved as well. It is performed by querying all individuals of `EnergyWaste` or `UsageAnomaly` class. If individuals of these classes are found, a predefined automatic notification to user such as sending SMS, email or visually on the GUI can be performed. With this mechanism, user can react more quickly in order to avoid more energy wasting.

SPARQL is also used to get appliances belonging to a certain energy consumption class. The SPARQL processing is implemented in analysis module.

VI. System Architecture

As depicted in Figure 3, the KEHL software architectural components are deployed in a service provider and in the building whose energy consumption to be analyzed. We develop a KEHL home gateway as the main component in the building. The KEHL home gateway acts as the integration of different functional definitions of heterogeneous building automation systems installed in the building. The gateway contains the ontology enriched with individuals and rules from building specific information. These individuals are created during the configuration phase of building automation system. After that, the resulted building specific ontology is synchronized to data processing server located in the service provider.

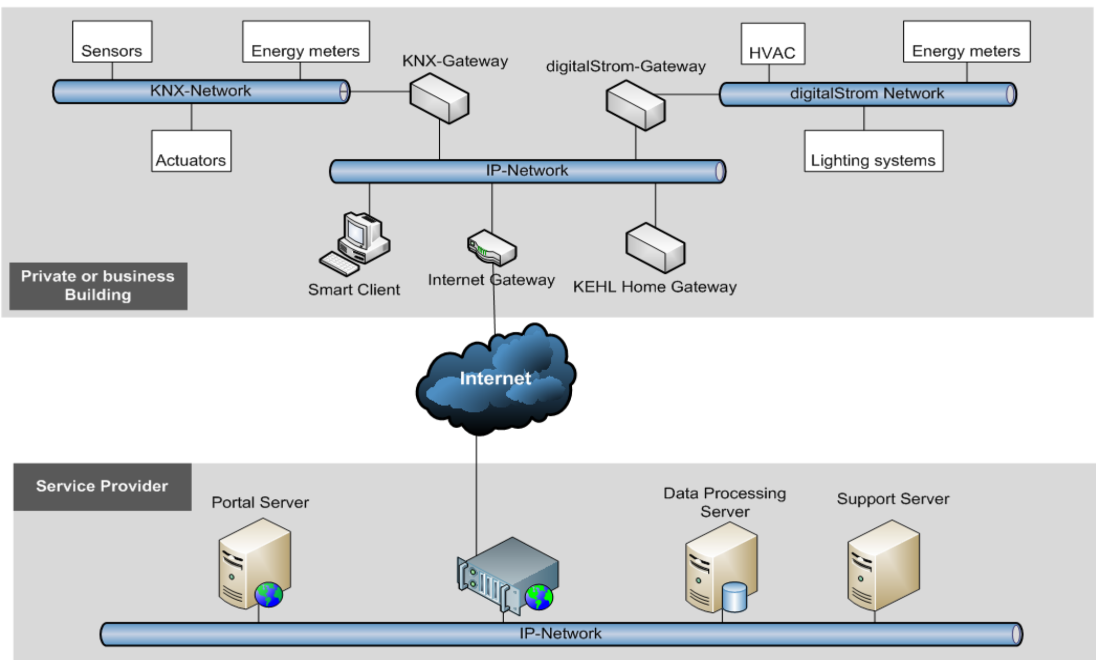

Figure 3. System Architecture of KEHL

The KEHL home gateway collects the data from different building automation systems gateways through SOAP protocol over internet. The collected data are aggregated and sent periodically to the data processing server. The data processing server executes data mining algorithms on the aggregated data. A high performance computer is required for the data processing server, since execution of data mining algorithms is resource intensive computing process. The results of data mining algorithms are stored as individuals and rules in the ontology. This ontology is then synchronized back to the KEHL home gateway.

The ontology stored in the KEHL gateway is used to perform knowledge-driven analysis by evaluating the incoming data from building automation devices against model represented by the ontology.

VII. Conclusion and Outlook

In this paper we have presented a system of comprehensive intelligent energy analysis in buildings. In the developed system, we extended the classical data-driven energy analysis with novel knowledge-driven energy analysis that supported by ontology. The analysis is performed on information collected from building automation devices. The ontology supported analysis approach provides intelligent assistance to improve energy efficiency in households, by strongly considering individual user behavior and current states in the building. Users do not have to read the whole energy consumption data or energy usage profile curves in order to understand their energy usage pattern. The system will understand the energy usage pattern, and notify user when energy inefficient conditions occur.

We have presented also the methods to generate ontological components i.e. individuals and rules, in building automation domain semi-automatically through interpretation of 2D-drawing and data mining approaches. The approaches can reduce ontology generation process, since the manual ontology components creation process is very time-consuming. However, the base ontology representing terminological knowledge in building automation is created manually.

The approaches described in this paper can be adopted in more complex systems such as production systems by integrating the base ontology with other ontologies in production system domain. Additional relations ontological components representing knowledge in production system, for example product, production tasks, machine related information should be created.

Acknowledgement

This work has been funded by German government (BMBF) through the research project KEHL within the program KMU-Innovativ. We would like to thank Enrico Kusnady, Ariel Guz, Mariusz Kosecki, and Youssef Aitlaydi for their contribution in implementing the prototype of this work.

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ISBN : 978-602-97809-0-1

A Genetic Algorithm for Highly Constrained University Course Timetabling Problem

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Abstract -**The timetabling problem is a specific type of scheduling problem concerned with the allocation, subject to constraints, of given resources to objects in space and time in such way as to satisfay as nearly as possible a set of desirable objectives. This paper present a real world timetable problem deal with hard constraints and soft constraints. A day-based Genetic Algorithm is used to solve the problem, while its fitness value is represent by each timetable satisfaction level. The method is preliminary tested for the problem, generating feasible timetable involving hundreds courses and lectures. The preliminary experimental result indicate that the algorithm is promising.**

Keywords─timetable, genetic algorithm, hard and soft constraints, satisfaction level.

I. INTRODUCTION

Timetabling problems (TTP) are a specific type of scheduling problems which may be highly constrained and difficult to solve. It is concerned with the allocation, subject to constraints, of given resources toobjects being placed in space and time, in such a way as tosatisfy as nearly as possible a set of desirable objectives[15]. Real timetabling problems have many forms like educational timetabling (course and exam), employee timetabling, timetabling of sports events, timetabling of transportation means, etc[8]. However, the TTP is encountered mainly in education institutions and to lesser extent in business too [16]. In academic field, its extent from school timetabling, course timetabling, examination timetabling [10] and congress timetabling [1]. Specifically, course timetabling problem was defined as *a multi-dimensional assignment problem in which students,teachers (or faculty members) are assigned to courses,course section or classes; events (individual meetingsbetween students and teachers) are assigned to classroomsand times"* [2].

Course TTP is very unique, involving hundreds course, lecturer, and several constraints (hard and soft); make it difficult to be scheduled. Timetabling problems are often over-constrained, since it is not possible to satisfy all requests of students for enrollment to specific courses [10]. The needs of satisfying requests also came from lecturer and institution, make it more difficult to solve. The TTP are mainly classified as constraint satisfaction problems [9][3][14], where the main goal is to satisfy all problem constraints, rather than optimizing a number of objectives. Thus, an effective timetable is crucial for the satisfaction of educational requirements, and the efficient utilization of resources, which make it an optimization problem.

The TTP is known to be NP-complete, so that solving it satisfactorily often presents great difficulties and such only combinatorial optimization methods could guarantee an optimal solution. However, this method is not practically and inefficient due to the needs of whole solution space evaluation. Thus, heuristics approach such as genetic algorithm (GA) can solve this combinatorial problem effectively and robustly [6]. Several empirical simulations demonstrate that GA is an efficient searching algorithm [7].

This paper present a method based on Genetic Algorithms (GAs) to solve a real world university course timetabling at UIN SunanKalijaga, as weighted constraints satisfaction problem (CSP). Each timetable tends to satisfy sets of hard constraints as well as soft constraints simultaneously. Since soft constraints represent stakeholder preference [4], weights are assigned to each constraint. A weight is obtained by calculating preference from a group of stakeholder using pair wise comparison technique. Thus, the GA can work on searching a timetable giving minimum unsatisfied weighted constraints.

II. PROBLEM DESCRIPTION

At Faculty of Science and Technology, UINSunanKalijaga, the timetabling process consists of constructing a class schedule for hundreds of courses and lecturers prior to student registration. Few years ago the process is handled manually over a week. Currently, an officer constructs timetable using interactive software based on trial and error. One should try to attempt a schedule one by one on a particular time slot, and be assigned whenever feasible. Therefore, it is still time consumed and needs to perform automatically rather than trial and error. Serious problemalso mayoccur caused by possibilities of student loosing their opportunities to take class because of time conflict.

The course timetabling is based on the following conditions:

- The timetable frame consists of *n* weeks; each week has *m* days and each day *t* periods (timeslots).
- The events are courses offered by the faculty (consist of 10 departments), having periods based on their credits. Each course may be split in a number of classes following the faculty policy due to students need.
- The set of lecturers, courses and rooms is fixed.
- The predefine class consist of lecturer conducting a course which is performed in a room.
- The rooms can be classified to certain room types based on their capacity and floor (1st, 3rd, and 4th).
- The timetable is performed by assigning a class into specific slots in a time-place horizon. This horizon is a combination of time periods and places (rooms).

The course TTP usually characterized by constraints, classified into two categories namely hard constraints and soft constraints. Hard constraints are those constraints that must be rigidly fulfilled. On the other hand, soft constraints are those that it is desirable to be fulfilled to the possible extent, but are not fully essential for a valid solution[8].

Typical Hard Constraints (HC) are:

1. No resource (teacher or room) may be assigned to different events at the same time.
2. The timetable has too few rooms (19 rooms) and there is a maximum number of time periods per day (10) and day per week (5), that can not be exceeded.
3. Specific lectures must be rigidly assigned to specific lecturer (could be more than one).
4. Events of same semester are not assigned at same time slot.

Typical soft constraints (SC) are:

1. **Course Distribution:** A student should have only one course at a time. Actually, this is typically a hard constraint. Since timetable is prepared before students take the course, it can be treat as soft constraint. In such condition, students may choose which courses they want while avoiding the constraint. Thus, there is need to extent courses distribution from the same department along time-space horizon, so that student can choose courses easily.
2. **Lecturer Adjacency:** Faculty member are limited and they have another tasks to conduct. It is necessarily to compact the timetable dedicated for faculty member needs. Such courses which are conducted by same faculty member should not have any free time slot between two courses on a day (adjacent slot). Thus, the first and the second soft constraint are conflicting soft constraint.
3. **Courses per Day Limitation:** Each faculty member has maximum limit number to conduct any courses in a day, due to avoiding any deterioration of lecture quality.
4. **Place Distance**: Spread the room usage in any floor as fair as possible for any faculty member. The building has many floors, the favorite one is the first floor and the worst one is the top floor.
5. **Over Capacity:** Avoid room over capacity due to the size of the class. Sometimes several new course members are added for special purposes. Actually, room capacity is not the maximum one but setup to be comfortable. Faculty may add facility due to the needs of increasing capacity, but deteriorate the course comfortable level.
6. **Place Utilization:** A proper utilization of room should be considered. A smaller class should not be scheduled in a room which can be used for a bigger class.

III. DEALING WITH CONSTRAINTS

The consequence of dealing with these two type constraints, imposing two steps on the mechanism of choosing a particular timetable slot to be assigned. First, deciding whether hard constraints were violated or not. If any timetable slots fulfilled all hard constraints condition, then course assignment can be done to the particular slot. Otherwise, if any timetable slots are violated by hard constraints condition, then the timetable become infeasible.Penalty cost will be assigned for each hard constraint violation.

The second step is assigning satisfaction level score due to satisfying soft constraints. Due to their characteristics, each soft constraint has their own satisfaction measurement. The main concept is that satisfaction level is a fraction of real achievement to the ideal one.

$$S_n = \frac{R_n}{I_n} \qquad (1)$$

Where

S_n : Satisfaction level of soft constraint *n*
R_n : Real achievement of soft constraint *n*
I_n : Ideal achievement of soft constraint *n*

Since there areseveral soft constraints with different characteristics, it is difficult to determine which soft constraint is more essential to fulfil than the others. Some weights may be assigned to each of soft constraints, but we must aware of weight fairness issue. It does not seem realistic to assign equal weights to all soft constraints. We have to deal with fairness perspectives about constraints from faculty members (lecturers) as stakeholders because each faculty members has their own impression to each of them. A pair wise comparison technique, such as in AHP mechanism is used to generate suchweights.

The necessary of fairness between stakeholders, force the pair wise comparison to be held on a group.Then,weightsaggregationshould be performed to the result of all pair wise comparison matrixes into one unit. The grouping method of the pair wise comparison can be performed by using geometric mean method [13]:

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$$w = (w_1 . w_2 . w_3 . \dots w_n)^{1/n} \qquad (2)$$

Where

w	: group weight by geometric mean
$w_1, w_2, w_3, \dots w_n$	: judgment of decision maker 1,2,3,…,n

The quality of timetable can be established in the perspectives of satisfying constraints. Supposed having total score (F) of timetable quality, it can be formulated as follows:

$$F = -\sum_{i=1}^{M}\sum_{j=1}^{P} H_{ij} + \sum_{i=1}^{M}\sum_{j=1}^{N} w_j S_{ij} \qquad (1)$$

Where

F : Total score of timetable quality

H_{ij} : Binary variable of hard constraint. $H_{ij} = 1$ if class *i* violate hard constraint *j*, $H_{ij} = 0$ otherwise.

S_{ij} : Satisfaction level of soft constraint *j* by class *i*.

w_j : Importance weight of soft constraint *j*.

The first part characterizes hard constrained violation while the second is soft constraints satisfying level.Thus, it may be three possible conditions of quality:

(1) The timetable is infeasible when F is negative (F<0), cased by hard constraints violation.
(2) The timetable is feasible but no quality, when F is zero (F=0). There is no hard constraints violation but the timetables extremely violate soft constraints.
(3) The timetable is feasible and having quality (F=(0,1]). Both hard and soft constraints are fulfilled.

IV. THE GENETIC ALGORITHMS

Genetics algorithms are stochastic search techniques based on mechanism of natural selection and genetics. A typical genetic algorithm starts with an initial set of random solutions called populations and each individual in the population called a chromosome. Chromosomes evolve through successive iterations, called generations. During each generation, the chromosomes are evaluated using some measures of fitness [5]. After several generations, the algorithm converges to the best chromosome, which hopefully represents the optimum or near optimal solution to the problem.

Genetic Algorithm Framework

The genetic algorithm framework used in this paper is depicted in Figure 1. The genetic algoritm starts firstly by generating an initial population. An individual in the population represents a solution. New population is generated by applying a reproduction strategy consisting of elistism, crossover, and mutation operators.

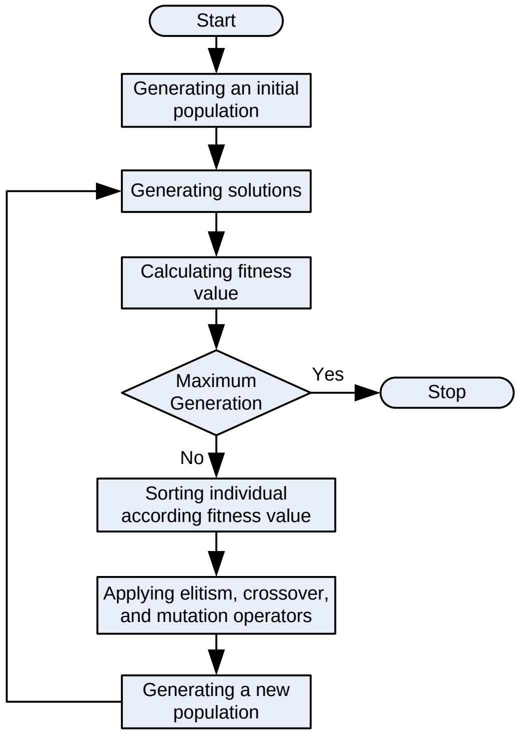

Fig. 1 Genetic Algorithm Framework

Individual Representation

An individual is represented by a sequence ofintegers[10][5] in the form of day-based representation [9] which is a special form of sector based representation [16]. Each day sector has 5 (integer fraction of hours per day to the minimum credit of class)genes slots which canbe filledby 5 genes.

The sequence of integers exhibits the sequence of dispatch priority of a class to be scheduled in time-place horizon. Each integer corresponds to a particular class (lecture-course assignment). Each class corresponds by querying to information of class name, course name, lecturer name, class population, and course credit.Figure 2 shows class and their labels while Figure 3 shows a representation in both phenotype and genotype styles.

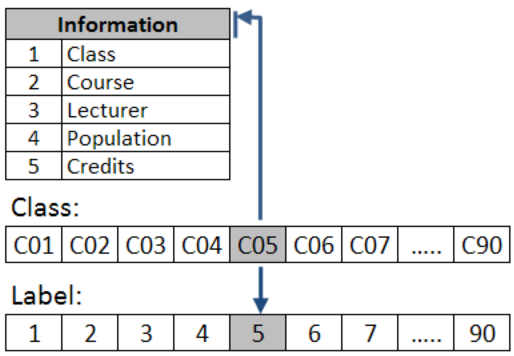

Fig. 2 Labels of class in integers

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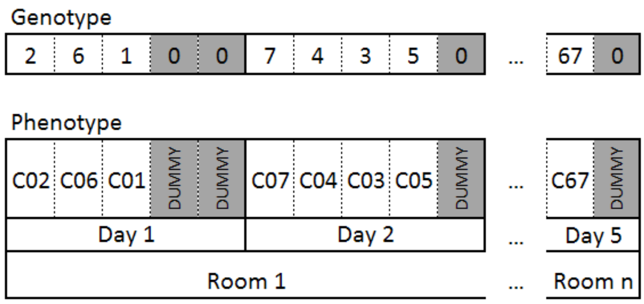

Fig.3 Day-basedrepresentation of phenotype and genotype

Initial Population

The first step of GA is initialize population. Each individual in the initial population are generated by sequencing random number between 1 to total number of available class. Each number has exactly one chance to appear, represent genotype which corresponds to one phenotype. Since a class can not put in consecutive time-place slot laid on two days, an individual must contain two type genes. The first gene is a representation of real class, while the second is a dummy. Dummy is used to fill the unused time-placeslot on a day, shown as Figure3.

Firstly, all classes are placed in a candidates list. The class to be assigned in the position is selected randomly among candidates and then this activity is deleted from the list. Cumulative credits of a series of consecutive class in a day can not exceed 10 since a day having 10 time slots. If the cumulative credits exceed 10, then the last class is moved to the next day. A series of dummies (zero number) are then assigned to the remaining gene slots until all gene slots in particular day are fulfilled.An illustration of the mechanism in generating an individual is shown Table I.

Table I. Illustration of generating an individual in the initial population

Position	Candidates List							RN	Selected Class	Cum. Credit	Genotype
	1	2	3	4	5	6	7				
1	(C01,2)	(C02,3)	(C03,2)	(C04,3)	(C05,2)	(C06,3)	(C07,3)	2	(C02,3)	3	2
2	(C01,2)	(C03,2)	(C04,3)	(C05,2)	(C06,3)	(C07,3)		5	(C06,3)	6	6
3	(C01,2)	(C03,2)	(C04,3)	(C05,2)	(C07,3)			1	(C01,2)	8	1
4	(C03,2)	(C04,3)	(C05,2)	(C07,3)				4	Dummy		0
5									Dummy		0
6									(C07,3)	3	7
7	(C03,2)	(C04,3)	(C05,2)					2	(C04,3)	6	4
8	(C03,2)	(C05,2)						1	(C03,2)	8	3
9	(C05,2)							1	(C05,2)	10	5
10									Dummy		0

RN = random number
(C01,2) = class 01 having 2 credits

Evaluation

The evaluation process deals with the quality score of timetable (*F*) which regard to hard and soft constraints. This quality score value becomes a fitness value which is obtained by generating timetable according to dispatch priorities represented by chromosome. Then, the timetable is evaluated regard to its hard and soft constraints. Despite the fact that during initialization, the fitness value might be extremely negative, it is expected that as the evaluation process continuous, more and more both hard and soft constraints would be satisfied and the quality score is going to be positive value. Thus, the objective is to avoid negative value and make *F* as close to one as possible.

Genetic Operators

Reproduction Strategy

In a particular population, individuals are sorted in decreasing order of their fitness values. Then, the population is divided into three parts: top, middle, and bottom.

The reproduction strategy used is illustrated in Figure 4. There are three operators used in the reproduction strategy, i.e., elistism, crossover, and mutation operators.

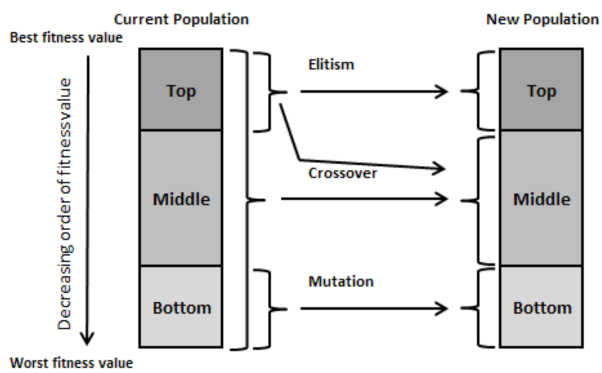

Fig.4Reproduction strategy

Elitism

The elitism operator works by copying directlyindividuals in the top part of the current population to the new one.

Crossover – Day based PMX

The crossover operator is performed to obtain children. Two parents are selected from individuals in the current population randomly, producing two children. One parent is taken from the top part and another is selected from the whole part.In this section, partially mapped crossover (PMX) is applied. And based on PMX, a day-based PMX (DB-PMX) is proposed. In generic PMX, the main procedures are as follows:

1. Select subset with corresponding location
2. Establish relationship between genes.
3. Exchange genes according to the relationships
4. Legalize the chromosome.

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DB-PMX is similar to generic PMX, except that the genes exchange is perform over day sector genes rather than random group of genes.

Table II. Day-based PMX procedure

Procedure Day-based PMX
Step 1 Set subset S1 and S2 for crossover according to the randomly generated block
Step 2 Recognize the range of locations of subsets, and set day block for crossover
Step 3 Apply PMX within each day block
(1) Establish relationship between genes within each day block
(2) Exchange genes according to the relationship
(3) Legalize the chromosomes
Step 4 Two children, C1 and C2 are generated

An illustration of the DB-PMXmechanism in generating children is shown on Figure 5. Notes, that two parents will produce two children.

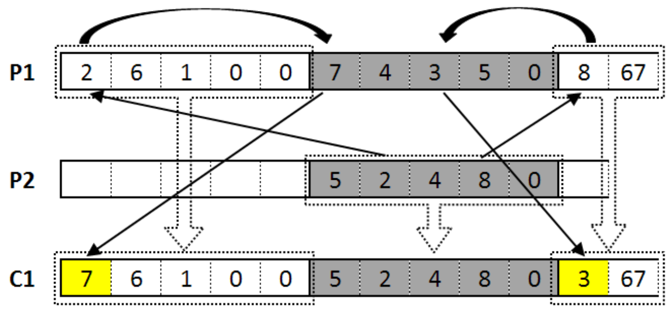

Fig 5 Example of genes exchange in Day-based PMX

Mutation – Day based mutation

The mutation operator is applied for individuals in the bottom part of population.In this part, a day-based mutation (DBM) is proposed. The mutation can be carried out in two ways:

(1) Day-based interchanging
All genes in two day blocks in a chromosome are interchanged as they are, shown as figure 6.
(2) Inner-day interchanging
The position of several genes in selected days, are interchanged inner their own day, shown as figure 7.

Choosing these two mechanisms is done randomly.

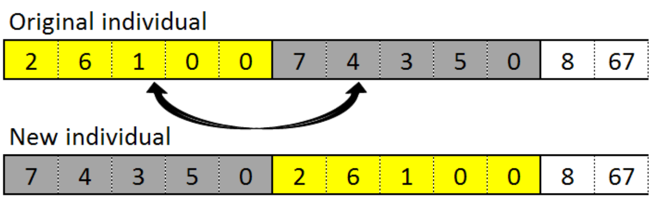

Figure 6 Example of DBM by day interchanging

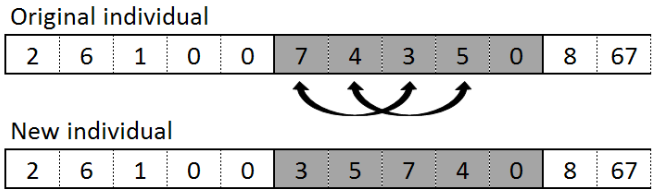

Figure 7 Example of DBM by inner-day interchanging

V. EXPERIMENT AND RESULT

Experiments were carried out on part of a university's real-world problem involving 260 courses which is conducted by 153 lecturers. All the constraints described in this paper were incorporated. The goal was to check whether the algorithm could actually generate acceptable timetables for the problem.

In Fig. 8 results from test runs of various population size, portion of top population (20%) and bottom population (20%) respectively are shown. As can be observed, the larger population size gives better solution. But, the solution improvement via growing population size will loose its significance impact after a certain number. Its indicate that one should be careful in defining GA parameters.

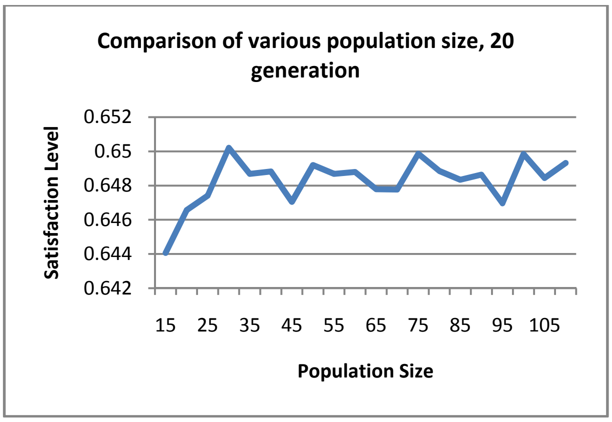

Figure 8 Experiment result on various population size

Future research is aimed at experiments using university's full data and then finding optimal parameters. We shall improve and extend the method to find more effective and efficient ways of initializing and searching during evaluation, and investigate the effect of various parameters.

VI. CONCLUSION

This paper has presented a genetic algorithm for solving a real world university timetabling problem incorporated hard and soft constraints. A day-based Genetic Algorithm is introduced to solve the problem, while its fitness value is represent by each timetable satisfaction level. Preliminary experimental results indicate that the algorithm is promising.

Improvement is necessary to find either better GA parameter and more effective and efficient methods.

Further investigation is necessary on some other timetabling issues: test the GA performance to some others real data and comparing its result with other algorithms. Second, the problem should incorporated more realistic problem. This will need to capture more various constraints. Third, future research should be conducted with differentreproduction strategies.

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ISBN 978-602-97809-0-1

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