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AUGMENTING SCIENCE IN THE ISLAMIC CONTEMPORARY WORLD
A Strategic Attempt at Reconstructing the Future

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Abstract

During five centuries (6th to 11th C.E.), the advancement of science in the Muslim world displayed Muslim civilization as the scientific Mecca. This era saw many other civilizations learning science from Muslims seen as exemplary in modernizing life and sharing guidance for moral conduct. This was accomplished by embedding norms and inventions and as a result of factors such as royal patronage and personal sacrifice. This paper seeks to reclaim historical data through reflection and contextualization. Analysis of relevant past contexts paves a path leading from romanticism and antiquanism into the contemporary world. Secondary resources, such as historical books and journals, reveal how science in Islam was developed and nurtured through patronage, institutional establishment, networking, and other factors, leading to valuable inventions. The Islamic Golden Era of science flourished because Muslims scientists had an ethos motivating them toward discoveries. Key innovating scientists made cities such as Nishapur, Alexandria, Jundishapur, and Damascus become preeminent in scientific invention. This brought rapid development to Muslim life, as well as to the surrounding nations, extending to Greece and India and China. This paper argues that Muslim scientists of today's world can benefit from the perspective that the Qur'an and hadiths are essential sources of general principles for conducting scientific and technological research. Both are key spirits for encouraging Muslim scientists to conduct rigorous studies.

[Selama 5 abad pertama, 6-11 Masehi, kemajuan ilmu pengetahuan di dunia

muslim terwujud pada peradaban muslim di Mekkah. Era ini menunjukkan pelbagai peradaban lain belajar kepada muslim sebagai model kehidupan modern dan petunjuk kehidupan moral. Hal ini teruji oleh norma-norma dan penemuan-penemuan serta hasil akibat dari loyalitas dan keikhlasan. Artikel ini mencoba mengklaim ulang bukti historis melalui refleksi dan kontekstualisasi. Analisa konteks masa lalu yang tepat menghindari dari kecenderungan romantisme dan kekunoan dari pada dunia kontemporer. Sumber sekunder seperti buku dan jurnal, membuktikan bagaimana pengetahuan dalam Islam berkembang dan tumbuh melalui patronase, institusionalisasi, jejaring dan faktor lainnya yang mendukung penemuan baru. Keemasan ilmu masa Islam menjamur karena ilmuwan muslim mempunyai etos yang tinggi pada penjelajahan pengetahuan. Kunci inovasi para ilmuwan telah membuat kota–kota seperti Nishapur, Alexandria, Jundishapur dan Damaskus berkembang menjadi pusat pengetahuan. Perkembangan pesat kehidupan muslim ini akhirnya menyebar ke Yunani, India dan China. Artikel ini menunjukkan bahwa ilmuwan muslim saat ini dapat mengambil manfaat dari perspektif Qur'an dan hadits sebagai sumber utama dalam prinsip-prinsip penelitian ilmiah dan teknologi. Keduanya juga, Qur'an dan hadits, menjadi kunci semangat bagi ilmuwan muslim dalam kajian yang lebih maju.]

Keywords: science in Islam, advancement, Islamic Golden Era, reconstruction

A. Introduction

Humans are uniquely able to connect the past with the present and future.[1] Al-Jabiri stated that when studying science of the classical era in Islam, the historian may seek to find its relationship to the science of today. Carr analyzed history as a continual process of interaction between historians and historical facts, being always in a dialogue between present and past.[2] Kuntowijoyo similarly denoted history as an attempt to illuminate the past through ongoing dialogues in order to find alternative

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1 Muhammed Abed Al Jabiri, *Kritik Kontemporer atas Filsafat Arab-Islam*, trans. by Moh Nur Ichwan (Yogyakarta: Islamika, 2003), p. 171.

2 Edward Hallett Carr, *What is History?* (New York: Random House, 1961), p. 35.

solutions for contemporary problems.[3] In studying data from the past, the historian examines history in order assess current events.

Fazlur Rahman suggested a process that he calls the 'double movement' method[4] for reviewing history. It is a way that historians come to understand important past events as being bridges from past to present in order to construct the future. In this view, the past and present have a reciprocal relationship for the benefit of learning and of implementation. Accordingly, the first movement is to glean lessons from the past, so that the second movement can contextualize these ideas to apply them as solutions for contemporary problems.

This paper considers science from the point of view of Islamic history in order to apply development strategies in the contemporary Muslim world. The first area of discussion presents the status of science and the explication of science during Muslim civilization's historical zenith. The second discussion focuses on benefactors' leverage for supporting scientific development by means of political patronage. By institutionalizing such developments and using networking, many key organizational bodies have proliferated in global contexts because their institutionalization and networking were interwoven. Examples will be given from case studies in Malaysia and Pakistan on their efforts to become leading nations for science in the Muslim world. In addition, the researcher provides reflections on the Indonesian context, with a view of how science could be beneficial for managing the nation's human and natural resources to provide welfare for all.

Scrutinizing scientific developments in the Muslim world, Azyumardi Azra asserted that before the reign of Caliph al-Ma'mun, science had reached its peak yet left no trace in the *madrasah*. Azra took note of Muslims' endeavors being the result of strong motivation for scientific inquiry, as with the Qur'anic verses of *kawniyyah*.[5] Huff emphasized science as a process of invention and noted that Islamic higher institutions such as the madrasah had systematically taught

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[3] Kuntowijoyo, *Pengantar Ilmu Sejarah* (Yogyakarta: Tiara Wacana, 2002), p. 17.

[4] Fazlur Rahman, *Islam and Modernity: Transformation of an Intellectual Tradition* (Chicago: University of Chicago Press, 1982), pp. 5–7.

[5] Azyumardi Azra, *Pendidikan Islam: Tradisi dan Modernisasi Menuju Milenium Baru* (Jakarta: Logos Wacana Ilmu, 1999), p. ix.

philosophy, physics, and science. As a result, dozens of scientists were roaming in centers of learning (*rihlah 'ilmiyyah*) to gain scientific experience by studying these subjects.[6] Given this background, this study formulated three primary questions: Which factors supported the flourishing of science in Islam to reach a zenith in its history? Which factors restrained Muslim science and caused stagnation? And which strategic paradigms did Muslim scientists employ to reinvigorate science?

B. Rise and Decline of Science in Muslim World: An Historical Overview

Science arose during the classical era of Islam by means of six augmenting factors: patronage, capital support, networking, coherent attitudes, marketing, and functional alignment of methods with objectives. Later scientific decline was due to two factors of note: lack of critical thinking, and lack of a scientific ethos. These two sets of factors are described and discussed below.

1. Factors Engendering Scientific Development

Patronage is marked by support from a ruling power. Caliphs, sultans, and wazîrs were advocates for science during the eighth to thirteenth centuries of Islamic political dynasties. These include the 'Abbasid (750-1258),[7] the Umayyid (756-1031) in Andalusia,[8] the Fatimid (909-1171),[9] the Buwayhid (945-1055),[10] the Samanid,[11] the Muwahhid,[12]

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[6] Toby E. Huff, *Rise of Early Modern Science: Islam, China, and the West* (Cambridge: Cambridge University Press, 1995), p. 204.

[7] Harun Nasution, *Islam Ditinjau dari Berbagai Aspeknya* (Jakarta: UI Press, 1985), p. 23.

[8] W. Montgomery Watt and Pierre Cachia, *A History of Islamic Spain* (Edinburgh: Edinburgh University Press, 1977), pp. 30–60.

[9] Philip K. Hitti, *History of the Arabs: From the Earliest Times to the Present* (New York: Palgrave Macmillan, 1970), p. 623.

[10] Edward G. Browne, *A Literary History of Persia*, vol. 1 (Cambridge: Cambridge University Press, 1956), pp. 360–5.

[11] Carl Brockelmann, *History of the Islamic Peoples*, trans. by Carmichael Joel and Perlmann Moshe (London: Routledge, 1980), p. 409.

[12] Watt and Cachia, *A History of Islamic Spain*, pp. 103–10.

the Ghaznawid,[13] and the Hamdanid (929-991).[14] Also, there were some small dynasties that developed when the power of the 'Abbasid caliphate was too weak to effectively manage the state.

Several caliphs of the 'Abbasid Dynasty who had great interest in developing science were al-Mansur (750-775),[15] Harun al-Rashid (785-809), al-Ma'mun (813-833), al-Mu'tasim (833-842), and al-Mutawakkil (847-861). They each had a reputation for sponsoring translations of pre-Islamic manuscripts from Greek, Sanskrit, and Latin, which aided the progress of science. They also established libraries and observatories. The same activities were done by the Umayyid Dynasty in Andalusia. Among the caliphs who remarkably became patrons of science were 'Abd al-Rahman III (912-961) and al-Hakam II (961-976).

Even after the decline of the 'Abbasid Dynasty, Islamic science continued to develop in the Fatimid Dynasty under the patronage of Caliph al-'Aziz (975-996), in the Buwayhid Dynasty under the patronage of 'Adud al-Dawlah (949-983) and Sharaf al-Dawlah (983-989), in the Saljuq Dynasty under Malikshah (1072-1092), in the Hamdanid Dynasty under Sayf al-Dawlah al-Murabitun and Yusuf ibn Tashfim (1090-1106), and in the Muwahhid Dynasty under 'Abd al-Mu'min. The era of Muluk al-Tawaif was also notable for support of science. Such patronage depended on the interplay of political factors with each caliph's attitude toward science. If the caliph perceived science to be important, for any motivation, then the caliph made a serious effort to support the progress of science. Conversely, if the caliph spent his time largely on political issues not related to science, then his support was less intense.

The championing of Islamic science was enhanced by provision of significant capital support for scientific development.[16] This included gathering reference materials and manuscripts from other civilizations. Caliph al-Ma'mun, for example, established a task force

[13] Hitti, *History of the Arabs*, pp. 464–5.

[14] *Ibid.*, p. 456.

[15] Al-Mansur appointed Khalid ibn Barmak as a wazîr and tutor for his children because Barmak's family seemed to have role in planting seed of love and passion toward science in the palace.

[16] Ali Kettani, "Science and Technology in Islam: The Underlying Value System", in *The Midas Touch: Science, Values and Environment in Islam and the West,* ed. by Ziauddin Sardar (Petaling Jaya: Pelanduk Pub., 1988), p. 85.

for this objective. The role of capital patronage was a key factor also by means of establishing scholarly teams to translate into Arabic the many scientific manuscripts from Greek, Sanskrit, and other classical sources. Al-Ma'mun's Bayt al-Hikmah was erected with the help of the state's budget and was equipped with rooms specifically for reference materials, discussion, and reading. In addition, an observatory was established.

Another aid to scientific development was the vast territory of Muslim land that supported networking of disciplines across regions and localities. The Caliph 'Umar ibn Khattab deserves credit for the expansion of Muslim territory that was continued by the Umayyid Dynasty. This expansion facilitated intercivilizational contact, mainly in cities that had become centers for learning, including Nishapur, Alexandria, Jundishapur, and Damascus. According to Ragaei and El-Mallakh, the trade routes at the end of eighth century went from Mesopotamia and Basrah along such rivers as the Tigris and the Euphrates; also south across the Indian Ocean to Madagascar; and to eastern India and Ceylon to China and Indonesia.[17] Routes also headed northwest from Bactria (Balkh) and Chorasmia (Khwarizm) to Bukhara and Samarkand (Kazakhstan). These areas became the trade centers of the Muslim world.

The vast array of trade networks enabled inter-civilizational contact between scientific traditions. Networking strengthened the development of science wherever there was an open atmosphere in society. Science in Muslim's past tradition included *'ilm al-hikmah*, and Ibn al-Qifti wrote *Târîkh al-Hukamâ'* as a biography of scientists specializing in philosophy, medicine, chemistry, biology, astronomy, mathematics, and physics.[18] As well as mastering many disciplines, scientists exhibited their ability to write logically, or *naqlî*. Those who studied *'ilm al-hikmah* mastered several disciplines and were encyclopedia-like experts. Such scientists were necessarily interdisciplinary. Those who learned medicine also needed to know biology and pharmacy; scientists who studied astronomy employed mathematics and geography as well; and those who mastered technology

[17] Ragaei and Dorothea El-Mallakh, "Trade and Commerce", in *The Genius of Arab Civilization: Source of Renaissance.*, ed. by John R. Hayes (Cambridge MA: MIT Press, 1983), p. 224.

[18] 'Alī ibn Yūsuf al-Qifṭi, *Tā'rikh al-Hukamā' wa-Huwa Mukhtasir al-Zawzani al-Musammā bi-'l Muntakhabāt al-Multaqaṭāt min Kitāb Ikhbar al-'Ulamā' bi-Akhbar al-Ḥukamā'.*, ed. by Julius Lippert (Leipzig: Dietrich'sche Verlagsbuchhandlung, 1903).

also needed knowledge in physics and mathematics.

Fazlur Rahman described that varied disciplines arose from critical thinking and caused a progression in science without yet having to denote and define the individual branches of knowledge.[19] There also were influences of locality, society, and culture since local natural phenomena influenced science and technology. For example, in some Arab countries, biology was less pursued because the local terrain has so few varieties of plants to be studied. Similarly, the technology of irrigation and waterway management was less needed in certain climate areas. Pragmatism is a natural factor in the growth of branches of science.

Sarton[20] and Magner[21] contend that through the spirituality-based Qur'an and Sunnah, Islamic science developed and that, through influences of Islamic teaching, the process of appropriation from pre-Islamic science traditions to the Islamization of science could occur. Pre-Islamic literacy heritage was partly incorporated when it was compatible with Islam. Muslim scientists translated, appropriated, and adapted the past materials to create new versions. Muslim scientists were at first passive learners, then later became accommodative and proactive, and finally were creative and innovative.[22] The natural human process enabled Muslim scientists to become mature in their profession. The concepts of Islam during such development were neither artificial nor remote; rather, were they substantially enriched through experience.

Science in Islam reached a zenith over five centuries. Places which became the centers of learning, as mentioned earlier, attracted foreign learners and flourished. Given this fact, the question arises as to why

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19 Rahman, *Islam and Modernity*, p. 148.

20 George Sarton, I*ntroduction to the History of Science* (Baltimore: Williams & Wilkins Co., 1953), p. 5.

21 Lois N. Magner, *A History of the Life Sciences* (New York: Marcel Dekker, 1994), p. 78; Howard R. Turner, *Sains Islam yang Mengagumkan: Sebuah Catatan terhadap Abad Pertengahan*, trans. by Zulfahmi Andri (Bandung: Penerbit Nuansa, 2004).

22 About the process of Muslim scientists' attitudes, some of which could be found in Mehdi K. Nakosteen, *Kontribusi Islam atas Dunia Intelektual Barat*, trans. by Joko S. Kahhar and Supriyanto Abdullah (Surabaya: Risalah Gusti, 1996), p. viii; Manfred Ullman, *Islamic Surveys II: Islamic Medicine* (Edinburgh: Edinburgh University Press, 1740), pp. 30–1; Turner, *Sains Islam yang Mengagumkan*, pp. 43–4; Richard Walzer, *Greek into Arabic: Essays on Islamic Philosophy* (Oxford: Bruno Cassirer, 1962).

scientific development was stagnant after this period? When Napoleon Bonaparte came as an envoy to Egypt in 1798,[23] along with scientists in varied disciplines, he observed the worrisome condition that Egyptian *'ulamâ* no longer had respect toward science in the previous way that the caliphs during the Golden Era of Islam had exhibited. The Egyptian *'ulamâ* were deeply engaged in mysticism rather than in analytically creative thinking. The same situation also occurred in the sub-continent of India-Pakistani, in Southeast Asia, and elsewhere in the Middle East. This situation has seemed to endure into the modern era, even while science and technology became standard in advanced civilizations.[24]

The development of science in the Golden Era of Islam was widely supported by merchandise trade with other nations. The 'Abbasid Dynasty had gained a huge territory, spanning Andalusia to India,[25] and this achievement led Muslim scientists to collaborate with scientists who traveled extensively for learning (*'rihlah 'ilmiyyah*). With high self-motivation, they began to transfer, translate, and summarize, and then to generate feedback and to produce new work.[26]

The vast area of land was not the only factor driving scientific development. Royal support also made positive contributions. The caliph as a science patron played a central role in developing science, especially marked by his policy to establish institutions for science, such as Caliph al-Ma'mun with Bayt al-Hikmah. The caliph's respect exhibited tolerance and support. Merton elaborated these obsrvations by describing how scientific development was dependent on the positive role of scientists

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23 Hitti, *History of the Arabs*, pp. 721–2.

24 The opinion of Abdus Salam decades ago is still relevant: "Today in every civilization on the earth, science has the weakest manifestation in Muslim world. The consequence from this weakness could not be manipulated because society is wrestling with life survival which is directly dependent on science and technology." See Mohammed Abdus Salam, "Kata Pengantar", in *Islam & Sains: Pertarungan Menegakkan Rasionalitas*, trans. by Luqmān and Thohiruddin Lubis (Bandung: Pustaka, 1997), p. v.

25 Kettani noted that the width of land was 40 billion kilometers square. Kettani, "Science and Technology in Islam: The Underlying Value System", p. 85.

26 Franz Rosenthal described many things that had to deal with the scholarship tradition of Muslim intellectuals, such as critical thinking, conducting series of experiment and observations, and ethics. See Franz Rosenthal, *Etika Kesarjanaan Muslim: Dari Al-Farabi Hingga Ibn Khaldun,* trans. by Ahsin Mohammad (Bandung: Mizan, 1996).

and their ethos, on the community of science, and on review of internal historical events, as compared with other civilizations.[27] During that time, the Muslim scientists and the community supporting science exhibited growth through such characteristics.

Another factor historically for Islamic science to reach its zenith was the congruence between methods and objectives. Although many people think objectives may be reached with any method, even if it is not compatible with religious teaching, Muslim scientists did not violate their ethics during their work in the Golden Era. They were conscious of the need to align method with objective. Anees in Sardar stated that science and values should run in parallel.[28]

The Stockholm Seminar Forum on Science and Values identified relevant concepts connected with the relationship between method and objective. These are *tawhîd, khalîfah, 'ibâdah, 'ilm, halâl, harâm, 'adl, ẓulm, istiṣlâh*, and *dhiyâ'*. The concept of *tawhîd* means the oneness of God, and it becomes a value for the integration of humans with the universe, as well as science with values.[29] In this concept the term *khalîfah* appears, meaning that there is no partition between human and God, and that humans are responsible to God for the results of science and technology. This responsibility implies that humans must make right choices in what they do since they have a duty to guard and defend their integrity throughout life

Meanwhile '*ibâdah* is the manifestation of *tawhîd* and *khalîfah*, meaning that one is conscious toward God through self-submission to God. This is not a narrow meaning, and thus '*ibâdah* in this context can include developing science. The concept of '*ilm* or knowledge is as a means of becoming closer to God. And when becoming so, knowledge is essential so that humans can know what they may do and what the consequences of their actions may be.

The principles of *halâl* and *harâm* are not included in the definition

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[27] Huff, *Rise of Early Modern Science*, p. 15.

[28] Ziauddin Sardar (ed.), *The Midas Touch: Science, Values and Environment in Islam and the West* (Petaling Jaya: Pelanduk Pub, 1988), p. 6.

[29] S. Parvez Manzoor, "Environment and Values: The Islamic Perspective", in *The Midas Touch: Science, Values and Environment in Islam and the West*, ed. by Ziauddin Sardar (Petaling Jaya: Pelanduk Pub, 1988), p. 155.

of *fiqh*, but they do form part of social behavior. *Harâm* covers activities destructive to humans and to the environment. The word 'destructive' applies to the physical, but also to the mental and spiritual; hence any science or technology which is harmful to humans or to the environment is forbidden.[30] Meanwhile, *halâl* comprises all things useful to individuals, society, and the environment. Thus *halâl* activities are beneficial for someone, and this can include the societal and environmental effects. In such contexts, the concept of *'adl* applies in parallel with *halâl*, meaning that justice among all people and for the environment is taken into account.

To embrace *halâl* dan *'adl*, we brush aside *harâm* and *ẓulm*. *Żulm* and '*adl* are opposite terms, where the former is rendered in relational contexts: humans-God, humans-humans, and humans-nature. Science and technology, following this structuring, must deal with *halâl* and *'adl* due to any negative aspects that may affect human lives. Such aspects could include alienation and dehumanization, hoarding of wealth, unemployment, or a devastated environment-all of which are within the category *ẓâlim* and are therefore forbidden. Characteristics of bad science and risky technology (*ẓâlim*) can be disastrous for humans and for spirituality.[31] Ideally, *halâl* science and technology prioritize the principle of *istiṣlâh* (the public good).

The above discussion has emphasized coherence between objective and method. The understanding of science and technology comes through the way a Muslim approaches God with an utmost obligation as His creature to utilize resources for welfare and justice among fellow humans. And as such, in the process of scientific and technological development, humans shall be conscious of relating transcendentally to God, and thus put the societal relevance of their work in its rightful place.

2. *Factors Causing Islamic Science to Decline Historically*

There are many scholarly accounts about factors causing scientific stagnation internally and externally. Internally, there was an effect of Muslim political decline, marked by disintegration of governance and simmering disputes among elite politicians. Also internally was a decline

[30] Ziauddin Sardar (ed.), *The Midas Touch: Science, Values and Environment,* p. 7.

[31] *Ibid.*, p. 78.

of critical thinking. Muslims tended to revive communally by defending subjectivity and opting for *itbâ'* rather than *ijtihâd*. As a result, in their scholarly work they summarized, commented, and compiled ideas of past scientists without critique or fresh opinions, and therefore they pursued justification rather than discovery.[32] However, this drawback did not apply to the entire era. Some successfully worked on discoveries, especially in the thirteenth to fourteenth centuries, when Muslim astronomers, led by Ibn Shatir and the school of Maraghah, cemented their foundations in astronomy.[33] Tremendous inventions were made via observations and experiments. Prominent scholars such as Ibn al-Haytham studied optics; also, al-Razi improved medical practice; and astronomers such as Ibn Bajjah, al-Bitruji, al-'Urdi, Ibn Tufayl, and Ibn Rushd made many discoveries.[34] Scientific advancement was nonetheless slow, while the West meantime had progress through its Renaissance. The slow pace was not due only to internal factors, but also to external sociological and cultural ones. An example is the invasion by the Mongol military force led by Hulagu Khan into Baghdad in 1258.[35] This disruption did not ruin all Islamic science as many historians tend to report, but it did cause overall harm to Muslim civilization, as compared to a glorious past. And the decline of particular aspects of science was due to another factor. Science in Islam had been dependent on both location and communication. When mathematics and astronomy developed in one region, for example, other regions could follow since locality was not imperative. But the impetus for medicine and biology could not as easily ensue without connection to locations and their resources.

Huff argued that the decline of Islamic science was due to the lack of institutionalizing the ethos of science, which is defined by Merton as comprising universalism, communalism, skepticism, and disinterestedness.[36]

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[32] Thomas.S. Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1970), p. 52.

[33] Huff, *Rise of Early Modern Science,* p. 150.

[34] *Ibid.*, pp. 210–2.

[35] Hitti, *History of the Arabs*, p. 486.

[36] Robert K. Merton, *The Sociology of Science: Theoretical and Empirical Investigations* (Chicago: University of Chicago Press, 1974), p. 269; Huff, *Rise of Early Modern Science,*

Muslims without these four values tended to diminish scientific advancement and invention. Muslim scientists and some caliphs had embraced these values; for example, Caliph al-Ma'mun and Caliph al-Mutawakkil both would not have appointed Hunayn ibn Ishaq as official state translator and supervisor if he had not possessed an open mind. Additionally, Muslim scientists in general would not have been able to build upon science from other cultures (*'ilm 'ajam*) if they had only a narrow perception of Islam.[37] Accordingly, it is seen that the madrasah at that time used and extended foreign knowledge.[38]

Merton defines the value of universalism as standardizing pre-established impersonal criteria to assess individual achievement.[39] Kettani confirmed that universalism in Islam[40] recognizes oneself regardless of ethnicity, gender, language, or race. From this perspective, inclusivity of Islamic spirituality, openness, and pluralism are important. Muslim scientists and statesmen without these values have few chances to promote intercivilizational dialogue.

Standards for each human actor exist regardless of social status, position, community affiliation, and ethnicity. Deeds are measured through universal standards of internal activities or disciplines. In the context of the Islamic Arab, it is absurd to stand on a level of moral neutrality and ethics in philosophy, according to Huff, because of particularistic attribution of Islamic law. Consequently, the resurgence of Islamic law has taken a role in establishing particularism rather than universalism.[41]

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p. 402.

[37] Munir-ud-Din Ahmed, *Muslim Education and the Scholars' Social Status: Upto the 5th Century Muslim Era (11th century Christian era)* (Zürich: Verlag der Islam, 1968), p. 31.

[38] Huff, *Rise of Early Modern Science*, p. 233.

[39] Robert K. Merton, *Social Theory and Social Structure* (Chicago: Free Press, 1957), p. 553.

[40] Kettani, "Science and Technology in Islam: The Underlying Value System", p. 85.

[41] When establishing higher education institutions, such as madrasah in eleventh century, each madrasah appointed mudarris of one of the prominent law schools: Shafi'i, Maliki, Hanafi, and Hanbali, meaning that *madrasah* was constrained by the perspective of law. See N.J. Coulson, *A History of Islamic Law* (Edinburgh: Edinburgh University Press, 1994), chap. 3; George Makdisi, *The Rise of Colleges Institutions of Learning in Islam*

Universalism means that the association among individual Muslims is the faith association and a life objective. Everyone is grouped within the larger unit of congregation called *ummah*, calling for goodness (*amr bi al-ma'rûf*), forbidding wrongdoing (*nahy 'an al-munkar*), and believing in Allah (*tu'minûna bi allâh*). Kuntowijoyo characterized three qualifications of *ummah*, as being liberal encouragement, emancipation, and transcendence.[42] The union of *ummah* accordingly can go beyond family, race, and geography to include other entities because in *ummah* there is a priority for all humanity when interacting with other believers. Thus Muslim scientists in history worked together with other scientists of different faiths.[43]

Universalism during the Golden Era of Islam was integrated with tolerance. To understand the word 'ummah' without tolerance would have isolated Muslim scientists from international forums. In order to spread blessings for the entire world, the Muslim scientific community could be inclusive, regardless of race, language, and religion.[44] This openness toward other adherents of science included mutual respect to achieve harmony without sacrificing identity. This of course would recently be different from some groups of people using tolerance and pluralism while tending to sacrifice identity so these two aspects were totally rejected.

The second scientific ethos is communalism which, according to Merton, refers to the communal character of science, such as its imperative to make one's findings public[45] because confidentiality is its antithesis. In the context of Islamic civilization, ambivalence has become an issue in knowledge dissemination. On the one hand, granting *ijâzah* was meant to preserve personal relationships by transmitting knowledge, and on the other hand, the system could not restrict someone from

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and the West (Edinburgh: Edinburgh University Press, 1981), p. 2.

42 Kuntowijoyo, "Ilmu Sosial Profetik: Etika Pengembangan Ilmu-Ilmu Sosial", *Al-Jamiah: Jounal of Islamic Studies,* no. 61 (1998), pp. 70–6.

43 According to Nurcholish Madjid, this was the time when pluralism was applied in society.

44 Muslim science networking has been recorded in variety of books, and some of them evidenced these characteristics. See Ibn Abī Uṣaybi'ah, '*Uyūn al-Anbā' fī ṭabaqāt al-Aṭibbā*' (Beirut: Dār Maktabat al-Ḥayāh, 1970); Muḥammad Ibn-Isḥāq Ibn-an-Nadīm, *al-Fihrist* (Beirut: Dâr al-Ma'rifah, 1970).

45 Merton, *Social Theory and Social Structure*, p. 556.

duplicate manuscripts, such as making copies for the purpose of giving to scholars and political elites. This practice had existed through storing and distributing manuscripts between libraries.[46]

This third ethos, also called organized skepticism, was a methodological and institutional mandate. Methodologically, holding judgment and explanations temporarily followed logical and empirical criteria in which both the mandate and source of a conflict are against other institutions.[47] In other words, epistemology, metaphysics, and social foundations are a united experience which spoils influenced objects.

The last scientific ethos, disinterestedness, according to Merton, is a mechanism for institutional oversight, distinctive from many other motives. The institution establishes a non-interest activity, but for the interest of scientists it was prone to sanctions and psychological conflict when the ethos was internalized.[48] Scientists' subjugation toward the accountability of their academic colleagues was the most effective method to deal with universalism.

The last two norms of ethos, namely skepticism and disinterestedness, to some extent could be found in a tiny circle of philosophers outside the centers of learning within Islamic civilization. These groups had not been validated by Muslim mediator elites. Some Madrasah were shut down for teaching science and philosophy, *sharî'a*, and *fiqh*, and some scholars resisted anyone inclined to learn Greek and Platonic logic. Islamic jurisprudence did not have a role for individual conscience to be the deepest morality for guiding actions and managing dilemmas. Furthermore, there was little space for organized skepticism in Islamic thought.[49] The faithful were obliged to prove a right opinion and find its reason in the Qur'an, and this was a cause of conflict about teaching philosophy in madrasah. A growing perception was that merely studying philosophy did not make one become wise, and those engaged in such study sometimes were subject to assaults. In Andalusia, scientists developed philosophy and astronomy secretly, as they were in fear of

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[46] Huff, *Rise of Early Modern Science*, p. 224.

[47] *Ibid*., p. 560.

[48] Merton, *Social Theory and Social Structure*, p. 559.

[49] Huff, *Rise of Early Modern Science*, p. 233.

being alleged as zindiq,[50] and if they were discovered, the consequence was that they would be stoned or even immolated. For this reason, there were no longer physics studies conducted publicly and the support for research was much reduced under the waqf system.

As stated earlier, a notable factor that kept Islamic science from experiencing a Renaissance in the modern era was the absence of institutionalization of the four factors. This situation contrasted to the tradition of science in the West in which there was an institutionalization of the scientific ethos in the education institutions. In some Muslim countries, the formation of higher education institutions called *madrasah* was geared more toward the interest of elites, and the disciplines receiving priority were *naqlî* science, such as *tafsîr, hadîth, fiqh*, *'ilm al-kalâm*, *taşawuf,* and *lughawiyyât*.[51] Elites and Muslim scientists were interested in establishing institutions that developed religious *naqlî* science, such as *kuttâb, maktab, masjid, masjid-khan, ribât, zawîyah, khanqah*, and *madrasah*, while other institutions for developing science were limited in number, except through spontaneous institutions owned by the elites, such as Bayt al-Hikmah, Dâr al-Hikmah, private libraries, and *halaqah* owned by the scientists.[52]

A consequence of the lack of institutionalizing the ethos of science was that science development became ad-hoc in an advanced civilization that was dependent on the will of elite politicians, and there was scant regeneration or innovation by the scientists. This occurred because there was a community of scientists trained and educated through institutions whose function was to conduct extensive research through discussion and teaching, except for several institutions that took crucial roles as the disseminators of science, such as Bayt al-Hikmah, the Maraghah observatory, and the University of Cordova. Additionally, there was a growing tendency of Islamic science to become elitist, since science was taught exclusively within the circle of the royal palaces.

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[50] J. Pedersen, "Madrasah", *Shorter Encyclopedia of Islam,* ed. by H.A.R. Gibb and J.H. Kramers (Ithaca, N.Y.: Cornell University Press, 1974), p. 306.

[51] Lihat Bayard Dodge, *Muslim Education in Medieval Times* (Washington: Middle East Institute, 1962), pp. 50–90.

[52] Ahmed, *Muslim Education and the Scholars' Social Status*, pp. 52–85.

C. Strategic Paradigms in Developing Science in Islam

Based on earlier causal factors for scientific progression during the classical era of Islam, the Muslim scientists of later generations have developed certain strategic paradigms and governmental policies.

1. *Shift of Scientific Paradigms from Bayâni to Burhâni, and 'Irfâni*

The term 'paradigm' means a process of thinking and refers to one's attitude toward a believed conception. The related discussion herein is that ontologically, epistemologically, and axiologically, science is an integral part of Islamic studies. Without these aspects, scientific developments in Islam would only justify inventions within verses of the Qur'an and hadiths, because the paradigm would not denote science as being in complementary position with religion. Ontologically speaking, one could approach God through verses of the Qur'an called either *qawliyyah* or *kawniyyah*.

More than 750 verses of the Qur'an speak about natural phenomena,[53] and thus one could say that all kinds of science have existed in the Qur'an. About this, there are two perspectives. First, all kinds of science including natural science are found in the Qur'an. Second, the Qur'an gives initial guidance for further scientific development.

The first perspective found many advocates; one being Ibn Mas'ud asserting: "If someone would have liked to master science, whether in the classical era or modern times, he or she should have pondered the Qur'an". All kinds of science, according to Ibn Mas'ud, include attributes of Allah, and the Qur'an explains His essence, attributes, and deeds. There is no limitation to science, and in the Qur'an there is a mark indicating a meeting point of the Qur'an and science. Al-Ghazali supported this perspective in *Jawâhir al-Qur'ân*, explaining that medicine and astronomy exist in the Qur'an,[54] and similarly al-Suyuti (d. 911) in *al-Itqân fie 'Ulûm al-Qur'ân*, said that the Qur'an covers many kinds of science,[55] by which the

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[53] Mehdi Golshani, *Filsafat-Sains Menurut al-Qur'an*, trans. by Agus Effendi (Bandung: Mizan, 1995), p. 144.

[54] Abu Hamid Ġazzālī, *The Jewels of the Qur'ān: Al-Ghazālī's Theory*, trans. by Muhammad Abu Qāsim (London: Routledge, 1983), pp. 45–8.

[55] Muhammad H. ad-Dahabī, *At- Tafsīr wa-'l-Mufassirūn: Baḥt Tafṣīlī 'an Naš'at at-Tafsīr wa-Taṭauwuruhu, wa-Alwānuhu wa-Madāhibuhu,* vol. 2 (Cairo: Dār al-Kutub al-

Qur'an has clearly revealed that it explains everything.[56] Maurice Bucaille is one who is included in this category of stating that all disciplines have been embedded in the Qur'an.[57]

The second perspective contended that the Qur'an does not speak in detail about scientific development, but is comprised of the general ethics for explicating theories of science. Muslim scientists in the Golden Era, such as Ibn Sina, al-Biruni, al-Tusi, and Ibn al-Haytham, did not seek formulas in the Qur'an, although they had strong belief and understood its contents. Furthermore, trying to match the contents of the Qur'an with scientific inventions would be inappropriate because the Qur'an is the word of Allah, which is absolute in nature and could not be forced to justify science which is relative.[58] Similarly, the geocentric scientists would think the center of the galaxy is the earth and say the Qur'an justifies it, and yet later the heliocentric scientists would think the center of the galaxy is the sun and would also contend that the Qur'an justifies it. The contents of the Qur'an would be claimed differently by one or another scientific perspective.[59]

Given any two juxtaposing perspectives, Golshani suggested that the Qur'an is not an encyclopedia or arbiter of science, but that it can be used as an aid to draw the attention of readers to know that Allah has all miracles and His creatures close to Him.[60] Golshani acknowledged that modern science allows scientists to appreciate the contents of the Qur'an; for example, a verse states that in the initial time the heavens and the earth were one mass, and then they were torn apart,[61] referring to the processes of the galaxy and the role of water for human life. Similarly, a verse states: "We created all things in pairs, so that you may

Ḥadīts, 1961), p. 420.

56 Qur'an, 16: 89. See also Qur'an, 6: 38.

57 Maurice Bucaille, *The Bible, The Qur'an & Science* (Indianapolis: Crescent Publishing, 1978), p. 251.

58 Compare with al-Farmawy's critique on disadvantages of the approach of tafsîr *bi al'ilmy*, some of which reflects that the Qur'an is compatible with technology. In Islam, science and technology have developed because they got inspirations from the Qur'an.

59 See Dahabī, *At- Tafsīr wa-'l-Mufassirūn*, 2: 485–9.

60 Golshani, *Filsafat-Sains Menurut al-Quran*, p. 143.

61 Qur'an, 21: 30

reflect and ponder".[62] The Qur'an reveals what we perceive as general principles, meaning that with the help of these, one may see knowledge about physical development and human spirituality. The Qur'an suggests Muslims should think about the mysterious process of how the universe was created, which it states on many occasions in the Qur'anic verses. For example, "And in your own creation, and in the creatures He scattered, are signs for people of firm faith"[63] and "... roam the earth, and observe how He originated the creation...".[64] Therefore to be able to discern verses of the Qur'an, one needs to use intelligence. Those Muslim scientists did so during the Golden Era of Islam, and as al-Biruni asserted, any causes beyond his series of research was because of the verses, "... and they think about the creation of the heaven and the earth: "Our Lord, You did not create this in vain...".[65]

There is also the question of how Muslims could implement the Qur'an according to the context of scientific development because the Qur'an basically puts emphasis more on daily practices than on anecdotal theories.[66] Regarding this, Fazlur Rahman championed Iqbal's perspective on the need for articulating the Qur'an so that it is able to address contemporary issues. Rahman offered the double movement method, which included both the situation when the Qur'an was revealed and the current situation, because the Qur'an is God's response, through Muhammad's thinking, about socio-morals of the Arabs when the prophet lived.[67] The first movement is to understand the meaning of the Qur'anic statements by scrutinizing the historical situation and issues. This historical understanding starts with the contexts of society, beliefs, customs, and institutions existing in the Middle East prior to Islam. The first movement then focuses on the need for the deepest understanding the Qur'an, so that Muslims could be responsive to its issues and catch

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[62] Qur'an 51: 49.

[63] Qur'an 45: 4.

[64] Qur'an 29: 20.

[65] Qur'an 3: 191.

[66] About this Muhammad Iqbal put "The Qur'an is a book which emphasizes on 'deed' rather than 'idea'." See further Muhammad Iqbal, *The Reconstruction of Religious Thought in Islam* (Lahore: Sang-e-Meel Publication, 2017), p. v.

[67] Rahman, *Islam and Modernity*, p. 5.

the logic of its contents.[68]

The first movement analyzes principles, values, and main themes of the Qur'an, and the second movement then brings the ideas and concepts into current settings. In this way, our deepest understanding of a current situation contributes to the effort of contextualizing morals stated in the Qur'an. In doing so, we use critical analysis to understand the nature of issues so that we can contextualize the Qur'an's offerings from the first movement. Rahman identified the first movement as the job of historians, and the second movement as that of social scientists.[69] To this purpose, we need the historians who analyze the past, and the social scientists who map the issues of today's world; thereby, the historian's findings are useful for alternative solutions of contemporary problems. Such a role may be embraced by every Muslim if he or she wishes to contextualize the Qur'an.

Finally, the Qur'an is considered an inspiring source for Muslims in their daily activities and for the general values of humanity. Al-Faruqi has said that the Qur'an is a compilation of inspiring materials for Muslims, inclusive of developing science.[70] Qur'anic norms encouraged Muslim scientists in the Golden Era of Islam. Many verses of the Qur'an advocate for Muslims to utilize reason, and among the myriad of phrases is found *afalâ ta'qilûn* (wouldn't you think). The root word of *'aql*[71] has a central role in reflecting on those verses, either *qawliyyah* or *kawniyyah*.

To understand Islamic teachings through the Qur'anic texts,

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[68] *Ibid.*, p. 6.

[69] *Ibid.*, p. 7.

[70] Ismail Raji Fārūqī and Lois Lamya Fārūqī, *The Cultural Atlas of Islam* (New York: Macmillan u.a., 1986), p. 109.

[71] The word *'aql'* in the noun form is not found in the Qur'an but is only mentioned in the form of verb *'aqaluh* in one verse (Qur'an 2: 75), *ta'qilûn* in 24 verses (Qur'an 2: 242), *na'qil* in one verse (Qur'an 57; *ya'qiluha* in one verse (Qur'an 29: 43), and *ya'qilûn* in 22 verses (Qur'an 22: 46). The word *'aqala* means to tie or to hold. According to Izutzu, the word *'aql* in the era of pre-Islamic tradition was used to mean practical intelligence, or what modern psychology calls problem-solving capacity. According to Harun Nasution, the word 'aqala has two meanings: understand and think. See Hans Wehr, *A Dictionary of Modern Written Arabic (Arabic-English)*, ed. by J. Milton Cowan (Beirut: Librairie du Liban, 1980), p. 631; Toshihiku Izutsu, *God and Man in the Koran: Semantics of the Koranic Weltanschauung* (Tokyo: Keio University Press Inc, 1964), pp. 65–7; Harun Nasution, *Akal dan Wahyu dalam Islam* (Jakarta: UI Press, 1986), pp. 9–10.

Muslims need to enhance the capacity to understand what Allah revealed to them through the spoken language, which is Arabic. However, none are singly able to assume this task fully, except for messengers and scientists. In Greek tradition, the one able to be a conduit between Gods in the heaven and humans on the earth was Hermes.[72] Hermes' role could be seen as analogous to the messenger's role in the Islamic tradition, and after the messengers have passed away, then *ulamâ* should take the role.[73]

Epistemologically, the study of science in Islam may combine three ways of thinking: *bayâni, burhâni*, and *'irfâni*. A Muslim scientist can embrace the Qur'an and Sunnah as primary sources of inspiration. Both are studied literally, as their contents reflect the phenomena of nature, which tended to express the situation of Arabs when the verses descended down by the angel; yet they are not limited only to a specific situation. When the Qur'an motivates Muslims to reflect on the creation of a camel, then it not only means that one kind of animal in the desert needed to be scrutinized, but also that such reflection is useful in geographical contexts anywhere Muslims live. Thus in terms of the Indonesian context, Muslim scientists self-reflect on how grasshoppers, frogs, bugs, and other tiny animals were created. We may understand the paradigm of *bayâni* in wider horizons, not limited to historical settings of the Qur'an and hadîth, and our understanding should include the Qur'anic texts about science. Many scientific studies in Muslim world were conducted a priori toward theories and opinions of predecessors. And laboratory practices similarly can follow the paradigm of *bayâni*.

The *burhâni* paradigm therefore is employed toward scientific improvement. Muslim scientists engage in reflection and experimental

[72] Komaruddin Hidayat, *Memahami Bahasa Agama: Sebuah Kajian Hermeneutik* (Jakarta: Paramadina, 1996), p. 13.

[73] In a hadîth, six matans existed, referring to the role of ulamâ as the successors of the messengers. See al-Imam Bukhārī, *Ṣaḥīḥ al-Bukhārī* (Beirut: Dâr al-Qalm, 1987), chap. Kitâb al-'Ilm; Muhammad ibn 'Isa Tirmidhi, *Sunan al-Tirmidhi* (Beirut: Dar al-Fikr, 1983), chap. al-'Ilm, hadîth no 2606; Abū Dā'ūd Sulaymān ibn al-Ash'ath al-Sijistānī, *Sunan Abū Dāwud* (Beirut: Dār Iḥyā' al-Sunnat al-Tabawīyat, 1960), chap. al-'Ilm, hadîth no 3157; Muḥammad ibn Yazīd Ibn Mājah, *Sunan Ibn Mājah* (Beirut: Dār Ibn Kathīr, 2016), chap. al-Muqaddimah, hadîth no 219; Aḥmad ibn Muḥammad Ibn Ḥanbal, *Musnad al-Imām Aḥmad ibn Ḥanbal* (Beirut: Mu'assasat al-Risālah, 2008), al-Anṣâr, hadîth no 2023; 'Abd Allāh ibn 'Abd al-Raḥmān Dārimī, *Sunan Darimi* (Cairo: Dâr al-Kutub al-'Araby, 1987), chap. Kitâb al-Muqaddimah, hadîth no 346.

research about natural phenomena and thereby carry forward dynamic themes relating to environmental growth. Consider as an example the terrain of Gunung Kidul Region in Yogyakarta Province, which in some parts is dry and has arid soil. This region could become a project of developing science by use of rigorous, integrated, and sustainable studies about the structure of soil types and the characteristics of native animal species, as well as for the potential of the native plants to provide herbs and medicines.

This paradigm would enable developing community-based science and technology, meaning that there is a mutual relationship between the empirical reality of socio-cultural environments and of science and technology. A person would find his or her first footsteps in science, starting from their curiosity, by means of systematic observation of natural phenomena and by their deepest thoughts about causality. This would induce a tentative assumption to be later embraced by many in society. For example, stars at night appear as if they had moved by circling the earth; the sun would also move from east to west, and in the following day, it would have loomed from the east to the west as well.[74] Myriad events repeatedly occur and then a tentative assumption appears-for example, that the center of the universe is the earth. The assumption may further develop by thinking about natural phenomena, such as mountains, winds, water, fire, air, and clouds. Indeed, scientists observed such phenomena and progressed from what was visible by naked-eye to what could be seen by using new equipment such as the telescope.

Technology at first was at first invented to fill human needs, and early creators made tools to facilitate their work and escalate production. This means that they had conducted activities and then produced tools to facilitate their jobs. When kinds of job and challenges between two eras were different, then the equipment was different. Accordingly, Indonesia, which is rich with natural resources, has much potential to produce locally based unique tools for scientific pursuits.

Meanwhile the paradigm of *'irfâni* is related to attitudes and esoteric aspects of the scientists perceiving natural phenomena. The development of science is not for science alone, but also for the mission

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[74] Anna Poedjiadi, *Sains Teknologi Masyarakat: Model Pembelajaran Kontekstual Bermuatan Nilai* (Bandung: Remaja Rosdakarya, 2005), p. 61.

of *khalîfah* on the earth, which is to converse with God through natural observation. And in this pursuit, scientific and technological projects should not harm the environment. For Muslim scientists, there are three sources of projects: first, the holy scripts of the Qur'an, hadîth, monographs, theories, postulates, and reasons of the scientists regardless of their religious and national background; second, environments and realities; and third, experience and intuition, particularly associated with scientists' appreciation of Islamic values. They therefore apply ethics in developing Islamic science because its significant role is to facilitate humans to achieve happiness and welfare. But if the studies of science and technology are limited only to immediate interests, this would be contracditio in terminis with the essential meaning of the science itself. If it were so, then it unfortunately could repeat the tragedy of King Midas.[75]

2. Power that Champions Science

There was a significant role played by the royal court during the Golden Era of Islam for patronage of scientists. Projects were completed because the caliph or sulṭans was involved. This facilitated an array of infrastructure, including sites, reference materials, and funding. This would occur because the patron felt that science and scientists were important, and it was understood that if no elite politician had any commitment to developing science and technology, there would be low probability of such development.

Accordingly, there was a significant correlation between the role of the elite politician and the progress of science and technology. The care, respect, and support toward science and technology came through policies that included regulation, establishment of institutions, and

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[75] Once upon a time, a king named Midas reigned powerfully in Phrygia, in the southwest of Asia Minor, where he lived. He was greedy and materialistic. To fulfill his avarice, Midas persuaded the Greek god Dionysus to bestow upon him the power to alter things by changing them into gold. And indeed, the god answered Midas' prayer and granted him a "golden touch". Any object that Midas could touch would change into gold, including even the water in the River Pactolus. At first Midas felt happy, but later he realized he could no longer eat, because even his food was changed into gold by his touch. So finally, he implored Dionysus to revoke the magic power. Ziauddin Sardar, "Introduction", in *The Midas Touch: Science, Values and Environment in Islam and the West*, ed. by Ziauddin Sardar (Petaling Jaya: Pelanduk Pub., 1988), p. 1.

provision of adequate budgets. Ideas in science and technology need fiscal support for their development. Policies for abundant development of scientific institutions cannot take effect unless there is a sufficient budget. There was a striking case of such effect in Islamic history when Caliph al-Ma'mun invested heavily in developing science by means of establishing institutions together with supporting funds.[76]

3. *Malaysian Case*

An illustration of a modern case arose in the 1970s when Malaysia provided a huge budget in the education sector for sending lecturers and students abroad to pursue their higher education degrees. As a result, Malaysia in the 1980s experienced an education 'boom' with many master's and doctoral graduates in various disciplines.[77] In the 1970s Indonesia had educated many Malaysian students. In a turnabout now, Indonesia is sending more students and lecturers to Malaysian universities. Although the policy of the Malaysian government in the educational sector was partly caused by ethnic tension in 1969, the great effort to allocate a huge amount of money for education had valuable impact within two decades. To illustrate, in 1963 the Malays who had been admitted to two universities in Malaysia and Singapore were only 11% of the total students, although their number was half of the entire population. In Universiti Malaya alone, the Malay students were 20% of the total number of students in 1963. In the following five years just before the ethnic conflict broke out, 2,373 of the 6,672 university students were Malay people, a greater number of whom studied at the Faculty of Literature (around 90%), and only 6,3% and 0,4% of the total enrolment were respectively spread at the Faculty of Science and the Faculty of Technology.[78]

This governmental policy shift began in 1971 when the parliament seriously assumed its role, and as the King and Ghazali Shafei, a politician and the founder of New Economic Policy, focused their attention on filling educational gaps between Malay and other ethnic groups. In an

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[76] Huff, *Rise of Early Modern Science*, p. 204.

[77] Hussin Mutalib, *Islam dan Etnisitas: Perspektif Politik Melayu*, trans. by A.E. Priyono and Christiadi, (Jakarta: LP3ES, 1995), pp. 87–8.

[78] *Ibid.*, pp. 88.

official speech before the parliament, the King stressed the importance of education as a means for national unity and security. Since that time, many Malay graduates have sought higher degrees abroad. In 1972, three years after the conflict, the government's spending for education was the highest ever in its history compared to other sectors, and the number of natives (*bumiputera*) sent to domestic and foreign universities was the highest as well.

To illustrate, from 1970 to 1972 at Universiti Pertanian and Universiti Kebangsaan Malaysia, there was an increase of 150% for Malay candidates. The entrance of Malay students into higher education institutions surged 65% from 1970 to 1975, while there was decreased number of non-Malay students, to 35%, down from 50%, over the same period. According to the Third Malaysia Plan, between 1970 and 1975, there was to be an increasing number of Malay people to pursue courses with degrees (58%), and at diploma levels (85%) from the total number 14,254 who entered five Malaysian universities, including 57,2% Malays, 36,6% Chinese, 5,2% Indians, and 1% others. Still, over the same period, the number of Malay students pursuing middle and high school majors in science rocketed 94%.[79]

The Malaysian government consistently encouraged Malay people to continue their higher education overseas. In 1975 there were 31,500 students who pursued their education in Western countries. This number was doubled compared to the total number of Malay students registered in all Malaysian universities, and their proportion was also higher than other non-Malay students. During the period of 1970-1975, the number of graduates from foreign universities reached 6,050. Also, the higher their educational level, the stronger was their perception of the importance of understanding and applying values of universalism and humanism, including justice, tolerance, compassion, and peace.[80]

4. *Pakistani Case*

Pakistan has been known as a Muslim country with advanced science and engineering higher than any other Muslim country except Iran. In 1985 the Pakistani Ministry of Science and Technology sent

[79] *Ibid.*, pp. 89-90

[80] *Ibid.*, p. 91.

about two hundred students to the United States and Britain to complete their graduate studies. Those chosen were considered the best students, and their tuition fees of $30,000-$35,000 yearly were paid fully by the government.[81] The program was eventually declared a failure because, of the 187 students sent to the United States between 1985 and 1986, only nine ever completed a PhD and only 30 received an MSc by 1991. Even so, the program illustrated the Pakistani government's seriousness for developing science and technology.

5. Indonesian Case

In light of such efforts by Malaysia and Pakistan, the role of the Indonesian government can be crucial for improving education. Patronage in supporting education could have an important positive effect for strengthening human resources. Reflection on the period of classical Islam illuminates the significant roles of Muslim elite politicians. Though not institutionalized, the policies for Malaysia's education in the modern era highlight a significant correlation between political will and the progress of science. The problem for Indonesia has been that, although our constitution via Act No 20, Year 2005, on the National Education System,[82] set the allocation for education to be at least of 20% from the total national budget, the implementation of this policy is still far from being a reality.

A small allocation for education causes discouragement when researchers in science and technology do not receive support. Without funding, there are insignificant findings and even a lack of motivation to conduct rigorous studies. Consequently, many qualified academic researchers hesitate to work in Indonesia, and instead accept more lucrative offers in foreign countries. Repercussions of this 'minimum' policy are found in the lack of scientists empowered to explore Indonesia's natural resources to augment the people's welfare. This in turn increases our nation's dependence on foreign scientists to tackle domestic projects.

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[81] Pervez Amirali Hoodbhoy, *Islam & Sains: Pertarungan Menegakkan Rasionalitas*, trans. by Luqmān and Thohiruddin Lubis (Bandung: Pustaka, 1997), p. 52.

[82] See Acts No. 20 Year 2005 on National Education System, Article No. 49.

D. Institutionalization of Science

Discussions earlier have focused on the stagnation of Muslim scientists in the modern era, and the lack of institutionalization of the four aspects of a scientific ethos: universalism, communalism, organized skepticism, and disinterestedness,[83] as well as the paradigm of *tawhîd* in understanding science in Islam from ontological, epistemological, and axiological perspectives which include institutionalization. These norms and paradigms could not be used to build an exclusively Islamic science, however.

There is a growing fear over institutionalization of the norms and paradigms which would make science more exclusive and Islamist. It would, however, not necessarily occur because institutionalization is more substantive, including such values as universalism in Islam which brings a mission of mercy for the universe. Therefore, as challenged by Kettani, the pluralist attitude needs to be included in the platform.[84] Accordingly, creativity, critical thinking, patronage, and networking need to be nurtured via integrated systems rather than through an individual figure so that the process of regeneration could happen.

In one lecture conducted in Albert Hall, Calcutta, India in 1882, Ernest Renan stressed the urgency of science in all aspects of human life:

> "...all wealth and riches are the result of science. There are no riches in the world without science, and there is no wealth in the world other than science. In sum, the whole world of humanity is an industrial world, meaning that the world is a world of science. If science were removed from the human sphere, no man would continue to remain in the world."[85]

Renan's lecture was aimed at encouraging mainly Indian Muslims to realize that Islam respects science and that science developed in the history of Muslims. He asserted that "Islam is one of the closest religions to science and knowledge, and there is no incompatibility between science and knowledge and the foundations of the Islamic faith."[86]

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[83] Merton, *Social Theory and Social Structure*, pp. 552–63.

[84] Kettani, "Science and Technology in Islam: The Underlying Value System", p. 85.

[85] Charles Kurzman (ed.), *Modernist Islam, 1840-1940: A Sourcebook* (Oxford: Oxford University Press, 2002), p. 104.

[86] *Ibid.*, p. 106.

Renan added that religious education as taught in many parts of the Muslim world today is *naqli* science, far from the ideal, and that there is are negative effects lingering from colonialism. Beliefs are held that science is forbidden (*harâm*), due to it coming only from the West and having been brought by infidels and conquerors. To reawaken a Renaissance of Islamic science, Renan stated the need to utilize philosophical spirits in overseeing varied natural phenomena and making an unfragmented view toward science. There is a growing tendency among scientists who do not study philosophy to set science apart, rather than have an inclusive view. According to Renan, as previously noted, the zenith of Islamic science was reached because the morals that Muslims philosophers embraced were rooted in Islamic teachings, especially self-encouragement for transcending nature, man, and history.[87] This reveals a human need for scientific information and explanation in order to maintain human survival.

Institutionalization of science in Islam could take place from paradigm to practice. For paradigms may have our attention. First, there is a need for redefining Islamic studies to include not only *al-'ulûm al-naqliyyah* but also *al-'ulûm al-'aqliyyah* as part of science. Included would be substantive spirituality-based understandings of the Qur'an and Sunnah. Second, from various points of view, including ontology, epistemology, or axiology, there can be synthesis of science and religion. Third, epistemologically, the study of science can integrate the three paradigms of *bayâni, burhâni*, and *'irfâni,* meaning that science comprises texts, nature, and experience. Scripts include the Qur'an, Sunnah, and science. Nature includes physical and non-physical environments, to which the application of science adapts. Added to this is scientific intuition for finding solutions. The paradigm of *'irfâni* is significant to raise the scientists' effectiveness as assertive persons.

Fourth is a requirement for a spiritual philosophy to evaluate science comprehensively. An understanding of other disciplines requires addressing issues through more than one scientific approach and involving the humanities and social sciences. For example, to alleviate environmental disasters, the physical scientists will listen to social scientists as well. In a spiritual philosophy, scientists do not promote claims without evidence;

87 See Iqbal, *The Reconstruction of Religious Thought in Islam*, p. 91.

also, they respect various points of view in the process.

The above paradigms are needed, as stated by Sayyed Hussein Nasr, so that science and technology in the Muslim world today do not become a signal of decadence. Such a perception might occur due to Muslims' resistance if they assess 'any kind of science as truly secular'.[88] This means that the decline of science and technology could be generally caused by a misunderstanding about the nature of science and its role, particularly when using Islamic perspectives.

For institutionalizing science there are essential practices, such as budgeting, providing facilities, and supporting research institutions, to be prioritized. The government's role as a policy maker includes support of science and technology development with adequate budgets for researchers. The government also can supply infrastructure to support scientific studies. Infrastructure includes libraries, labs, discussion forums, and refereed journals, as well as a combination of multiple disciplines. Looking back to the highest achievements of Muslim science in the past, this institutionalization could revive collections of primary documents from such prominent classical scientists as Hippocrates, Aristotle, Plato, Galen, Diocorides, Euclid, Ptolemy, Ibn Sina, Ibn al-Haytham, and al-Fazari. Besides providing primary references, institutions need to scrutinize those works especially through forums such as study groups, round table discussions, seminars, and experimental research. All such aspects of institutions for Indonesia's scientific research will enable use of rich natural resources to be conducted alongside the spirituality of Islamic teachings.

E. Concluding Remarks

Science and technology in the contemporary Muslim world lagged behind other civilizations after the Golden Era of Islamic science when *ulamâ* did not focus as much attention on science as did the caliphs, sultans, and wazirs during the eighth to thirteenth centuries. Muslim scientists during that prior era used the Qur'an, Sunnah, and hadîth as strong motivating factors to develop many disciplines benefitting the *ummah*. That era was fruitful for Muslim scientists due to strong support from the ruling powers. Such support enabled networking, integrity,

[88] See also. Hoodbhoy, *Islam & Sains,* p. 63.

funding, marketing, and coherence.

The many factors which supported Muslim scientists' endeavors, discoveries, and inventions included universalism, communalism, organized skepticism, and disinterestedness. The achievements arose from encouragement by the Qur'an which motivates Muslims to use reason and logic as part of their human ability given by God. The term in the Qur'an called 'khalîfah' contends that human responsibility to manage life includes caring for nature and developing livelihoods. Science thereby plays a critical role in creating welfare, which people need when restoring their lives after unfortunate circumstances of unemployment, sickness, misfortune, lack of education, or faith and gender discrimination. Science developed by Muslim scientists in that era was universal (one of the ethos' tenets), having benefits for Muslims and for non-Muslims.

Science in the contemporary world can be universally beneficial, regardless of religion, faith, social status, or culture. Science is neutral and universal and therefore can be beneficially pursued by every race, religion, and nation. No particular science is exclusively owned, nor is any one science to be used a way to discriminate. Governments can take a role to facilitate opportunity for education in science and technology, from which learners benefit by then making their own living and contributing to others. The Indonesian government in particular may use the perspective of how Muslim scientists in the Golden Era of Islam flourished by facilitating a quality educational infrastructure from which people's livelihoods could benefit. Middle and high schools, as well as universities, may open even more science and technology departments. Science courses can cover many disciplines, combining thereby the technical, the humanities, spirituality, religion, mathematics, and other beneficial subjects. These are the disciplines that Muslim scientists in the past learned during their life courses to make them into mature and true scientists.

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