

The Importance of Ecological and Spiritual Approaches in Chemical Engineering towards
Practical Conception of Sustainable Development.

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Abstract

The issues in sustainable development are of two kinds; the interdependent of three principle pillars of sustainable development-environment, social, and economy development and human spiritual development. The main objective of this paper is to discuss on the importance of spiritual enhancement and ecological approach in chemical engineering to develop a notion of conception for sustainability. We elaborate and discuss contemporary Islamic principle named “Jurisprudence of Priorities” (*Fiqh Al-Aulawiyat*) and what it suggests for sustainability and concurrently delineate the need for ecological approach in chemical engineering. The study was conducted based on available published articles from books, handbooks, journals, and other on-line reliable sources related to environment and sustainability. The study concentrates on both Islamic jurisprudence principle in conserving the nature and ecological approach in chemical engineering. The examples presented in this article provide new information on the importance of spiritual development and ecological considerate in chemical engineering towards successful sustainable development. This study is perhaps one of the first to address the incorporation of spiritual enhancement (Islamic principle) and ecological approach in chemical engineering to create environmental awareness among world community.

Keywords: Environment, Islamic jurisprudence, spirituality, sustainability.

1. Introduction

The issue on environmental pollution is becoming a recent concern since it involves the complexity in ecological aspects, and this awaking everybody to look upon this issue seriously. For the past few decades we have witnessed significant indiscriminate utilization of natural resources in the name of development and industrialization. Although there are a lot of programs being organized and conducted on the platforms of academic and political discussion, and also

international conferences but the ultimate consensus is yet to be achieved unanimously and to certain extent, it invokes numerous debates among developed and developing countries. The need for continued economic growth and societal development has led to activities that should inline with both objectives. Since preservation of earth's ecology grasps an intention of world community and come into dispute, the process to reach the need of both economic growth and societal development remains within a boundary of uncertainty.

Holmes Rolston (2006) argues that escalating population and development as well as the issues of peace and environment are four critical items that hindering human agenda and require global attention. These items are interdependent and the first three influence a lot to the performance of nature. It is not possible to decouple population growth and development from its consequences to nature since both agendas utilize environment equities. Some people even don't realize that peace is one of the equity that leads indirectly to environmental sustainability on a difference platform. It is also apparent that development will create obvious consequences to deteriorating the environment, if not being incorporated in sustainability agenda. In the early twenty-first century, the earth supports a human population that is more numerous and at the same time, there is an unprecedented events that associated with the huge fatalities and tremendous destruction caused by what so-called the "natural" disasters. In addition to natural disasters, emphasis is also need to be placed on "man-made" industrial and technological disasters that create an anxiety among world community (Keith Smith and David N.Petley, 1991). Industrial and technological disasters seem to create unprecedented modern catastrophe than that of natural disasters. Recent catastrophe likely to be more significant and technology-induced was regarded to be a catalyst for their occurrences.

K.-H Robert *et al* (2002) introduces the five interdependent-level hierarchical system to resolve the confliction of various tools for management and monitoring of sustainable development and suggests four systems condition that need to be emphasized in order to ascertain the success of sustainable development. Those systems are; the elimination of concentration of substances from the Earth's crust and societal production, eliminate the physical degradation and fourthly, contribute as much as we can to meeting human needs, for example using all of our resources efficiently, fairly and responsibly. The mushrooming development and industrialization which come from technological input has been applied worldwide at a very speed. In the meantime, coupling the technological innovation with business expansion may accelerate the unpredictable environmental consequences if not being dealt ethically and in-depth integrity with accordance to values and faith. World communities have to make value judgments to focus on sustaining economy and societal development in balance with environmental needs. However, there are yet numerous conflicts to be answered and it remains in debate among business players and nature lovers. Issues such as how much original nature we wish to restore and how much technologically modified or physical degraded nature we want. Eventually the conflict will remain on two underlying issues; on giving a priority to sustainable development or to emphasize on a sustainable biosphere. It is obvious that business players and technology developers are more concern about creating wealth rather than preserving the nature and to be fair, they are actually sitting on the right platform because they contribute to meeting human needs; human affluence and well-being. On the other side of the coin, environmental needs are also should be put into account because of their role in balancing the cycle to prevent unprecedented events due to overwhelming utilization and degradation. Y. Jin *et.al* (2004) argues that human activities relative to the earth's ecology have two important stands on sustainability whereas the

mainstream is a stand for continued economic growth and the second stand is environmental sustainability. They also highlighted that engineering issues that involve the ecology are complex because they depend on the notions of value and justice of a person. However, both important stands require values that have an ability to direct sustainability process to the apex of human civilization. Any system may have a difficulties and barriers to reach the objective unless there is a mechanism that will enable the players play their role to achieve the targets. Indeed, these so-called environmental conflicts (or dilemmas) are remaining unsolved because of its complexity and none of the solutions being reached to satisfy all parties.

Regardless of whether giving a priority to societal improvement, economic growth or nature conservation, balancing spiritual development with these three principle pillars of sustainable development is of paramount important. The ecosystem must be managed with accordance to godly guidelines towards human sustainability. Sustainable economy and sustainable environment are tools to reach the apex of human civilization and eventually, man is the one who will benefit from this glorious achievement. The failure of achieving them indicates a weakness of humankind managing the globe and we should be accountable for. The needs for godly guidelines therefore lead humankind to sustain their life with the nature harmoniously. Strengthening spiritual values is not only essential in term of sustainability but it is also encouraging mankind to appreciate other God's creatures and treat them accordingly and respectfully.

R.Clift (1998) refers to Brundland statement and come to conclusion that the role of the new model engineer is closely associated with the concept of sustainability which he prefer this term to sustainable development. Incorporating spiritual development into good engineering practice could stimulate new paradigm shift for practically sustainable development. Hence, the presence of this value will reflect to the importance of developing a strong connection between human and the Creator, through enhancement of this value and understanding our ultimate responsibility and accountability (trusteeship).

1.1 "2Es + 1S" for sustainability

The hotly debated topic, sustainable development has been discussed for so many years. The word "sustainable development" has become popular recently; even some have questioned the motive behind this popularity (Bawden R., 1997), and the main catalyst for its popularity was the Rio de Janeiro Earth Summit held in 1992. The Rio Summit agreed a set of action points for sustainable development, collectively refer to a blueprint named Agenda21 (Simon Bell and Stephen Morse, 1999). The most cited principle of sustainable development is about sustaining the economy, society and nature or environment for the sake of inter and intra-generational equities. Sustainable development becomes our national agenda and the commitment showed by our government is obvious and practical. It is an important aspect for all countries to make development sustainable and it based on the assumption that societies need to manage these three types of capitals. The capitals may be non-substitutable and whose consumption might be irreversible, and of course, consideration to sustain inter-generational and intra-generational equities must be taken into account. In fact natural capital, social capital and economic capital are often complementarities. Even there is an attempt to replace some natural resources but it is much unlikely that they will ever be able to replace services that provided by ecosystem. Because of multi-functionality of many natural resources, substitute other service with others is likely not

possible. Consumption of natural and social capital may have no observable impact but the consequences may appear after certain period of time or until a certain threshold is reached.

Business and economy therefore hinges upon good practices to stay sustain. Hence, it is often said that good and effective business practice is sustainable development in business (Ghazali Mohd Yusoff, 2008). However, in order to ensure the success of this agenda, we have to face a few challenges that mainly in the areas of awareness (public and business domains), strengthen the government and private agencies and establishment of monitoring or data collection system to gauge the success of this vision. There are more else factors that hinder this objective but most of them are physically oriented and require technical solution. However, the essence of the success of sustainable development is still subject to development of strong spirituality and comprehension on our role over all creatures.

2. Methodology

The study was conducted based on available articles collected from journals, books, handbooks and other reliable resources related to environment and sustainability and . The emphasis was placed in the Islamic perspective of sustainability with accordance to the “Jurisprudence of Priorities” (Arabic: *Fiqh Al-Aulawiyyat*). The logical views outlined by this jurisprudence towards spiritual enhancement with accordance to Islamic principle for sustainable development is of paramount important to ascertain the success of this objective. In addition to this, the ecological approach in chemical engineering is also discussed.

3. Results and discussion

3.1 Spirituality and sustainability

According to Keith Smith and David N.Petley (1991), environmental hazards exist between the natural events system and human use system. Hazards and human response to them can influence global change and here the concept of sustainable development has come into attention. Environmental hazards also linked to ongoing global environmental change that includes many factors and those factors will interact to each other to determine the prospects, failures and success for sustainable development. In fact, human actions contribute to hazardous processes and disaster outcomes are obvious and due to the greater complexity of human society and discovery of mega-advanced technologies, many say that future disasters are likely to be larger in scale than in the past if no comprehensive measures being implemented and no explicit directions being made.

The unprecedented disasters are unpredictable and serious attention need to be paid to deter tremendous loss of properties and fatalities. Since nature and society are interconnected, any changes in one have the potential to affect other. Such relationships are increasingly important for those human actions that over-exploit and degrade natural resources through “man-made” activities and consequently amplify the risk from natural hazards. Our understanding of hazards and disasters has to be changed since the chances of facing the catastrophes are always unpredictable. The great catastrophes have to be seen as “Acts of God” due to “Man wrongdoings”. This perspective viewed damaging events as a divine punishment for consequence of human use of the earth rather than mere “natural disasters” (Figure 1). We therefore, need to

relies on how human faith and depth spirituality lead to its outcomes.

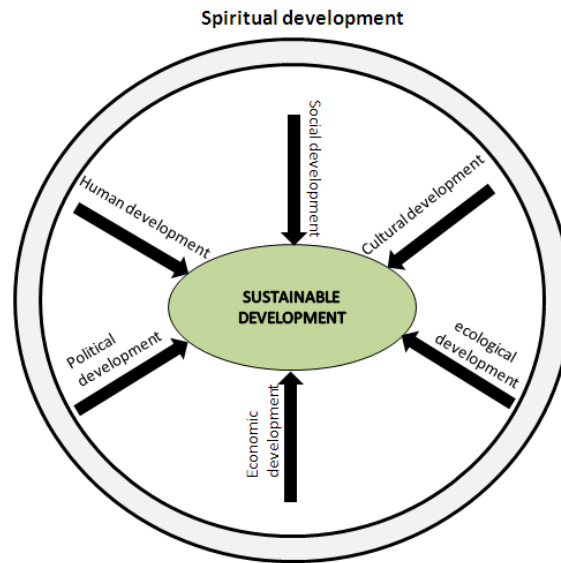


Figure 2: New pattern of “sustainable development” by incorporating “spiritual development” as an essence.

The most cited controversial article written by Lynn White (1967) has opened the world eye to see religion as something that being misunderstood. Lynn White concluded that the Christians emphasis on a transcendent deity who is exterior to and above nature was a major root of techno-industrial culture’s disregard for the nature. He argues that the religious teaching was regarded to provide permission to utilize and exploit natural resources for the benefits of mankind. His controversial viewpoint awoke intellectual and community leaders of all the world’s religions to articulate ethical and cosmological rationales for better environmental care (Susan Power Bratton, 1990)

In fact, the world’s religions have historically appreciates the nature as a part of religious rituals. Susan Power Bratton (1990) also reported that world’s religions have served as important cultural reservoirs of ecological understanding and in addition, it valuing nature preservation. The Koran, the Hebrew Scriptures (Torah), the Bibles, the Bhagavad Gita and Buddhist doctrine of *prattysamutpada* discuss about ecology issues and the way we exploit and utilize them in a very ethical.

According to Harold Coward (2003), Hindu texts speak about ecology is closely related to righteousness or *dharma* and even the key Hindu text, *Bhagavad Gita* has said that a vision of universe as the body of God which every single Hindus has to respect and treat them harmoniously. According to him, in Hindu, destruction of forest is condemned and planting of trees encouraged. He also roused out an example of a temple in *Tirumala Tirupati* in South India that establishing large nursery forest. Other than forest, the Hindus also believe water as a powerful media of purification and as a source of energy. O.P Dwivedi (1990) said that according to Manu (*Manusmrti IV : 56*):

“One should not cause urine, stool, cough in the water. Anything which is mixed with these impious objects, blood and poison should not be thrown into water”.

The respectfulness to the nature is not only taught in Hindu, the Buddhist doctrine of *pratityasamutpada* sees the world as a single whole. They share a holistic paradigm of nature with the environmental science (Ronald Y.Nakasone, 2003). Noise is recognised as a serious environmental pollutant and in Buddhist the element of silence is a part of their ritual condition. The Buddha and his followers revelled in the silent solitary natural habitats unencumbered by human activity and even the choice of monasteries also seriously concern about the quality of silenceness (Lily De Silva, 1987) such as the Shoalin Temple and others. The Hindus and Buddhist are among the many examples that prove the relationship between religions and nature.

3.2 Islamic Jurisprudence and Environmental Conservation

Islamic principles are suggestive of a variety of implications for governance and reflecting upon Islamic principles, we here engage with the notion of Islamic jurisprudence for the environment. In general, Islamic laws that govern human activities are divided into *ibadah* (religious rituals) and *muamalah* (relationship between man-to-man and man-to-surrounding). The practice of both *ibadah* and *muamalah* should be guided and governed in accordance to Islamic laws. Hence, environmental management and the process of establishing sustainable development (considered as *muamalah*) also should be in line with Islamic laws principle.

One of the unique characteristics of Islamic teaching is its concept of flexibility and mandatory. The sacred text of Koran, as the highest source of jurisprudence has underlined laws in general. It also outlined the main principles of Islamic teachings. The laws and principles that had been underlined in the Quran are mandatory and should not be argued. Literally, these laws are related to *ibadah* and as for *muamalah*, Koran merely outlined the basic principles and we are allowed to practice it as long as they are not against the basic principles.

Furthermore, from the view of Islamic jurisprudence philosophy, the laws of Allah have their objectives as included in Shariah Objectives (*“Maqasid al Shariah”*). The Shariah was revealed to realize human interest and wellbeing and its objectives are to safeguard faith/religion (*din*), life (*nafs*), reason (*aql*), posterity (*nasl*), and property (*mal*). The main objective of Shariah is to preserve public good (*maslahah*) and prevent harm (*dar’ al mafasid*). *Maslahah* can be classified into three categories: *daruriyat* (the essentials), *hajiyyat* (the complementary), and *tahsiniyat* (the embellishments) (Asyraf Wajdi Dusuki and Nurdianawati Irwani Abdullah, undated).

“Jurisprudence of Priorities” or *Fiqh Al-Aulawiyat* reflects the Shariah and offers problem-solving mechanisms to the contemporary issues. In the context of environment conservation, *fiqh Al-Aulawiyat* suggests what so-called the art of weighing between the alternatives to opt the lesser harms and minimize the negatives impacts as well as maximize the good impacts in the long run. It is mainly concerned with finding solutions to people’s problems and making their life easy. In other word, it is an art of Shariah jurisprudence to safeguard the greater benefits by the exclusion of the lesser and to remove the greater harm by acceptance of the lesser. *Fiqh Al-Aulawiyat* offers within the following set of laws:

- (i) Prioritize the necessities (*daruriyat*) above the complementary (*hajiyat*) and the embellishment (*tahsiniyat*): The things under category of *Daruriyat* in Shariah are religion(*din*), life(*nafs*), posterity(*nasl*), reason(*aql*), and property(*mal*).
- (ii) Prioritize the benefits which offer obvious result upon implementing.
- (iii) Balancing among benefits, prioritize the one that offers the better.
- (iv) Balancing among harms, prioritize the one that offers the lesser.
- (v) Balancing between benefits and harms when clashing, prioritize which one can be tolerated in achieving the long run benefits. (e.g choosing harm in return of achieving some benefits is tolerable)

In the case of sustainable development, we are under dilemma to balance the economy, social and environment needs and eventually, the process of materializing the result will become complicated. To choose the alternatives, the benefits and harms should be examined and assessed carefully in terms of their size, effects, durations, importance and urgency. As well as they also should be scrutinized in term of their degree of actuality and certainty. In an attempt to ascertain the implementation of sustainable development vis-à-vis the Shariah, one may refer to some of the principles of *fiqh Al-Aulawiyyat* which offers the art of weighing between the alternatives. Yusuf Al-Qardawi (2000) stressed that safeguarding, protecting and caring for the environment are deeply rooted in all fields of Islamic teaching and culture and when we are facing a conflict to make a decision, the *fiqh Al-Aulawiyyat* offers the solution: balancing the priority among alternatives without compromise the basic teaching of Islam.

There are many verses in sacred text and Hadith (prophet's say) show how Islam respect and treat the nature. Below are some of the Quranic texts of many which emphasize on caring and appreciating the nature :

“That Home of the Hereafter We shall give to those who intend not high-handedness or mischief on earth and the end is (best) for the righteous” (Surah 28, verse 83)

“Do you not observe that God sends down the rain from the sky, so that in the morning the earth becomes green” (Surah 22, verse 63)

“There is not an animal in the earth, nor a creature flying on two wings, but there are nations like you” (Surah 6, verse 38)

“Eat and drink but waste not by excess: Verily He loves not the excessive” (Surah 7, verse 31).

“Such as remember Allah, standing, sitting, and reclining, and consider the creation of the heavens and earths, (and say): Our Lord!, Thou createdst not this in vain. Glory be Thee!” (Surah 3, verse 191)

“They hasten about the Earth, to do mischief there, and God loves not the workers of mischief” (Surah 5, verse 64)

The practical example of environment-conscious in Islam is the concept of “*hima*” as cited by Mawil Y. Izzi Deen (1990). In Islam, *hima* comes out with a regulation on the

management on unowned lands whereby it must be conserved for common use. Historically, the “*harim*” is another ancient institution that manages the ecosystem. *Harim* is usually found in association with wells, natural springs, underground water channels, river and tree planted on barren land and the *harim* zones based on the practice of Prophet Muhammad p.b.h and the precedent of his companions. In addition, the element of respectfulness to other creatures is a part of Islamic teaching (Figure 3). Thus, this is our responsibility to treat them ethically. Man is not created as a master to conquer the world but as a “*khalifah*” (vicegerent) to manage it with accordance to godly guidelines (sacred text, Koran and Al-Hadis).

“*It is He has appointed you as regents in the earth*” (Surah 35, verse 39)

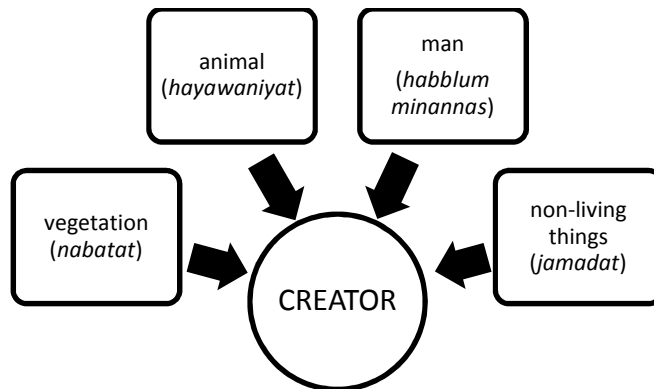


Figure 3 Human relationships with other creatures

3.3 Chemical engineering and sustainability

The chemical based industries have been long known to be the major contributor for many types of pollutions and ecological disturbances, in which it simulate the best example of how human consume natural resources and produces toxic waste as the by product. The chemical engineering practices have undergoes series of evolution to address these issues, starting from pollution control to pollution prevention, green engineering and the latest development was towards sustainability.

Having gone through rapid development during industrial revolution and the emerging environmental awareness, the international scientific community was started to embraced the idea of sustainable development after the publication of a report entitled ‘Our Common Future’ by the Brundtland Commission in 1987 (J. Garcia-Serna et al., 2007). As far as the chemical industry is concern, the major issues concerning sustainability are the environmental related problems. For example, the carbon emission which leads to the Green House Effect was significantly contributed by the burning of fossil fuels, which is the prime product and core business of the chemical industries. In general, total share of world carbon emission is estimated to increase from 21,518 Million Metric Tons in 1990 to 40,178 Million Metric Tons in year 2030 (Figure 4). This data surely reflect the needs for pre emptive action to be taken in order to minimize the projected impact. If we analyze the data further, we could see that the industrial sector and energy generation are the major contributors for carbon emission.

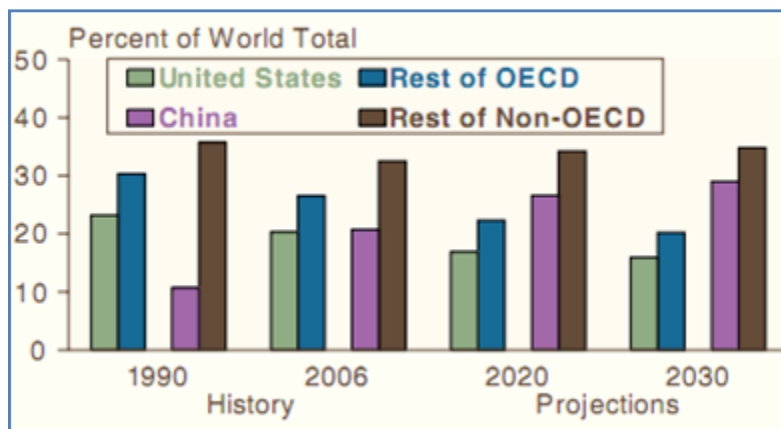


Figure 4: Regional Shares of World Carbon Dioxide Emissions, 1990, 2006, 2020, and 2030 (Source: Article on Emissions of green house gases in the United States 2008, p8)

With more arising environmental global issues other than carbon emission, such as acid rain phenomena, water pollution and industrial disasters, many chemical corporations responded by becoming more environmental friendly and committed to minimize waste emission. On the other hand, it created vast opportunities for the current chemical engineers to take the leading role in promoting and implementing sustainable development.

3.3.1 Current Scenario

In engineering practice, there are four aspects concerning sustainability: the environment, technology, economy, and societal organization (H. Tony Bi, 2005). The traditional approach for most of chemical engineering schools was to produce chemical engineers equipped with sufficient knowledge on technology development and economic analysis, less priority were given on the societal organization and the environmental considerations towards holistic approach of sustainability development. However, due to the increasing awareness of the needs, the modern approach of chemical engineering teachings has incorporated the element of environmental and social obligations into the curriculum structure. R.J Batterham (2006) has suggested a sustainability scorecard to be developed based on the respective areas, shown in Table 1 below. This will enable chemical engineers to identify critical factors in their design considerations towards sustainable development.

Table 1: Critical Elements in Sustainability Scorecard (R.J Batterham, 2006)

Economic	Environmental	Societal
Direct	Material consumption	Quality of life-cycle
Raw material costs	Products & packaging mass	Breadth of products or service availability
Labor costs	Useful product lifetime	
Capital costs	Hazardous materials used	Knowledge enhancement
Operating costs	Eco-efficiency	Employee satisfaction
Potential hidden	Energy consumption	Peace of mind
Recycling revenue	Life-cycle energy	Perceived risks
Product disposition costs	Power in use operation	Community trust

Contingency	Local impacts	Illness & disease reduction
Employee injury costs	Product recyclability	Illness avoided
Customer warranty cost	Run-off to surface water	Mortality reduced
Relationship	Regional impacts	Safety improvement
Customer retention	Smog creation	Lost-time injuries
Business interruption due to stakeholder intervention	Acid rain precursors	Reportable releases
	Biodiversity reduction	Number of accidents
Externalities	Global impacts	Health & wellness
Ecosystem productivity loss	Global warming emissions	Nutritional value provided
Resource depletion	Ozone depletion	Subsistence costs

For current practice particularly in Malaysia, the Malaysian Government through the Engineering Accreditation Council, Board of Engineers Malaysia has responded to this issue by introducing integration between the technical and technological knowledge with the elements of environmental and social obligations as part of the element that need to be address in the curriculum structure of all Malaysian chemical engineering schools. As an example, the Faculty of Chemical & Natural Resources Engineering, University Malaysia Pahang has outlined 10 Program Outcomes (PO) to be achieved by its graduates. As can be seen from Table 2 below, at least 4 out the 10 POs are addressing the elements related to sustainability, in which PO6 deals specifically with understanding the principles of design for sustainable development.

Table 2: Programs Objectives for Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang, Malaysia

No	Programs Objectives
1	Ability to acquire and apply knowledge of science and engineering fundamentals in chemical engineering and related areas.
2	Ability to communicate effectively, in verbal and written forms, with both technical and non-technical groups.
3	Acquire in-depth technical competence in chemical engineering and related discipline
4	Ability to identify, formulate and solve chemical engineering and related problems
5	Ability to utilize systems approach to design and evaluate operational performance
6	Understanding of the principles of design for sustainable development
7	Understanding of professional, ethical and safety issues in engineering practices, the responsibilities and commitment to them
8	Ability to function effectively as an individual and in a group with the capacity to be a leader or manager
9	Understanding and responsive to the social, cultural, global and environmental responsibilities of a professional engineer
10	Ability to recognize the need for and engage in lifelong learning

Such proactive actions taken by chemical engineering academia to inculcate sustainability was a major contribution towards sustainability development. The importance should be recognized by the society and university's stakeholders by providing support and assistance needed.

3.3.2 New Trends for Sustainability in Chemical Engineering

As discussed earlier, the approach of chemical engineers to address the environmental related issues of the chemical industries has gone an evolution stages. Being the contemporary approach, sustainability development requires chemical engineering students to have a strong fundamental of the underlying philosophy of it. Therefore the knowledge of pollution control,

pollution prevention and green engineering becomes a crucial competence that need to be mastered by the current chemical engineers. J. Garcia-Serna *et al.* (2007) have even concluded that the education in Green Engineering is the key weapon to tackle the current needs.

The trend of implementing sustainability in chemical engineering can be observed in two ways, the preventive and reactive approach. The first approach is mainly related to the task for academicians through proper refine of education in the chemical engineering schools. It is through education that we are able to ‘organically’ produce graduates of chemical engineers with sustainability at heart. The curriculum need to be designed to incorporate the element of sustainability especially in the core chemical engineering subjects such as material and energy balances, unit operations, chemical reactions, heat transfer, thermodynamics, process controls, process plant design and perhaps even in the elective subjects. The approach should be holistic and involvement of private chemical corporations in the process is highly recommended. In this way, it will enables student to really comprehend the real problems face by the industries. Through proper education, the sustainability awareness among future chemical engineers will last longer and they will able to materialize the philosophy when they become the people who will do design and make decision later.

Through the reactive approach, it involves introductions of structured legal framework and regulation related to sustainability. It is the part played mainly by the authoritative body such as the government and the Institution of Chemical Engineers. The developed system must not necessarily that become guidelines for the practical chemical engineers, but it may also comes with the reward and punishment system. The recent example was the concept of Carbon Credit which was brilliantly design to allow the trading of carbon emission. Introducing the economic factor will surely attract the private corporation to positively respond to the call and becomes the motivation factors to reduce carbon emission.

4. Conclusions and discussions

All of all, the integration of working framework for sustainability in chemical engineering are based on two standpoints;- understanding a basis of Shariah as guided in *Fiqh Al-Aulawiyyat* and incorporating ecological principle. Application of *fiqh Al-Aulawiyyat* in decision-making will guide to sustainable outcomes and incorporation of “green” ideas is in-line with the Islamic principle as guided in Shariah. All chemical engineers, particularly Muslim engineers should be equipped with depth-understanding on *fiqh Al-Aulawiyyat* concept and practice “green” approach while handling any issues related to their discipline. The goals of sustainable development can be resulted in success if both spiritual strength and “green” approach come in parallel. Lacking in these values will be a barricade to the success of practical sustainable development.

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