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Abstract—Construction industry is considered as one of the main contributors of natural resources depletion, responsible for high level pollution and it is one of the attributes that pose climate change and other environmental issues. A lot of efforts had and have been done to reduce and control these impacts. Project Environmental Management (PEM) includes the processes required to ensure that the impacts of the project execution to the surrounding environment will remain within the limits stated in legal permits. The main aim of these researches conducted managing Environmental Impacts (EI) is to prevent each project from pollution. These researches are presenting four major environmental elements: Environmental Management System (EMS), Environmental Design (ED), Environmental Planning (EP) and Environmental Impacts Assessments (EIA). Although everything has been said about environmental management for construction projects, but almost everything remains to be said and therefore to be explored or reevaluated because continuously, almost everything remains to be done. This paper aimed at reviewing some of what has been said about PEM. Also one of its objectives is to explore and redetermine the whole views of managing the EI problems by proposing a framework that based on the relation between these environmental researches.

Keywords—Environmental planning, sustainable design, EMS and EIA.

1. INTRODUCTION

Construction as any other industry is an organized economic activity concerned with manufacture, extraction and processing of raw materials, or construction[1]. This definition addresses two terminologies: activities (processes) and output (products). Performance of any industry is evaluated based on specific set of criteria: cost, time, quality and environmental performance. These criteria evaluate the products based on their attributes and processes based on the objectives they can achieve.

Environmental performance as a criterion follow the same way to evaluate and control the environmental performance of construction industry. This explains one of differences between the previous four environmental research categories: sustainability is focusing on design attributes while EMS and environmental planning maintains construction processes attributes.

Construction projects will be ready for execution when client signs contracts with many parties; like design contractors, governments and so on. Design team and construction system can be considered as a set of high importance from technical point of view. This paper reviews some literature about how contract conditions construction systems and design teams are managed to achieve the environmental requirements of the client. Also it proposes a framework to coordinate these management efforts done by design and CS.

II. ENVIRONMENTAL IMPACTS ASSESSMENT

Building life-cycle (BLC) is a very important for studying environmental impacts. BLC in general include five stages represented in Fig. (1)[3].

Fig. 1 BLC Flow chart

There is a conflict in the information about the significance of environmental impact at each stage [2]. Thus most studies are trying to cover all of them in one model; for example green building concept defined as "an environment sustainable building, which was designed, constructed a operated to minimize environmental impacts" [4]. Recent studies indicated that construction was ranked in seventh industry in USA based on generating Green House Emission (GHG). Hence the environmental impact of construction processes must be of great consideration [4].

Fig. 2 classified some of the methods used for assessing environmental impacts EIA of construction processes.
Managing Construction Project

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Impact assessment

It is very important for studying its

impact of a project include five stages as

Fig. 2 EIA Methods

III. INCLUSION OF ENVIRONMENTAL MANAGEMENT ELEMENTS IN CONTRACT DOCUMENTS

Importance of contract documents comes from the fact that,

they are the exclusive governors which directing the

relationship between construction parties. They include

contract form, general conditions, supplementary conditions,
technical specification, drawings, addenda and change orders.

One of the studies addresses that specifications preparation is
the shortest way to ensure inclusion of environmental elements
in contract documents. It justifies that by saying
"specifications define the materials and products to be used,
the standard of work required, any performance requirements
and conditions under which the work is to be executed" [5].

IV. ENVIRONMENTAL IMPACTS AND DESIGN

The importance role of design comes from the fact that
environmental problems are global so they required global
solutions, and design is one of them [6].

Green and sustainable design concepts are hot debatable
issues over the world. Sustainable design taken signify the
responsibility of the industry for the efficient use of natural
resources, minimization of any negative impacts on
environment as well as satisfaction of human needs and
improvement of life quality [7].

Nurshah [8] believed that the future of sustainability in
Malaysia is promising because of many reasons including:
- The trend is going towards sustainability,
- There is a gradual improvement among all industry
  parties about this concept,
- The rise of material costs would force these parties to
  seek more sustainable construction applications,
- Various universities improve students awareness for
  sustainability issue, and
- Awareness among citizens is increasing.

The Council International du Batiment (CIB) postulated
seven principles for sustainability: reducing resource
consumption, reusing resources, using recyclable resources,
protection nature, eliminating toxic, applying life cycle
costing and emphasizing quality [7].

How to apply sustainability depends on it it is drivers some
studies focused on these drivers; energy conservation, waste
reduction, indoor environmental quality - Environmentally
friendly energy technologies - Resources conservation -
Incentive programs - Performance based standards - Land use
regulations and urban planning policies - Education and
training - Re-engineering the design process - Sustainable
construction materials - New cost metric based on economical
and ecological value systems - New kinds of partnerships and
project stakeholder - Product innovation and/or certification
and recognition of commercial building as productivity assets

Study from South Africa discuss the relation between
sustainability and construction procurement system (CPS), it
concludes that attaining sustainability construction is not
possible due to inappropriate CPS there [11]. Sebake [12]
achieved the same result when he discuss the limitations of
applying sustainability into work plan stages in South Africa,
Fig. 4 presents Sebake approach.
Strategy of sustainable construction in UK based on ten drivers: the reuse of built assets, design for minimum waste, the aim of lean construction, minimizing energy in construction, maximizing energy in use, do not pollute, preserving and enhance biodiversity, conservation of water, the respect of people and their local environment and target setting [13].

Some studies frame value management as a mode towards enhancing sustainability integration in early stages. Nurmuk [14] specified 7Cs which are necessary for this mode: characterization, commitment, caution, conservation, coherence, continuity and control.

Nazrin [6] mentioned many factors which impede active implementation of sustainability in Malaysia such as lack of knowledge, poor enforcement of legislation, education, experience and passive culture.

V. ENVIRONMENTAL MANAGEMENT SYSTEM (EMS)

The main role of construction systems is to make decisions which are required to execute the project according to design criteria.

System is composed of many sub-systems like Information Management System (IMS), Environmental Management System (EMS), Cost Management Systems (CMS) and Quality Management System (QMS).

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For the purpose of this paper only EMS will be considered.

According to [15] there are six general characteristics required for any EMS:

I. Goals, methods and timeline for meeting environmental requirements
II. Documentation procedure relating to these goals
III. Defined structure and responsibilities
IV. Corrective and preventative actions
V. An employee training plan
VI. Periodic auditing plans

An EMS was developed using Delphi method in adaptive environmental management [13]. This EMS applied in Greece; results indicated that the competitive advantage in the future of sustainable construction is realized by the majority of the participants and the most important factor for it is assigned to efficiency/reasons of energy issues and then conservation methods and techniques.

Study in Singapore [16] discussed the relation between ISO9000 QMS and ISO14001 EMS. It was found that there were similarity in some structural features, components, policies and objectives, training, monitoring and review, documentation, performance and specification. Some differences were recognized in five features; impacts, motivation, target audience, focus, continual improvement and supplier involvement. This study found that some of the advantages of QMS can be offset by integrating it with an EMS, implementation of integrated management systems (EMS-QMS-EMS) assisting in improving both of QMS and EMS.

Zhen [17] proposed a qualitative approach to assess and control IE problems. To develop a method to calculate the Construction Pollution Index (CPI), the methods of preventing pollution and hazards are divided into four categories: technology, managerial, planning and building material.
Applying this method in China showed that it is vital for major construction companies to obtain ISO14001 EMS certification because this will enable them to establish comprehensive environmental management policies within the context of construction management. Benefits of implementation of ISO14001 by firms in newly industrialised Malaysia are examined by Tan [18]; some of reasons for seeking after certification and some of actual benefits gained are shown in Fig. 6.

Two other important studies based on Hong Kong construction companies, the first one [19] discussed the benefits and problems appear when applying ISO14001, and the other [20] focused on barriers. The results are shown in Fig. 7.

VI. ENVIRONMENTAL PLANNING (EP)

The results of searching for papers which addressed environmental planning in just very few ones. But there are a lot of manuals and guidelines suggesting best practices. The importance strategic recommendations for improving environmental practices in construction industry are proposed by CIDU [21]. It looks like a guideline which considers five EP issues in Malaysia; strengthening the development approval process, enhancing law and enforcement, promoting self-regulation, increasing capacity and public awareness and addressing knowledge gaps.

VII. CONCLUSIONS

First thing recognised from this review is that all those studies are based on either case studies or questionnaire survey; fragmented and partial efforts done in different construction industries. The differences between these industries may make the results valid only where they have been conducted. Another recognised notice is that these researches fragmented also on their aims; each of them has specific function on the overall PEM. Depending on only EMS may not solve the problem because there are many other factors required like design criteria and/or contract clauses. So there is a need to develop a theoretical PEM developing a framework which is driven from the previous literature like this one suggested below; Fig. 8.

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Fig. 6: Benefits and Problems from ISO14001

Fig. 7: ISO14001 Benefits, Barriers and Problems

Fig. 8: Theoretical framework for managing environmental impacts of construction project based on literature review

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This framework is illustrated by the following steps:
1. Design which meets client requirements is selected.
2. The feasibility of design is defined by determining initial characteristics of the project in terms of money, time, and equivalent Kg of CO2.
3. Filling process is proceeded based on the capabilities of the construction system (designer + contractors) which can execute the design in such way that achieve its initial requirements.
4. These requirements must be included in the contractual agreement, mainly in specifications.
5. Project plans, plans of cost, time, quality, environmental plan and so on, will be established according to the previous contractual agreement.
6. The presence of the environmental impact, if any, is inevitable. Assessment of these risks can be done by one of the EPA methods shown in this study. Results of this assessment process are compared with the initial values in step 2.
7. According to these computations there is at least one of the following decisions has to be taken:
   - Results are matching the initial values then it might be accepted.
   - There are minor differences which may be maintained by doing some re-planning efforts.
   - The differences are so big and there will be a need to review the contract agreement. This revision will lead either to re-design, re-engineering or both of them.
8. These procedures will be continued until optimum design, system and plan are achieved.

REFERENCES