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Developing a Conceptual Framework for Value Oriented Environmental Management System (V-EMS) in Offshore Construction Projects

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Abstract: Offshore platforms are huge steel or concrete structures used worldwide for a variety of functions including oil exploration and production, navigation, ship loading and unloading and to support bridges and causeways. Construction of these platforms represents a significant challenge to designers, planners and environmentalists. The environmental challenge is how to construct these platforms as huge as possible to satisfy all required functions but with less possible environmental impacts. Environmentalists encourage using Environmental Management System (EMS) to ensure including of environment issues in the operation of companies/businesses which perform construction processes. Operations are maintained by Business Processes Management (BPM) and Business Processes Re-engineering (BPR). Efficiency of EMS depends on these two concepts; BPM and BPR. In construction, site wise Environmental impacts Value Management (EiVM) will lead to achieve planned environmental objectives. Environmental impacts of different types of structures can be assessed by using Life Cycle Assessment (LCA) method. The efficiency of the overall environmental management depends on the degree of compatibility between EMSs of project parties and the procedure by which the project activities will be environmentally managed. This study aims at analyzing the elements required to reinforce this compatibility. It suggests a theoretical framework for Project Environmental Management (PEM) based on EMS, BPM, BPR and EiVM. It is expected that this framework will effectively tie EMS to EiVM. Such conceptual frameworks will encourage more researches about value oriented EMS.

Key words: Business process management, business process reengineering, life cycle

INTRODUCTION

Offshore structures may be defined as structures that have no fixed access to dry land. Such structures are highly exposed to environmental loadings and required to withstand and overcome all bad weather conditions. The main purpose of offshore structural analysis is to ensure that all offshore operations shall be performed in safe manner with respect to safety environment and economical risk (Hika, 2012).

There are two main categories of offshore structures; fixed and floating. Each has many sub-categories; fixed structures include jacket, tower, jack-up, compliant tower gravity structure and mono-tower. Mono-hull, semi-submersible, tension leg platform and spar are classified as floating ones. Each of these structures used for some purposes like drilling, production and storage.

There are two possible materials for constructing hull of any structure; steel and concrete. Steel is being widely used in the ship building industry for merchant ships, warships, etc. Materials such as aluminum, glass reinforced plastic or timber are also used in small units with lengths lower than 100 m and with less adverse conditions than in the offshore industry (Fernandez and Pardo, 2013).

Offshore structures are considered as very heavy structures, require big quantities of materials like steel and concrete. Extraction, transportation and manufacturing of these materials release a lot of CO_2 emission. These emissions are considered as part of the major environmental impacts caused by these structures.

Managing environmental impacts of offshore structures is more critical than impacts of other construction projects for the following reasons.

Offshore platforms are classified as heavy weight structures. Weight of Nkossa, the world's largest pre-stressed concrete barge is 107,000 tons (Sandvik *et al*., 2004), can be compared with mass of 288,100 metric tons of one the two towers of World Trade Center (Urich, 2007). That heaviness makes them consume a lot of materials and then release a lot of CO_2 emissions.

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Most of the offshore structures are constructed by using steel. Steel is one of the highest carbon inventory materials; 1.77 kg CO_2 per kg (Hammond and Jones, 2011). Simple calculation shows that construction of Nkossa released more than 180,000 tons of CO_2.

The life span of these structures is around 25 years (Sadeghi, 2007) while that of other types of buildings like houses is longer than 50 years (Balasbaneh *et al*., 2012). The number of construction projects of such platforms is expected to increase in higher rates.

These three reasons increase the responsibility of those who work in offshore construction to develop an efficient Environmental Management System (EMS). These reasons also show the importance of managing the environmental impacts within project management context.

PROBLEM STATEMENT AND OBJECTIVES

Most challenges in construction projects are maintained by management processes. These processes are categorized into what is called knowledge areas (PMI, 2008). Managerial problems must be solved in a multi-knowledge areas framework. In most cases, cost and time cannot be ignored in any decision making framework. Time affects most of other processes and it is very critical to consider these effects.

Cost performance can be evaluated by using S-curve which represents the change in cumulative cost through project life time. Slope of this curve is sometimes of a higher importance than the total cost because the continuity of project may depends on the response of its parties to liabilities due at any point of time; solvency situation. The plan of lower cost may not be feasible due to solvency problems.

Evaluation of environmental performance also is following the same philosophy. Pollution sources are classified according to their total impact and seriousness. Seriousness is sometimes assessed by effect concentration at peak times. Environmental plan with minimum total impacts may not protect environment from peak time disasters.

Many studies have been focusing on developing a decision making framework to determine the optimum plan for construction projects. Recently environmental issues have been considered widely in these multi criteria decision making framework. Two studies have suggested two frameworks for optimizing environmental impact, cost and time during project construction phase (Ozcan-Deniz *et al*., 2012; Xu *et al*., 2012). However, they consider only the total values of cost, time and environmental impacts as objective functions. These efforts can be improved by using value management techniques.

Applying value management requires other efforts in developing business strategic management. Business Processes Management (BPM) and Business Processes Reengineering (BPR) are strategic techniques which can support applying value management at project management level.

There are two ways to improve the environmental performance. First; processing project activities may present some improvement opportunities during project life cycle. Value management techniques can be used to analyze environmental opportunities and threats. The second way depends on business side where EMS can be strengthen by updating its environmental objectives through applying BPM and BPR concepts.

This study aims to develop a framework for managing values of environmental impacts in offshore projects. It is about a value oriented EMS supported by business processes management and reengineering.

BUILDING LIFE CYCLE AND ENVIRONMENTAL IMPACTS ASSESSMENT

Recent studies indicated that construction is ranked as third industry in USA based on generating greenhouse gases Emission (GHGs). Hence, the environmental impacts of construction processes must be of great consideration (Ozcan-Deniz *et al*., 2012; Xu *et al*., 2012).

There are many Environmental Impacts Assessment (EIA) methods used in construction projects. These methods have been classified as shown in Fig. 1.

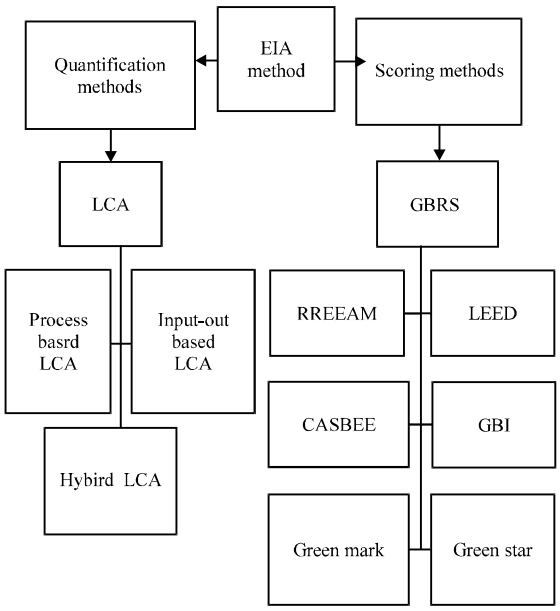

Fig. 1: Environmental Impacts Assessment (EIA) methods

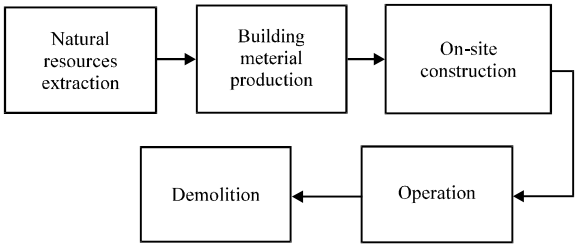

Fig. 2: Building Life Cycle (BLC) flow chart

Building Life Cycle (BLC) is very important for studying its environmental impacts. BLC include five stages as represented in Fig. 2 (Wang, 2005).

The BLC is the key element for many assessment and management methods like Life Cycle Inventory (LCI) Database, Life Cycle Management (LCM), Life Cycle Costing (LCC), Life Cycle Energy Analysis (LCEA) and Life Cycle Assessment (LCA) (Bayer *et al*., 2010).

The BLC add the concept of time value to project management knowledge. One of the most important applications of BLC are LCC and LCA. Both of them used as value assessment and management methods. Value management techniques can be used to improve processes of planning, monitoring and controlling.

According to International Standard ISO 14040, LCA is a "compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle" (Bayer *et al*., 2010).

ENVIRONMENTAL MANAGEMENT

Environmental management has two pillars:

- Project Environmental Management (PEM) which is defined as "including all processes required to ensure that the impact of the project execution to the surrounding environment will remain within the limits stated in legal permits" (PMI, 2003)
- Environmental Management System (EMS) which is "a systematic approach for incorporating energy and environmental goals and priorities into routine operations" (Christini *et al*., 2004)

The best environmental formula will be driven when all businesses have enough competitive advantage to manage and reengineer their processes in such a way that the project will release lower possible value of environmental impacts.

Due to the importance of PEM and EMS, they will be briefly discussed in this study before developing V-EMS framework.

Figure 3 summarizes the details of environmental management pillars.

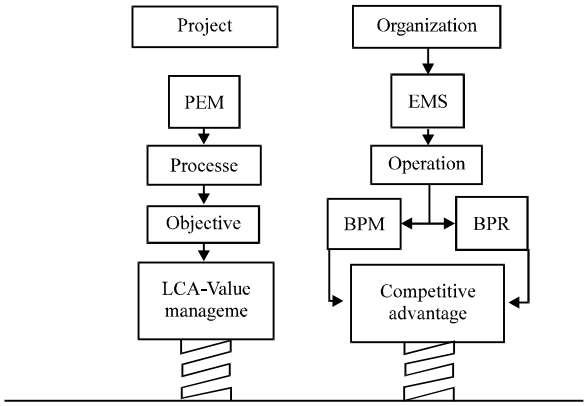

Fig. 3: Pillars of environmental management

PROJECT ENVIRONMENTAL MANAGEMENT

Project Management Institute (PMI) of USA had specified nine knowledge areas required for managing all types of projects; integration, scope, time, cost, Quality, HR, communication, risk and procurement (PMI, 2008). Many studies tried to deal with environmental issues from quality management point of view (Ofori *et al*., 2002).

Recently, many studies show that construction projects must be considered as special cases in management context. That makes PMI to publish the Construction Extension to PMBOK. The latest adds other four knowledge areas to management of construction projects; safety, finance, claims and Project Environmental Management (PEM) (PMI, 2003).

Importance of PEM has been growing up with appearing of environmental problems like global warming and widening of the Ozone layer hole.

Three types of processes are required for PEM; planning, assurance and control (PMI, 2003).

- Function of environmental planning is to determine the impact that the project will bring to the environment and how to satisfy environmental standard
- The role of environmental assurance is to evaluate the results of environmental management on regular basis according to environmental standard
- While environmental control aim is to identify ways to eliminate causes of unsatisfactory environmental performance

Figure 4 shows the functions of these process categories.

It can be concluded that PEM processes need to be arranged as the following:

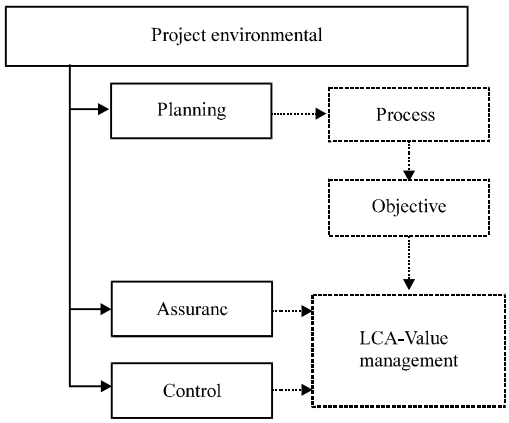

Fig. 4: Processes of construction project environmental management C-PMBOK

- Assessing of expected impacts and defining the environmental objective and the set of processes required for achieving them
- Monitoring change in values of environmental impacts during project life cycle and capturing any deviation from planned environmental performance
- Making required decisions to keep these impact values as planned
- The orientation of the environmentalist appears as only keeping the impacts within plan limits

BUSINESS STRATEGIC MANAGEMENT AND EMS

Strategic management consists of the analysis, decisions and actions that an organization undertakes in order to create and sustain competitive advantages (Dess *et al*., 2005).

At the level of strategy implementation, competitive advantage grows out of the way firms perform discrete activities-conceiving new ways to conduct activities, employing new procedures, new technologies or different inputs.

Environmental technologies can give business unique competitive advantages at firm and industry levels as well as in global trade (Shrivastava, 1995).

The systemic approach to greater efficiencies gained from Environmental Management Systems (EMS) is considered as source of competitive advantage for multinational firms (Sroufe *et al*., 1998).

Some competitive advantages can be gained by any business when EMS is considered an integrated part of proactive business practices. These advantages include benefits of cross-functional efficiencies, introduction of environmental improvements ahead of the competition, the reduction of new product development cycle time and unique information to aid the cost/benefit decision making process (Sroufe *et al*., 1998).

Types of EMS: The EMS is "that part of the management system which includes organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the environmental policy" (Sroufe *et al*., 1998).

The EMS has 3Ps orientations; product, process and project.

Project oriented EMS covers the work of all Integrated Project Teams (IPTs) and is designed to comply with government policy whilst meeting many stakeholders' expectations.

Product orientated EMS concerns with sustainable and green design. Recent study on EMS focuses on the environmental improvement of the products instead of a solely production site or process oriented approach (Ries *et al*., 1999). Barriers for product oriented EMS are, narrowed perception of the significant environmental aspects, justifying invested time and money for environmental programs and evolutionary aspect of EMS. In addition, barriers for environmentally oriented product development are; lack of knowledge of the environmental impacts of specific products, cross functional characteristic of design and environmental issues, cost-orientation instead of strategic orientation and lastly lack of methods for early planning stages.

Process oriented EMS aims at minimizing the environmental burden caused by their own business operations, including product distribution, display and packaging, operation of stores etc (Van Berkel *et al*., 1999). Many authors like this approach for aspects in non-regulated areas (Rondinelli and Vastag, 2000).

More studies seem to be required for process oriented EMS due to the barriers facing product oriented EMS and environmentally oriented product development. And because of the facts that process oriented EMS are preferred sometimes and they present a complementary component to project oriented EMS.

EMS of ISO14001: ISO 14001 is "an internationally accepted standard that sets out as a guideline to put in place an effective EMS." The typical EMS of ISO14001, as shown in Fig. 5, includes environmental policy, planning, implementation, checking and reviewing (Cascio *et al*., 1996).

A study in Hong Kong showed that some benefits are recognized from applying this EMS by construction companies; efficient use of energy, minimizing material wastes, reducing chemical hazardous and insurance premium (Raymond, 2001).

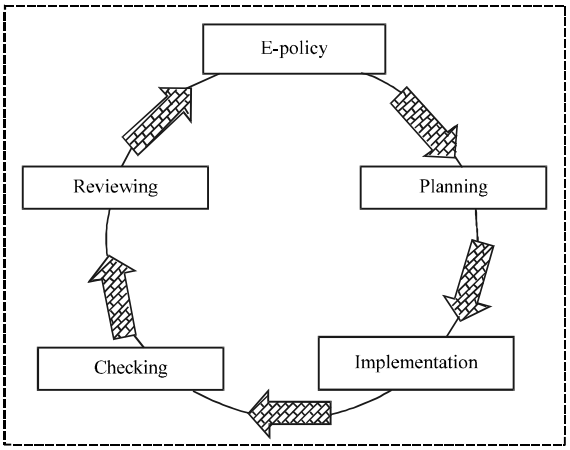

Fig. 5: ISO14001 EMS

Other study in Malaysia concluded that there is a positive and significant relationship between implementation of ISO14001 and the performance of small and medium enterprises (Nee and Wahid, 2010).

It clearly noticed that applying EMS of ISO14001 has created some competitive advantages for construction companies in some countries like Hong Kong and Malaysia.

Classifying EMS of ISO14001 as a process oriented, reflects the importance of business process in the context of environmental management.

BUSINESS PROCESSES MANAGEMENT (BPM)

BPM is "a structured method of understanding, documenting, modeling, analyzing, simulating, executing and continuously changing end-to-end business processes and all relevant resources in relation to an organization's ability to add value to the business" (Recker and Indulska, 2007). BPM is often associated with the life cycle of a single business process, with that life cycle spanning from identifying and improving a process to deploying and managing it (Jensen *et al*., 2011). The characteristics and preconditions for BPM adoption include proper information technology infrastructure, solid understanding of process-oriented frameworks, clear articulated mission statement, sound change management procedures, clear lines of responsibility and accountability with appropriate business metrics or measurement protocols for assessing the outcomes of process-driven outputs and lastly, alignment of each of the remodeled processes with the overall organization strategy (Chong, 2007).

The BPM models are categorized into several groups: Pure models, specialized enterprise models, process level models, specialized redesign models and implementation level models (Prokop, 2008). Steps for building a BPM model include decisions on the model application, appropriate software, model structure, data collection, model building and validation with users and finally regular reviewing and reporting (May, 2003).

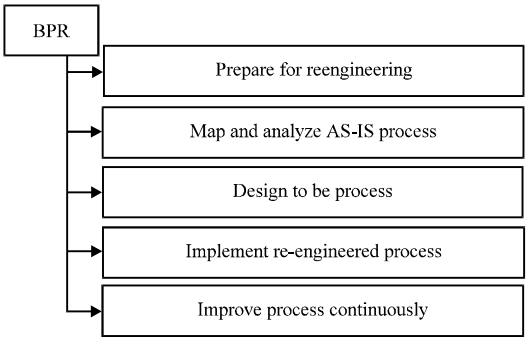

Fig. 6: BPR steps

Barriers are facing BPM in three managerial levels; strategic, tactical and operational (Sadiq *et al*., 2007).

The five most important factors that impede BPM implementation cover all levels, namely absence of cross-functional mindset amongst senior executives, lack of support from senior management, lack of clarity on a strategic level, lack of information technology expertise and lastly poor knowledge of process-oriented approaches (Chong, 2007).

BUSINESS PROCESSES REENGINEERING (BPR)

The BPR is "the fundamental rethinking and radical redesign of a business process to obtain dramatic and sustained improvements in quality, cost, service, lead time, flexibility and innovation" (Gunasekaran and Kobu, 2002).

The three primary applications of BPR were defined by Hammer as process reorganization, information technology implementation and organization redesign (Cheng *et al*., 2009).

There are a lot of models for reengineering business processes. They can be classified into classic and most recent. Actually, each business may has its own model like Kodak, McKinsey, ARIS, etc. but all of them are following the steps shown in Fig. 6 (Muthu *et al*., 1999).

The main reasons for failure in reengineering efforts include adoption of incomplete strategy, inappropriate use of external consultants and contractors, obsolete technologies with inadequate training programs, uncontrollable legacy system, too little validation of requirements, inadequate planning, lacking long-term commitment and predetermined technical decisions from management (Bergey *et al*., 1999).

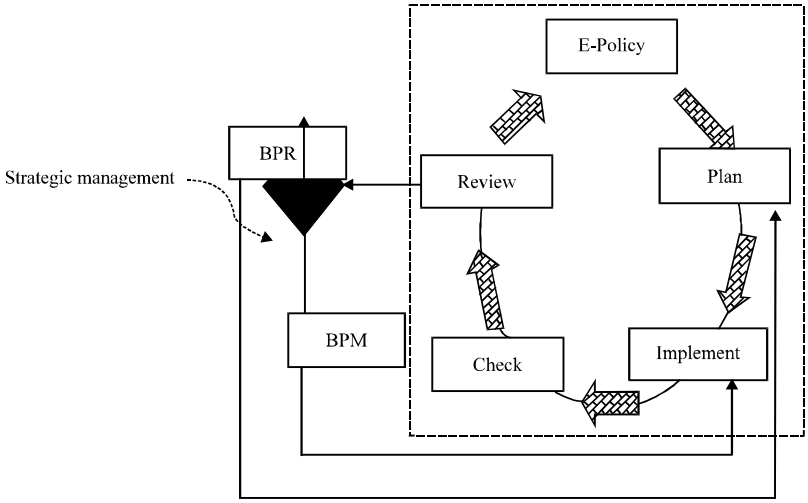

Fig. 7: EMS of ISO14001, BPM and BPR

EMS, BPM AND BPR

Kartam categorized bases of planning models into process and system (Kartam, 1995). Process oriented EMS is compatible with process based model of planning.

It can be concluded that process oriented EMS like ISO14001 can be improved by applying some techniques of BPM and BPR. This improvement will extend the role of EMS from environmental protection to improvement by analyzing business EMS strengths and weaknesses. Figure 7 shows an example of applying such improvement on EMS of ISO14001.

PEM AND IMPACT VALUE MANAGEMENT

Value Management (VM) had been used in improving cost performance. It is providing quantification measurement technique for planning, assurance and control processes. There are many value measurement techniques used for tracking processes like fixed formula, weighted milestone, percent completed apportioned efforts and level of efforts (PMI, 2005).

These techniques are suggested to be used for improving PEM model of PMBOK by adding a new set of processes concerning with improvement.

The function of this new set is to decrease the environmental impacts to be lower even than the planned values. Improvement of environmental performance is combatable with continues need for innovation and improvement in management of offshore construction project (Lewin *et al*., 2009). Figure 8 shows how can value management modify PEM by adding improvement function.

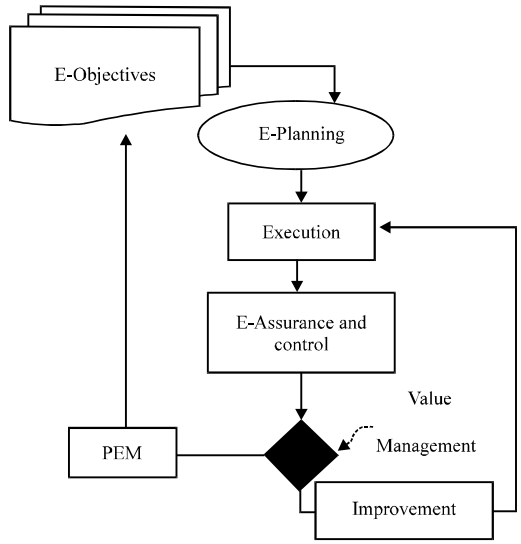

Fig. 8: PEM and VM

DEVELOPING V-EMS FRAMEWORK

There are three steps can be followed to develop this V-EMS framework:

Step 1: applying project definition on construction offshore structure will break it into a set of activities. Change in values of cost and environmental impacts will depend on the flow of these activities. They could be considered as the variables of VM process. The actual VM process will be started from extraction of materials and ended by recycling them again

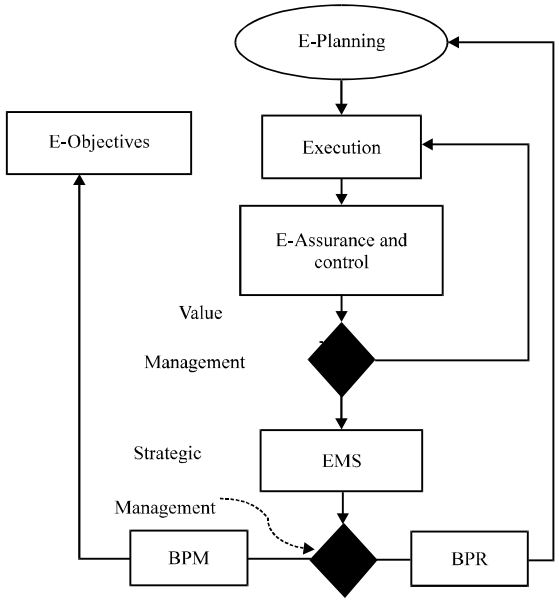

Fig. 9: Theoretical framework of V-EMS

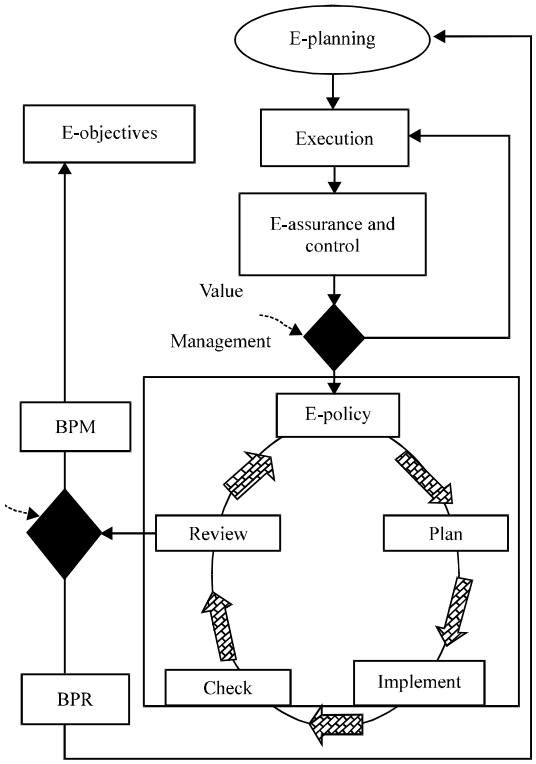

Fig. 10: V-EMS for ISO14001

Step 2: Business uses its competitive advantage to define the required set of processes for doing these activities. Both organizational matrix and set of processes assigned to specific project will be developed by applying BPM and BPR

Step 3: PEM processes of the project must be well defined for all its activities. Approximate value flow for cost and environmental impacts among project life cycle can be used as a reference for these performances. Considering capability of all project parties to perform BPR processes will enable improving these performance references

Any project is unique, has its own characteristics and objectives (PMI, 2008). This uniqueness is always challenging stability of business EMS. This challenge can be solved by combining BPM and BPR. Business has to establish an EMS which enable it to perform the PEM processes efficiently.

This framework is following the model of PMBOK for project environmental management, processes of planning, assurance and control.

The BLC based assessment methods for cost and environmental impacts, LCC and LCA, are applied by using one of the five mentioned methods of value measurement.

In this framework, the corresponding parties or businesses are expected to pursue effective processes management and reengineering. Rethinking for improving the environmental performance can be performed by following one of the mentioned BPR models. Environmental project plan must be compatible with the business organizational structure after reengineering. Figure 9 combining PEM, VM, EMS, BPM and BPR.

This developed framework can be used to improve EMS of ISO14001 as in Fig. 10.

Design process of offshore structure is expected to be more complicated in the future and that will require more researches on application of V-EMS.

CONCLUSION

This study is addressing using some managerial concepts in environmental management.

- All management processes cannot be considered with the absence of cost and time effects
- Each EMS has its own strengths and weaknesses but they can be maintained strategically through BPM and BPR
- The BLC and VM techniques can be used by project managers to analyze expected opportunities and threats. They have been used extensively to solve cost and time tradeoff problem. This study promotes applying them to improve PEM performance

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