Knowledge Integration in Engineering, Procurement and Construction Projects: A Conceptual Study

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ABSTRACT

EPC is a contractual arrangement in which the responsibility related to engineering services, procurement of raw materials, and construction lie with the contractor. Solar plants, infrastructure projects are some of the examples of EPC projects. With the need of rapid infrastructural development in developing countries like India needs scientific and better management strategies for the EPC projects.EPC projects are diverse requiring proper integration of knowledge of different fields of management and engineering.It is an accepted fact that when any term is understood conceptually it lasts long and is easier to integrate with other concepts.The workforce involved in the projects can share their knowledge with future projects which would lead to better knowledge integration. The problems of the EPC projects is unique therefore knowledge integration and better management strategies will go a long way in enhancing the efficiency of EPC projects. Thefocus of the paper is to identify the nature of EPC projects and understand conceptually the management strategies which can be used in the EPC projects for increasing the performance.The study is important for developing countries like India where EPC projects are gaining increased popularity.

Keywords: EPC Projects, Management Strategies, knowledge integration.
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INTRODUCTION

Project management is a very crucial area which determines the success of engineering ventures. Time schedules and limited budgets put immense pressure on EPC ventures to adopt the right management strategy which can help in project success. Some of the critical factors are compatibility and clarity in interpersonal relations and communication. All the stakeholders involved must know their responsibilities unambiguously. The EPC Projects starts with approval of investment decisions of the owners. The execution phase of projects consists of engineering; procurement and construction called EPCand must include a sound management plan and strategies to reduce risks, cut costs and improve success rates. Companies providing an integrated engineering, procurement and construction services are called EPC contractors. Management of EPC contracts become challenging if it is not backed by proper management strategies and expert integrated knowledge. There are different the attributes of EPC business such as EPC project lifecycle, phases and gates, the flow of engineering activities and interconnections between engineering and management disciplines apart from control and monitoring activities. A well-crafted document consisting of all the details including areas requiring special attention is helpful in EPC project management. Some of the points which require proper detailing are as follows:

1. Product description
2. Quality standards
3. Monitoring and Testing
4. System requirements
5. Spare parts and guarantees
6. Explosive environments certification

As discussed earlier an EPC project can be very challenging because it consists of a large number of interconnected sub-systems and components along with financial commitment, therefore it becomes important that it is backed by effective management strategies.EPC projects are gaining increased popularity in developing countries as it is the backbone of their economy. It is an important channel for globalization to grab the opportunities in foreign countries, especially the countries like Middle East, Africa and Southeast Asia. Use of EPCC as detailed below is common in the Middle East and some other countries.

The engineering functions include;

- Basic engineering
- Detailed engineering
- Planning
- Construction engineering

The procurement functions include;

- Logistics & transport
- Receiving
- Procurement
- Invoicing
- Purchasing

The construction functions include;

- Electrical installation
- Mechanical erection
- Civil engineering

The commissioning functions include;

- After-sales-service
- Testing & commissioning
- Modernization of plants

Companies in the developed countries such as fluor, Worley parsons, Technip, Petrofac, Hyundai and others have advanced systems which the developing countries lack, which makes the implication of EPC project mainly, based on experience in the case of developing countries. To overcome this problem of hit and trial method in EPC project management, the project knowledge accumulation has been given attention in EPC project management in the case of developing countries as it is both labour-intensive and knowledge-intensive. The effective management of EPC projects involves knowledge and intellectual creativity. Therefore it can be said that EPC project management is also a knowledge management process.Since the EPC projects have diverse work areas distributed among different stakeholders so it's difficult to work successfully by working in silos. The proper integration of the knowledge emanating from different EPC phase would be hugely beneficial for future project success. This knowledge generation from experiential learning in EPC project provides a framework for knowledge integration in EPC project. Presently Project Management Body of Knowledge (PMBOKR) provides a methodology for business integration of EPC based on the Work Breakdown Structure (WBS), but in such a system integrated experience management plays an important role.The interrelated factors of knowledge can be grouped into four main categories:

- The knowledge base that is to be managed. It includes data, information, and knowledge.
- The context of use.
- The actual processes, procedures and tools required to share and reuse knowledge.
- Measurement of the contribution of knowledge to improved business performance.

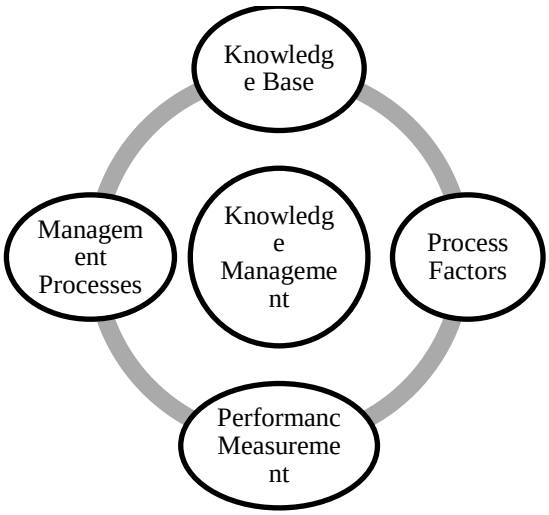

Fig-1: Knowledge Management Framework

The 'knowledge base' refers to the kind of information or project knowledge that is to be managed. 'Knowledge management processes' refers to the activities that are executed to manage knowledge, within the context of the EPC. 'Performance measurement' deals with the real-time use of knowledge management efforts; Knowledge Management adds value to the project and increases competitive advantage. The required knowledge helps during the project implementation, and finishing stage task and knowledge integration and the overall project success, it also solves the problem of projects failure in knowledge management of EPC projects, and it helps in maintaining the high standards for project knowledge system. The paper is an effort in the direction of proposing accurate management strategies by using knowledge management integration concerning EPC projects

EPC FRAMEWORK

Conceptual Framework is used to elucidate the establishmentof generic activities for an EPC project. The framework used is a general framework independent of the intervening factors. The first stage of the EPC process is pre-project planning, design, procurement also referred to as material management, and construction. EPC categories are called level one EPC schedule activities. The next level consists of external environment factors such as technological and politico-legal factors which can be further subdivided. The last level relates to the micro-level, in which the generic EPC activities are considered. The main focus of the paper is concerned with the micro and macro level where actual knowledge is generated and transferred.

LITERATURE REVIEW

The economy developing countries is immensely affected by the engineering, procurement and construction industry; any faults in the initial phases could affect the performance of the project and the economy of the country also (Doloi.H, et.al. 2012).The expertise which the developed countries have in EPC project execution is unmatchable for the developing countries. Therefore, it is important to identify the factors which result in the unsuccessful completion of the project, the identification of these factors will help the developing countries in better execution of the EPC projects (Manavazhi, M.R. &Xunzhi, Z, 2011). Zhang, G.F., (2010) emphasized that there are different methods which can be used for project delivery, amongst which EPC method is the most popular.Among all the EPC phases the procurement phase has the highest importance because the stated that unavailability of raw materials can cause serious problemsin the successful execution of the project (Kermanshachi et al, 2017).Another study by (Ngacho, C.; Das, D., 2014), acknowledged the critical success factors of EPC phases in which construction projects were given special attention and the authors prioritized the factors in the phases of EPC which affects the project performance.Rahmanet al. (2013) studied the financial factors contributing to delay ofprojects in Malaysia in which inadequate financial resources & market instability were found to be crucial points. In another study by Yang and Wei (2010) highlighted points such as poor scope definition,unreasonable and unpractical initial plan, change orders by client and project complexity etc. as the delay factors Although many studies have been carried on in the field of delay identification and prioritization of factors still there is are vital gaps in categorization and prioritization of these factors, an effort was made to fill this gap by a study conducted by (Pournader, M., et.al., 2015). The EPC model, offers more flexibility in the execution of the project, due to this EPC model has gained more popularity.De Silva, D.(2010), (Fidic, 1999)asserted that the workflow execution of EPC projects start from client requirements, engineering phases, procurement phase, construction phase, commissioning phase and the risks aspects of the project. The systematic approach to these risks involves four stages, which area risk classification, risk identification, risk assessment and risk response (Zhi, 1995).Wang et al., (2004) also emphasized that a systematic approach to risk management in the construction industry consists of three main steps: risk identification, risk analysis and evaluation, and risk

response. EPC consists of activities related to goods, raw materials and services for the sole purpose of designing, building and executing a project that delivers value for money to the client (Duncan, 2009).Masterman, (1996) elaborated on project procurementand asserted that it provides an organizational structure to design and build construction projects. EPC is a variant of 'Design and Build' procurement system. During the initial phase, the major activities include engineering services, materials procurement and construction services. The popularity of EPC projects grew by factors such as growing population, Economic growth, and the need for sustainable development. Leung and Ricky Yee-Kwong (2003) explained the concept of effective communication and acknowledged that it is an important ingredient of construction project which helps in smooth completion of the project. Lee et al. (2017) asserted that as construction projects consist of various components such as environmental regulation, financial constraints, time limits, in such a situation communication helps in better coordination and conflict resolution.Wang (2003) studiedutilization and transfer of knowledgein the EPC phases of project management, leading the research in

KNOWLEDGE INTEGRATION IN EPC PROJECTS

The knowledge integration in the EPC projects is dependent on how much project knowledge the participants/stakeholders possess. The knowledge integration is the cumulative knowledge which is built on by the contribution and distribution of individuals' and stakeholders skills in the organization, each individual and stakeholder possess some unique skill sets which can be integrated for the success of EPC projects. This knowledge creation is then transferred to other departments for future use. Knowledge integration framework (refer fig 1) provides a framework for knowledge integration in the EPC. The framework proposes the knowledge breakdown structure (KBS), which can lead to knowledge integration in EPC Projects. As the figure explains which have been given by Zhu, Sun, Xu&Haider (2013) deconstructs project knowledge and identify and organize project knowledge, systematically and thus promote knowledge integration and business integration. To further increase the efficiency of knowledge integration a multi-level KBS is knowledge management. Lee et al. (2019) conducted the study focusing on focusing on time and cost performance, including pre-project planning, project change management, and design. Carrying the study forward Safapour et al. (2017) assessed the utilization of Best Practices to reduce the schedule delays and reduce the cost of construction projects these five Best Practices are team building, alignment, change management, front-end planning, and partnering.Ilies et al. (2011) defined conflict as a negative situation that is accompanied by a controversial behaviour during knowledge and information exchange about different perspectives.De Wit et al. (2012) contented that conflicts arise due to differences in opinion of the parties or stakeholder or different aspects and perspectives. The conflicts have a delirious impact on the performance of the project such as delays, cost overruns and defects in quality and it also hinders the knowledge creation process (Habibi et al. 2019).Collaborative delivery methods are a promising method to improve and maintain a cordial working relationship between participants and disputes in the EPC projects (Kermanshachi, 2010)

a better idea to achieve an effective combination of knowledge and business layout in EPC, which would further enhance the EPC knowledge integration. The key to effective knowledge breakdown structure is to identify the elements of project knowledge and relationships between them. Knowledge package includes the individual, time, resource, cost, quality, etc. Along with this, there is a time dimension, resource dimension and the cost dimension (Refer Fig 2.). For comprehensive knowledge integration and project management three elements are important they are concepts, concept attribute and the relationship between concepts between pivotal. Generally, the project management knowledge fields are divided into nine categories which are, Project Integration Management, Project Scope Management, Project Time Management, Project Cost Management, Project Quality Management, Project Human Resource Management, Project Communication Management and Project Risk Management. The knowledge integration in the EPC projects requires that the knowledge elements are integrated and the process of business integration should be conducted according to the life cycle of Etc.

The knowledge packages are created following the stages of the project life cycle, and then the knowledge integration framework is established, thus promoting knowledge integration. The Overall knowledge integration model is done based on knowledge integration models in various life cycle stages. The final output of knowledge innovation ensures that the project objectives are met through effective knowledge integration.

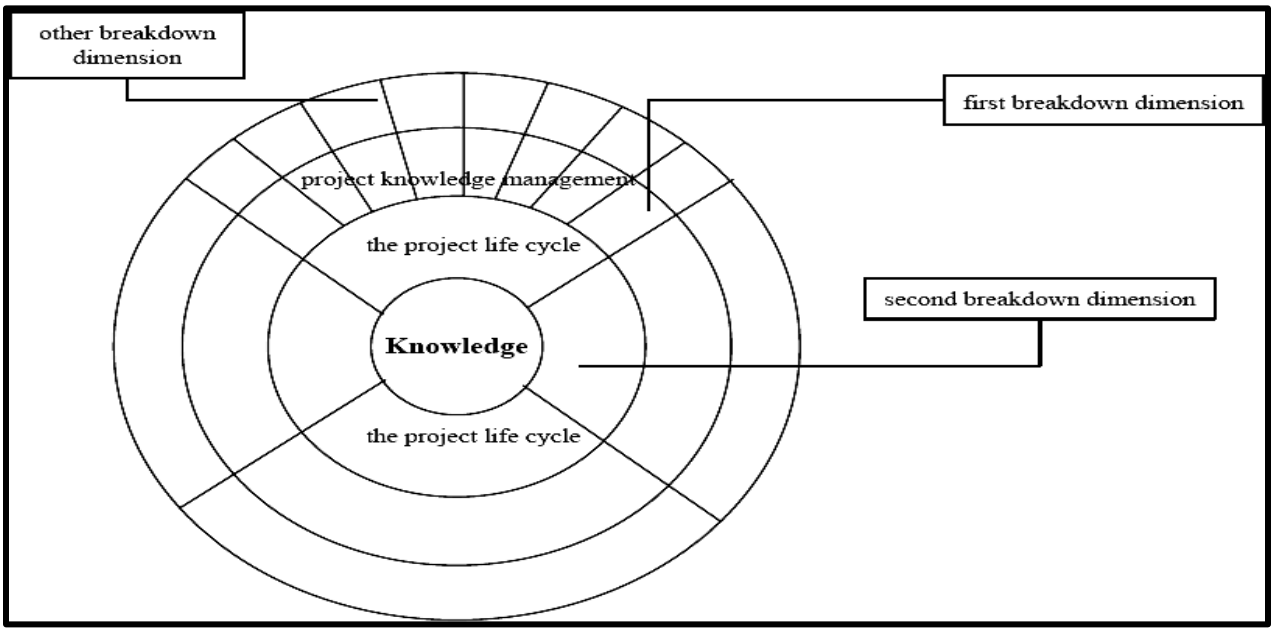

Figure: Knowledge deconstruction process (Zhu, Sun, Xu&Haider, 2013)

DISCUSSION AND APPLICATION

The EPCprojects as clear from the literature is not only labour-intensive industry, but it is equally a knowledge-intensive industry also. Thus the process involved in the project management applies to knowledge management also. The EPC projects have an interdisciplinary and multi-functional complex behaviour due to this complicated relationships knowledge of EPC project depends on different life cycle stages of the project along with expertise, and management strategies. In this process, stakeholders and the project participantscreateandapplyknowledgeto distribute the created knowledge in different phases of the EPC project, this is the continuous circuitous process. The knowledge integration takes place by the utilization of the knowledge resources with work packageswhich facilitatesits implementation in the EPC project. Knowledge integration is thus a process of identification, organization, sharing, application and innovation. It is about identification of project knowledge, sharing and integrating knowledge through project knowledge networkand finally achieving the unity knowledge integration. The figure given below shows the knowledge transfer as well as personal and organizational knowledge(Zhu, Sun, Xu&Haider, 2013). Finally, it can be said that knowledge integration is moving from the stage of knowledge sharing to knowledge innovation and this innovation creates a whole new dynamics in the knowledge ecosystem.In the EPC phases, new knowledge is created at each phase which needs to be integrated and stocked for future use in the EPC projects.

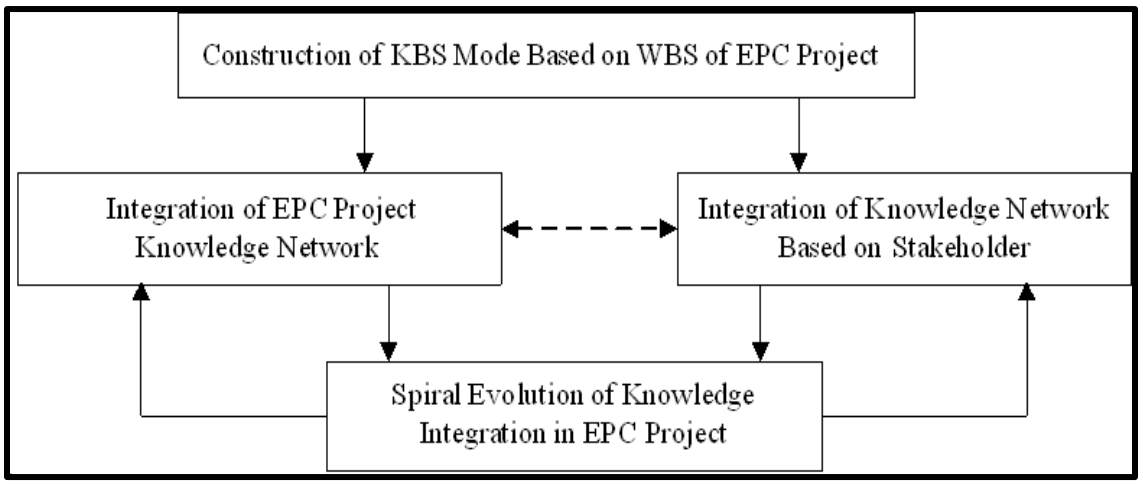

Figure 2: Knowledge deconstruction process (Zhu, Sun, Xu&Haider, 2013)

The firms should therefore understand that the human resources are the most important entity in knowledgemanagement,as it is the human mind which is the reservoir of knowledge. In the context of EPC projects Knowledge transfer in an effective way for knowledge integration in the EPC projects. Therefore, the companies should continuously monitor and control the coordination between individuals/Stakeholders using effective communication channels to minimize the chances of any loopholes.

CONCLUSION

EPC is a promising revolutionary concept for the economic development of the world countries in general and developing countries in particular. To encash on the opportunities which EPC projects can provide knowledge management and its integration plays an important role. Knowledge management and its integration with the other phases of the EPC is the key factor in the successful execution of EPC project successfully. From the study, it is quite clear that in the successful execution of EPC projects depends on the proper balance between project management and knowledge management. This paper proposes a conceptual framework for knowledge integration in the EPC project management, based on project life cycles stage and work packages. Each phase of the EPC project adds to the existing knowledge which upgrades with each passing phase. For maintenance of the balance between the two theoretical guidance and practical management is of utmost importance. On the one hand, Knowledge integration promotes the easy flow of knowledge among different stakeholders andimproves the knowledge learning and on the other hand, project integration helps in enhancing the systems andsocial relationship, etc. The framework in the paper lists out basic requirements for knowledge integration in the EPC projects. So to conclude the knowledge innovated at each EPC phase can be collected for future realization. These innovations would also help in better communication systems which would help in conflict minimization. Further study on knowledge integration can be taken up in the future researches.

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