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Knowledge Management In Engineering Through ICT

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Abstract

Organizations aiming to differentiate themselves from their competitors often acknowledge that their intellectual capital is the main source of competitive advantage. Organizations have started considering Knowledge management (KM) as an important strategy to stay ahead of competition and are initiating the integration of KM as a vital business activity. Construction is basically a project-based Industry in which each and every project are unique in design and built according to the specifications. In general, members of the project teams involved in the construction are diverse in nature and there are high chances for knowledge generated in a project may not be used in another project. The knowledge and cognizance developed in a project often extinct with the project if the same team members does not work in the future projects. Thus, the knowledge loss may be high as the same team may never come together to execute another project. Thus it is vitally important to harness the knowledge and utilize the expertise of the individuals for the growth of the organizations. Knowledge management in construction can be considered as an effective technique aimed at reusing and sharing knowledge to enhance the lead time in the completion of projects by reducing the cost and improving the competitiveness of the organization. This paper analyses current trend in knowledge management practices in five of the construction companies based in Chennai, Tamil Nadu. The study analyses the issues faced by construction companies in the implementation of knowledge management system. The study is exploratory in nature and interviews as well survey questionnaire was used to describe the current practices in KM.

Keywords: Knowledge, Knowledge Management, Construction, ICT,

Introduction

Knowledge is considered as the most important asset for the organizational success among other assets such as capital, materials, machineries, and properties (Fong & Wong, 2005). . The concept of knowledge economy is increasingly considered as a key policy in national and international levels (OECD, 1996). Knowledge can be defined as the facts, skills and understanding that one has gained, especially through learning or experience, which enhance one's ability of evaluating context, making decisions and taking actions (Awad & Ghaziri, 02004; Tserng & Lin, 2004).

Conroy and Soltan (1998) define three knowledge bases to contain the knowledge that is used and created in the execution of the project. These are the:

Organization Knowledge Base

It contains the data and information specific to the organization and wider environment in which the project is being executed.

Project Management Knowledge Base

It contains knowledge of the theory and application of project management. This is company specific and is the intellectual capital of the company.

Project-Specific Knowledge Base

It is the project specific knowledge acquired from the user at the outset and developed over the project life cycle.

According to Conroy and Soltan (1998), the project-generated knowledge is divided into three general categories:

Technical Knowledge-Engineering

It is related to techniques, technologies, work processes, statutory requirements, costs and so forth involved in the production of discipline-specific elements of the project. New knowledge needs to be fed back into and managed by the discipline departments of the organization.

Project Management Knowledge

It is related to the techniques and technologies for managing the execution of projects. This knowledge is of benefit to all project managers and others involved in the wider aspects of project management, including the company quality system.

Project Related Knowledge

It refers to the knowledge of the client and the historical aspects of the project, which are of use for future marketing purposes either in winning jobs with the same client or in improving the company's 'curriculum vitae'.

This is the potential for usable knowledge and it is at the source of much of the knowledge identified above.

Knowledge management (KM)in Enginerring is acknowledged as an important component in the success of organizations and is fast becoming a necessary business activity in the organizations are increasingly believe that maintaining a structured

approach for knowledge management processes like knowledge capturing, sharing, and creation can improve the process of organizational learning which in turn enhances performance and progress their chance to gain competitive advantages over others (Ahmad & An, 2008).

Various authors have given definitions for knowledge management. Some of the prominent definitions are:

"Knowledge management represents a systematic and organized approach of using knowledge for storing and extending knowledge in order to increase companies' output and performance KPMG (1998)."

"Knowledge management is equivalent to the strategies and processes for knowledge identification, documentation and influence with the aim of making companies competitive APQC (1996)".

According to Alavi and Leidner (2001), Knowledge Management System is an "IT-based systems developed to support and enhance the organizational processes of knowledge creation, storage/retrieval, transfer, and application". Organizations around the world have started to show increasing interest in KM activities. The primary reason behind KM expansion during the last two decades is due to the "globalization and high competition, improvement in new information and communication technologies, financial implications of intellectual property rights, recent procurement ways, new work methods, employment regulations, and contradictory political and ethicalunderp innings (Anumba et al. 2005)".

In a nutshell, knowledge management can be defined set of systematic procedures, methods and techniques that are commonly used for the effective creation, capturing, organization, distribution, use and sharing of both tacit and explicit knowledge, to enable individuals of the organization to be more effective and productive in their work in order to generate value for the projects and the organizations. Knowledge Management System (KMS) provide the tools and services for end-users to capture, share, reuse, update, and create new experiences, problem solutions and best practices to aid employees in processes such as problem solving, decision making and innovation, and so to enhance the total performance of the organization (Ahmad et al., 2007).

The construction industry in India is undergoing a critical phase and experiences numerous challenges primarily contributed to competitive market, impact of technology, increased demands from customers and higher quality expectations. Construction industry is traditionally regarded as an industry which rarely accepts changes and very slow in adapting to change (Chen et al., 2005).

Research Objectives

The overall aim of this paper is to explore the issues in knowledge management in construction companies in Chennai, Tamil Nadu. Based on the aim, the broad objectives of the study are

- To develop a critical understanding of knowledge and its management in construction organizations.

- To identify the emerging themes related to the governing factors in knowledge management in construction industry.
- To develop and validate the constructs of the instrument empirically by measuring the attitude of construction professionals towards the knowledge management.

Background of The Study

Knowledge Management In Construction Industry

Construction industry exhibits uniqueness in various aspects. Construction is a project based industry in which each project differ from other and every projects brings new experience (Raiden and Dainty, 2006). Project teams in construction usually consists of people derived from diverse background who work together as a team to accomplish the common task. Various stakeholders work collaboratively with others at various stages during the project lifecycle. Thus each construction project can be considered as a multidiscipline organization which may or may not continue to work together once the project is completed (Kamara et al. 2002). In addition, the construction industry is highly competitive where the pressure for better efficiency is more common. The reliance of construction organizations on information sources is very high and large volume of communication is more common among stakeholders in the various stages of project lifecycle. Many construction organizations are experiencing difficulties in the implementation of KM activities not only because of the complicated nature of KM operations, but also by the fact that most of the KM initiatives are often unplanned and informal (Ahmad & Gaterell, 2008).

KM implementation is proved to be very difficult task in the construction industry because of various reasons which includes the complexity of industry, diversity of team members in the projects, contracting nature of employment which often lead to adversarial relationships, pressure to complete the project and non-repetitive nature of work(KLICON, 1999). All these reasons causes “knowledge wastage” in construction companies and as a result important knowledge has been difficult to access (KLICON, 1999). The complex nature of knowledge and construction context increases the difficulty for organizations to plan and implement formal KM initiatives. Another challenge to KM implementation in construction organizations is the lack of systematic procedures for developing and applying knowledge management systems (KMSs). Thus, an effective knowledge management system in construction companies can promote innovation and enable improvement of the construction process.

A number of studies have attempted to identify the major obstacles to implementing in construction companies. Davidson and Sutherland (1992) have stated that workload stress, time pressure and long working hours are the major obstacles to KM implementation. Similar study by Robinson et al. (2001) described how culture and the lack of standardized work processes impacts KM implementation negatively. Loforte (2009) analyzed the application of technology and leadership on KM implementation. Organizations often struggle to define whether a KM initiative

should be considered a technical issue, a human resources issue, a procedural issue or as part of strategic management (Handzic & Hasan, 2003). For example, in a study on knowledge requirement in international construction firms, Javernick-Will and Scott (2010) found that developers, contractors and engineers had different opinions due to each type of firm's source of revenue and commitment time horizon.

Explicit and Tacit Knowledge

Knowledge can be grouped into two broad categories as Tacit and Explicitknowledge (Polanyi, 1966).Explicitknowledge is tangible, which means, it can be easily captured, codified/documented and shared with occurs. Explicit knowledge can be easily shared through discussions, writing and can be stored in databases and in repositories as documents, notes,etc (Nonaka and Takeuchi, 1995).Telephone directory, instructionmanuals, a research report can be figured as the examples of explicit knowledge (Erkan, 2007).

On the other hand, tacit knowledge is intangible, difficult to articulate, highly personalized, context-specific, and difficult to codify and share.It is embedded in the human mind, behavior and perceptions (Nonaka andTakeuchi, 1995). It is linked to personal perspectives, emotions, intuition,values, know-how, experiences and beliefs. Some of the forms of tacit knowledge sharing includes apprenticeship, direct interaction, networking andaction learning that consist of face-to-face social interaction and practicalexperiences (Erkan, 2007).

It is important to consider that explicit knowledge are readily available in construction companies, while, tacit knowledge is difficult to tap as the core employees of the construction organization are dispersed in various projects, fragmented at different places and frequently shift from one project to another in short period of time. The knowledge that an employee gather in a project resides within that employee and if he/she quits the organization, the tacit knowledge that are stored goes with the employee.

However, if an effective KMS is put forth in place in the construction projects, it can enable the companies to tap the tacit knowledge and complete the projects with reduced cost and time while improving quality of projects. It is widely believed that reusing and sharing of previous experiences and knowledge enable employees to solve the problems without spending extra time, efforts and resources on reinventing solutions that have already been invented elsewhere in the organization (Ahmad *et al*., 2007).The construction organizations are beginning to show heightened interest in KM as a necessary prerequisite for improved quality, innovations, business performance, efficiency of project delivery, and relationships with partners, suppliers and clients to gain competitive advantages (Egan, 1998; Kamara *et al*., 2002; Love *et al*., 2003).

Role of ICT tools in KM in Construction Industry

Explosive growth in ICT tools in the last decade has prompted keen interest among construction organizations to utilize these tools and techniques in KM initiatives. In fact, large organizations have their own corporate intranet where information such as contact lists, standard forms and databases, company news, and other relevant

information is shared on a web based platform. Companies are also implementing extranets to share information with the supply chain. Although these technologies have certainly transformed how knowledge is shared across organizations, they mainly address explicit knowledge rather than tacit knowledge.

Organizations can greatly benefit if emerging tools based on Web 2.0 technologies like Web based/Mobile enabled social networking applications, online forums and wikis are integrated into their projects. Such technologies has the potential in transforming the way people share knowledge and ideas with each other. In addition, these technologies can enable the construction organizations to innovatively share their tacit knowledge.

It has also been debated over the years that the construction industry has been relatively slow in adopting the innovative solutions offered by the developments in the ICT sector. The construction industry has always maintained a skeptical view of the ICT offerings, while other industries, such as automobile and manufacturing, have successfully utilized ICT to improve the efficiency of its processes. However in the last decade the construction industry has made significant efforts to embrace ICT solutions.

A number of studies on the use of Information Technology (IT) for knowledge management activities have stressed that construction industry can greatly benefit from Information and Communication Technology (ICT) tools, although only a few firms that too the larger ones are using the cutting edge of IT tools in (Nitithamyong& Skibniewski, 2006; Ingirige& Sexton, 2007; Rivard et al., 2004).

Issa and Haddad (2008) found that IT is perceived as a tool for assisting KM but not for motivating people in sharing their knowledge in construction companies. The study also believed that not all types of knowledge can be shared using IT. Better organizational culture, improved mutual trust between employees and organization, and the use of IT for collaborative work can lead to more knowledge sharing (Issa & Haddad, 2008).

This paper aims to study the KM practices in construction companies, drivers of KMS and issues in KM activities in construction projects.

Research Method

The research method followed four stage process – Focus group Interviews, Survey Instrument Design, Data Collection, Analysis and Interpretation

Focus group Interviews

The purpose of focus group interview was to gather information from construction experts and senior management of construction companies related to key issues in the knowledge management process. Around 10 senior project managers and 5 leaders of construction companies have participated in the focus group study. Open ended and semi structures questionnaire was used to elicit detailed responses from the subjects of the study. Collected data were analyzed and independently coded by three experts. The emerging themes were categorized. Six themes emerged from the interviews which are

- Organizational resource for KMS
- Organizational culture for KMS
- Management leadership and support for KMS
- ICT for KMS
- Learning and collaboration for KMS
- Measurement system for KMS

All the ideas generated by the experts were summarized into 48 brief statements which were further used to design the questionnaire.

Instrument Design

Based on the focus group interviews and review of literature on knowledge management in construction industry, a survey instrument containing 40 items was developed. The questionnaire was in a self-report format and used a five-point Likert scale foreach item. The scale ranged from ‘‘1 = very low” to ‘‘5 = very high”. The survey instrument included two sections. The first section included items related to the demographic characteristics of the sample. The second section measured the knowledge management practices in the construction companies. The subscales of the instrument

Organizational Resource for KMS

This construct measures the extent of the presence of resources for effective KM activities.

Organizational Culture for KMS

Organizational culture emphasis the extent to which the prevailing culture is conducive to KM related initiatives. It is important that a right culture facilitates the sharing of knowledge and collaboration among the employees to enhance the knowledge level of all the employees.

Leadership Support for KMS

The respondents were asked to indicate the extent to which they perceived their leadership support KM activities in the organization.

ICT for KMS

This sub-scale measures the extent to which existing ICT infrastructure supports and improves KM activities of construction companies. The role of ICT in decision support system, knowledge creation and dissemination was also explored using this construct.

Learning and Collaboration for KMS

This construct measure the degree of collaboration among employees and the prevalence of group-learning to promote KM activities in construction companies.

Measurement System for KMS
This construct measures the effectiveness of the existing system to measure the KM benefits.

Sample and Context of The Study
The study was conducted with the key project managers of construction industry involved in building residential houses and apartments in and around Chennai, Tamil Nadu. Around 120 employees from 5 constructions companies participated in the study.The choice of construction companies and the respondents of study were based on the convenient sampling strategy depending of the ease of access of the author(s).

Table 1: Demographic Characteristics of the Construction employees

Variable	**Parameter (s)**	
Age	M = 35.45 (SD = 0.890)	
Education	Undergraduate	84(70%)
	Postgraduate	36(30%)
Experience (Years)	Current Company	M=4.36, SD=0.57
	Total Experience	M=7.36, SD=0.60
Designation	Project Engineer	86(72%)
	Project Manager	34(28%)
Qualification	Civil Engineer	62 (51.7%)
	Electrical Engineer	12 (10%)
	Mechanical Engineer	5(4.16%)
	Structural Engineering	29(24.17%)
	Other	12(10%)

Note: M = mean, SD = standard deviation

Data Analysis
The collected data were analysis PASW (21.0) version (formerly SPSS). The correlation and multico-linearity of the data were checked and few items were removed. The final instrument consists of 40 items measuring 6 constructs.

Reliability and Validity
The reliability of the instrument was measured using Cronbach's alpha. The instrument yielded a higher Cronbach value of 0.86 for overall scale, signifying that the reliability of the tool was better. Similarly, all the constructs had reliability of higher than the 0.7. The construct validity of the instrument was tested using exploratory factor analysis using Principle Component Analysis (PCA). All the factors with Eigen value greater than one were retained. Varimax rotation was applied to identify the factor loading and the resulting rotating component matrix is shown in Table 2. The rotation converged in 6 iterations.

Table 2: Component Rotation Matrix (N=120)

Items	Component					
	1	2	3	4	5	6
Q1	.934					
Q2	.722					
Q3	.908					
Q4	.697					
Q5	.506					
Q6	.925					
Q7	.915					
Q8	.872					
Q9		.938				
Q10		.745				
Q11		.944				
Q12		.930				
Q13		.961				
Q14		.940				
Q15		.925				
Q16		.926				
Q17			.754			
Q18			.621			
Q19			.841			
Q20			.678			
Q21			.559			
Q22			.799			
Q23				.938		
Q24				.911		
Q25				.914		
Q26				.911		
Q27				.939		
Q28				.889		
Q29					.982	
Q30					.964	
Q31					.970	
Q32					.976	
Q33					.962	
Q34					.419	
Q35						.836
Q36						.870

Q37						.917
Q38						.887
Q39						.865
Q40						.833

Descriptive Statistics

The descriptive statistics of the constructs is shown in Table 3. It can be seen from the Table 3 that the respondents of the study have given highest rating (M=4.2) for leadership support for KM activities, closely followed by ICT support (M=4.1). The least rated factor was measurement system for KM activities (M=3.0). The respondents perceived that organizational resource for KM activities needs (M=3.4) is not that much significant when compared to the rating for other factors.

Table 3: Descriptive Statistics of the constructs

S.No.	Construct	No. of Items	Mean	Standard Deviation
1	Leadership and support	8	4.2	0.66
2	ICT support	8	4.1	0.85
3	Organizational resource	6	3.4	0.65
4	Organizational culture	6	3.8	0.87
5	Learning and collaboration	6	3.5	0.82
6	Measurement system	6	3.0	1.02

Discussion

Leadership commitment to support KM initiatives is important for the success and sustenance of KM system in the organizations. The leadership support for continuous learning and financial commitment to the KM activities are also vitally important. Even though the leadership support for KM activities has been reported as the highest rated factor (M=4.2), the commitment to allocate resources is far from better which reflects in the rating of the respondents for availability of resource for KM initiatives (M=3.4).

The participants of the study believed that the ICT support for the KM activities are much better in their respective organizations (M=4.1). ICT tools are mainly used for archiving and retrieving information, supporting collaborations, and searching web-based engines for information. Social media tools are effectively used for communication among members in the projects. However the usage of ICT tools for exploiting the tacit knowledge existing within the individuals needs further exploration.

Organizational culture plays an important role in transforming an organization into knowledge intensive one. The success of KM implementation largely depends on the organizational culture and commitment at all the levels of the organization (Gupta *et al*., 2000). Burgess and Singh (2006) also hold similar views by stating that

organizational culture together with management support can affect the ability of KM initiatives to deliver desirable results for individuals and organizations.

The biggest asset of a construction industry is the knowledge and experience associated with its human capital (Kamara et al., 2002). Effective learning promotes the acquirement of knowledge and collaboration enhances the transfer of knowledge. The explicit knowledge can be easily shared by using ICT tools while effective collaboration and trust between the employees alone can initiate the transfer of tacit knowledge. It is clear from the study that even though the overall system for learning and collaboration are better, still efforts are needed to improve them further. It is evidenced that the informal learning is highly prevalent and system for planned training or collaboration is not significantly

A system for measuring the effectiveness of KM implementation has been reported as the least rated construct (M=3.0) in the study. The review of literature also reiterates the findings that measurement system for KMS is one of the most difficult task in KM activities (Chen et al., 2009). Similarly, another study Kankanhalli and Tan (2005) also established that the fluid and intangible nature of knowledge makes its measurement an enormously complex and daunting task.

Conclusion

The overall aims of this paper was to investigate the issues in knowledge management in construction companies in Chennai, Tamil Nadu. The operational difficulties in the KM implementation in construction were identified and discussed. The focus group interview with the senior project engineers and managers were found to be helpful in identifying the key constructs to define the perception towards KM activities in construction companies. Further review of literature has guided the generation of statements relevant to the constructs in order to conduct a quantitative study. Around 120 engineers, construction project professional participated in the descriptive study. The data collected were analysed and the reliability, validity of the responses were verified. In conclusion, knowledge management is a core competency for construction industry, and it should be integrated within company's business strategy. An effective leadership establishes the culture for learning, encourage and support for creating, sharing and use of acquired knowledge.

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