

KM MODEL TO EMBED KNOWLEDGE MANAGEMENT ACTIVITIES INTO WORK ACTIVITIES IN CONSTRUCTION ORGANISATIONS

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Knowledge management (KM) is now becoming a vital issue in the business strategies of the construction organisations to gain competitive advantage. In the construction industry, the increased pressure from customers toward improving quality of works while reducing time and cost raises the needs of the construction organisations for continuous learning and innovating through KM. In order to apply KM into work activities more effectively and efficiently, it requires the support of KM methods and techniques. This paper presents a KM model that contains a set of KM techniques to support understanding and applying these techniques in practice, which focuses upon identifying the importance of KM tools and techniques and how they facilitate KM activities to improve the application of KM in the construction industry. Questionnaire survey and case study have been carried out, which aim at improving and testing the proposed KM model and tools to facilitate embedding KM into work activities. The results show that the use and implementation of KM in the construction organisations can support the competitive advantages of the organisations. The problems of the application of KM techniques and tools in the construction organizations are discussed. Recommendations are given in order to improve the implementation of KM in the construction organizations.

Keywords: business strategy, competitive advantage, knowledge management model, knowledge management system, knowledge management techniques.

INTRODUCTION

Over the last decade, many construction organisations have invested heavily in knowledge management (KM) application as a response to the growing demands for the improvement of their business processes. This current interest in KM has been motivated by the improvements achieved in data processing and communication capabilities (KLICON 1999). Companies can enhance organisational learning through knowledge generation combined with successful knowledge sharing (Li and Gao 2003), which will not only lead to enrich the knowledge of employees and organisations, but also will lead to more strategic innovations. KM is an effective way to gain competitive advantage, which involve the ability of a company to perform projects and activities at lower cost and time combined with higher quality of projects than other competitors. Therefore, the industry needs KM to gain competitive advantages through the enhancement of innovation, quality, business performance and

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efficiency of project delivery, and maintaining of long term relationships with partners, suppliers and clients (Egan 1998; Kamara *et al.* 2002).

With the rapid development in the construction industry, the industry faces many challenges of how to apply a successful KM system that provides the desired results and benefits. A successful KM implementation requires a major change in organisational culture and commitment at all the organisational levels (Gupta *et al.* 2000). It has been found that many challenges to KM implementation in construction, such as the complexity of industry, diversity of work players; adversarial relationships that encouraged by the strategy of contracting and the project nature with pressure to complete, and non-repetitive nature of work are all causes for much “knowledge wastage” and difficulties in accessing important information (KLICON 1999). Some empirical studies proved that construction companies, especially small and medium enterprises (SMEs) which consist about 99 percent of construction firms in the UK, suffer lack of awareness of many important issues associated with knowledge capturing and its benefits for construction organisations (Hari *et al.* 2005). The difficulty of KM implementation for many construction organisations caused not only by the complicated nature of KM operations, but the fact that the implementation of KM initiatives has often been unplanned and informal. A study conducted based on leading construction organisations showed that these organisations lack coordination and strategy to KM implementation, and a high percentage of them have not appointed a knowledge manager or a team to implement their KM strategy, with the fact that small and medium organisations are less successful than large counterparts in KM implementation (Robinson *et al.* 2004). Other studies argue that UK construction companies with domestic operations are less successful in KM implementation of their international counterparts, because they lack the adoption of well formulated KM strategies and implementation plans, and KM alignment with business strategy of the organisation (Robinson *et al.* 2005). A survey carried out by Carrillo *et al.* (2004), that investigated the main barriers to implementing KM strategies such as work processes, employees time, organizational culture, expenses, employees resistance and poor IT infrastructure, indicated that the most significant barrier to KM implementation in UK construction organisations is the lack of standard work processes such as having too many different procedures to perform similar activities and the lack of systematic procedures for collecting and reusing lessons learnt and best practices. Although previous studies attempted to develop and/or adopt an appropriate KM strategy for the construction industry, managerial courage is required to face this challenge and achieve changes (Ahmad *et al.* 2007).

All the previous challenges to KM implementation and the lack of awareness of KM importance in construction organisations cause the need for a more coherent and structured approach for utilising tacit and explicit knowledge within organisations (Hari *et al.* 2005). Many techniques have been developed and used in the construction organisation to enhance KM implementation and reduce the effect of knowledge barriers. For example, by using network knowledge maps, users can improve their ability to discover what knowledge exists and what knowledge is missed in a certain area or project (Lin *et al.* 2006). Dynamic knowledge map proposed by Woo *et al.* (2004) is a technique that facilitates searching for experts with relevant knowledge and communicating with them by using instant messaging, e-mail, telephone, Internet conferencing or other internet technologies. Another technique is the use of modelling methods that are used to develop and manage knowledge systems. Models are used to help people to understand the complexity of real systems by representing the main

features and dividing the large systems into its parts, to simplify understanding and managing (Abdullah *et al.* 2002). A successful technique in construction KM is the use of Activity-Based KM systems where information and knowledge from projects are categorized and saved in units related to the projects' activities so that these information and knowledge can be easily retrieved and reapplied (Tserng and Lin 2004). Another technique of knowledge categorization and organization is the use of Ontology-based systems. Ontology is an explicit specification that provides formal representation to show what knowledge of a domain exists in a knowledge-based system, which enhances searching capabilities, enabling the segregation of knowledge and reducing the overlapping topics between different discussion groups (Gruber 1993; KLICON 1999), which provides a mechanism to classify domain knowledge items into inter-related components, in the form of hierarchical structure and semantic relationship, in which information can be accessed based on meaning, better enabling computers and people to exchange knowledge (El-Diraby and Kashif 2005). However, these KM techniques and many other ongoing researches need a more structured coherent approach to KM and a better alignment of KM to business goals in the construction organisations.

Although the adoption of such techniques motivate and facilitate KM initiatives, they cannot guarantee that people in the organisation are willing to use the KM system to share their knowledge with others or to benefit from others' knowledge. This paper introduces a technique to enhance the participation of employees in the KM activities through embedding KM tasks and roles in the work processes and activities of employees. A KM model has been developed in this research to represent the technique, provide guidance for KM implementation and use, and help to understand the concept of knowledge and KM.

KM ACTIVITIES

KM processes can be categorized into two major groups of activities. The first group includes all activities related to building and enhancing a KM system, while the second group includes activities of applying and using the implemented KM system. Each group of KM activities includes main general activities that can be further broken down into specific sub-activities that vary according to the special requirements and characteristics of the organisations. The main KM activities of the two groups will be discussed in the following sections. The conflicts that may exist between KM activities and daily routines and processes of jobs, and also the poor links between KM activities and business performance are major challenges that negatively affect KM application in construction organisations (Robinson *et al.* 2005).

Activities of building and enhancing a KM system

The main KM activities of this group of activities include analysis, design, implementation and evaluation of KM system. These activities work in a cyclic continuous process as shown in Figure 1. Implementation of KM within the organisation starts from data and information collection from such as interviews, questionnaires, previous project documents, regulations and literature.

The objectives of the analysis phase are to understand the real state of the organisation and identify the desirable and feasible options for improvements in work processes and performance. The aim is to identify vision of the organisation top management, roles and culture of the employees, and existing business processes and operations which should be understood and considered when designing the KM system.

Identification of the options available for improvements of KM system includes understanding the types and forms of knowledge available and necessary for the organisation to be collected and shared. An effective way to perform the analysis phase is to establish a KM team dedicated to this purpose to examine challenges and potential problems that the organisation may face in planning, building, maintaining and evaluating the KM system. The more the efforts spent during the analysis phase, the more the design alignment with business strategy and organisational objectives. It is important to perform a high quality analysis in the early stages of KM system development to reduce the cost and effort of re-designing and re-building inappropriate parts of an implemented KM system. Preparation of detailed and proper analysis is the most effective way to implement KM so that the full potential of the KM system can be exploited.

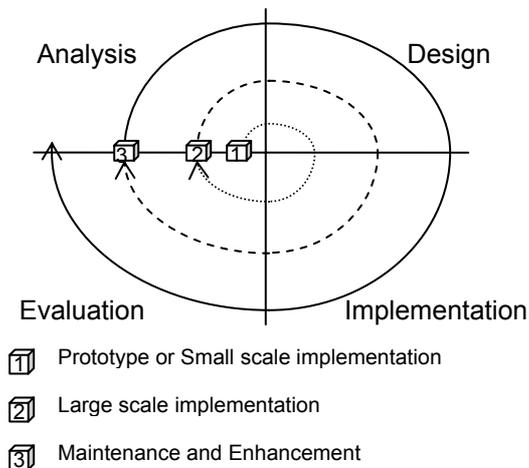


Figure 1: The cyclic process of Building and Enhancing KM systems

During analysis phase a set of needs and requirements (the output) is established, which are converted into appropriate design. The design phase requires transferring the organisation’s needs and requirements into technical specifications. In the design phase, the effective methods and tools to capture, create, categorise, disseminate, search and share knowledge should be determined. An effective action plan and a set of guidelines should be prepared to provide the step by step and details for KM implementation and evaluation, and show the relationship among KM initiatives. The system specification, the component of the architecture, the KM services and the interface details are also determined, which provides appropriate platform to deal with the organisation’s requirements. The design phase is very important for the organisations that intend to implement the KM system in order to avoid implementation errors and gain other benefits in terms of time, cost and effort, by providing directions on the KM procedures and specific details on how those procedures should be accomplished.

At the implementation phase, the design is transformed into the form that will be used by end users. This phase is the actual application of the plans that are made in the previous phases. Installing the technical part of a KM system is not enough to ensure the effective use. Employees should be motivated and encouraged to use the KM system, and roles should be identified and embedded in the work procedures of employees. Providing KM roles and appointing KM team and/or knowledge workers are an effective way to ensure capturing the required knowledge and providing the support and training for other employees.

In the evaluation phase the effect of the KM system on the performance of the organisation needs to be monitored. Data and information of projects can be used to compare the projects performance before and after applying the KM system. Furthermore, monitoring the KM system is important to ensure that the system is functioning according to the required design specifications and plans.

As shown in Figure 1, analysis, design, implementation and evaluation of KM system are a continuous process where the first iteration related to the implementation of a prototype of a small scale implementation of the KM system. The feedback from the evaluation of the prototype provides valuable information to modify the design of the system and start a wide range implementation of the KM system. Feedback from the users of the implemented KM system provides information for continuous improvements through the implementation of new KM parts, and enhancements and maintenance of the existing parts.

Some of these activities can be outsourced (e.g. purchase a KM software package that can be directly installed and/or design and build parts of a KM system by a specialized software companies). But it is recommended in that case to keep the design and implementation procedures under the supervision of the organisation people to ensure the alignment of the KM system with the special characteristics and procedures of the organisation.

Activities of applying and using the implemented KM system

The main KM activities of this group include knowledge creation, knowledge capturing, knowledge sharing and knowledge re-using.

Knowledge creation

The ability of people to create knowledge in an organisation is a critical success factor and has a major impact on projects outcomes and the organisational competitive advantage. Knowledge creation can be seen as the process of converting the knowledge embedded in organisation people, through planning, communications and problem solving, into a new form resulted from new combinations of experiences (Puddicombe 2006). Knowledge creation requires active interaction among employees to combine individuals existing tacit and explicit knowledge in order to refine current activities and explore new possibilities (Kodama 2006). It has been found that the main incentives for knowledge creation in the construction industry are the need to solve problems, innovate and manage changes (Egbu *et al.* 2004). The main sources that individuals depend on to create and produce new knowledge in addition to their own experiences and ideas are repositories, organisational processes and procedures, knowledge workers and/or knowledge teams, communities of practice, project teams and other individuals (Egbu *et al.* 2004).

Nonaka and Takeuchi (1995) suggest that knowledge created through continuous interactions between tacit and explicit knowledge to form four modes presented in the SECI (Socialization, Externalization, Internalization and Combination) model as shown in Figure 2. The spiral presents the continuous movement between different modes of knowledge creation and the increase in the spiral radius shows the movement and diffusion of knowledge through organizational levels. Socialization is to share experiences or tacit knowledge through direct contact among individuals. Through socialisation, an engineer can learn from an expert or senior engineer the tacit secrets of solving a problem in the construction projects (tacit to tacit). Externalization is to transform tacit knowledge to explicit knowledge to enable its communication. Through externalization, the engineer can translate the tacit

knowledge of the senior engineer into explicit format that is easy to understand and reapply (tacit to explicit). Combination of various elements of explicit knowledge is the third form of knowledge creation. Through combination, the explicit knowledge combined with other knowledge becomes available for other employees (explicit to explicit). Finally, Internalization means that the explicit knowledge transformed into experiences through reapplying knowledge so that knowledge can be updated according to the new experiences gained. Through internalization, explicit knowledge reapplied by other engineers, and users can produce new experiences and tacit knowledge (explicit to tacit). This new tacit knowledge can be shared among individuals through direct contacts (Socialization) to start a new iteration of the continuous spiral.

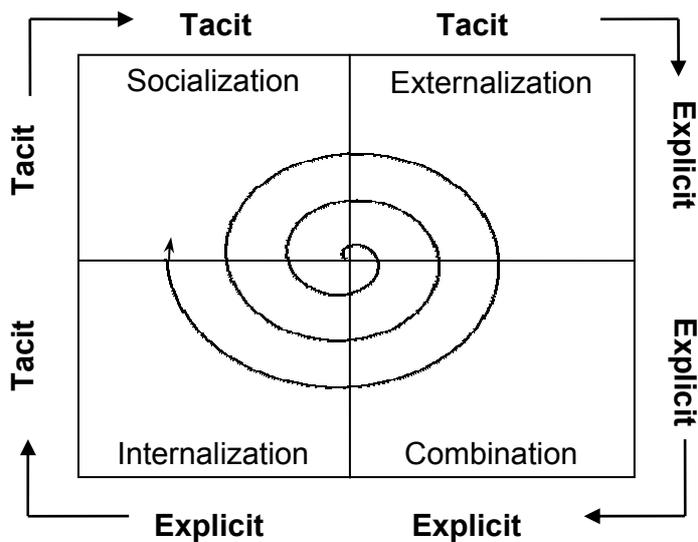


Figure 2: The SECI model (Nonaka and Takeuchi, 1995)

Knowledge Capturing

Most KM literature classifies knowledge within an organisation into two categories, i.e. explicit knowledge and tacit knowledge. Explicit knowledge can be expressed in formal, systematic language and shared in the form of data, scientific formulae, specifications, manuals and such like. Tacit knowledge is highly personal and hard to formalise. It includes subjective insights, intuitions and hunches (Nonaka *et al.*, 2007). Explicit knowledge is easy to be captured, retrieved, shared and used because it can be expressed in words and numbers that can be managed more easily. Tacit knowledge is personal and exists in the individuals' heads and memory in the form of experiences and know-how that is not easy to be shared and managed. However, tacit knowledge can be captured, mobilized and turned into explicit knowledge, which would be accessible to others in the organisation and enable the organisation to progress rather than have its members having to relearn from the same stage all the time (Gore and Gore, 1999).

Knowledge Sharing

During the lifecycle of construction projects a large volume of tacit knowledge is generated. With the changes of construction projects such the complexity of projects and construction technology, the need of tacit knowledge sharing becomes important, but, unfortunately, most construction organisations have not always been successful in collecting and sharing tacit knowledge (Carrillo *et al.*, 2004; Woo *et al.*, 2004). It can be essential for the KM system to capture and store knowledge in repositories, but

since tacit knowledge is hard to formalize, it is very important to share tacit knowledge by connecting people through collaborative tools such as e-mail systems and Groupware. These tools aim to facilitate the exchange of tacit knowledge rather than storing it into repositories. Successful KM systems provide details of the organisation people such as contact details, domain experiences, skills and qualifications, in order to facilitate finding people who can provide the desired support in problem solving and decision making processes.

Knowledge Re-using

The KM system should address the knowledge requirements of end-users and support their existing practices while guarantee security and confidentiality. Successful KM systems provide the ability to easily search and find desired knowledge. KM systems have to be designed to be available for people within the organisation with a key-word access process that defines the authority level for each user. In a certain level of authority, other users from outside the organisation are allowed to access and use the KM system in order to support the organisation relation to customers, suppliers and partners. In accordance with their authority level, end-users can update knowledge from the knowledge base by adding details, comments or relevant experiences, and removing invalid and unnecessary knowledge.

Knowledge collected by employees of the organisation needs to be approved before making it valid and available for users of the KM system. Knowledge added to KM system by employees needs to be reviewed, edited and adapted in the formats that are acceptable by the system. The knowledge also needs to be classified in order to facilitate knowledge searching and reusing function. Descriptions, details, photos and videos can be attached to the contents to help better understanding and reusing the knowledge. Referring to the knowledge sources and other related knowledge is an effective technique that facilitates a comprehensive understanding of the knowledge contents. Knowledge approval is about all the activities included in transforming knowledge content from non-approved invalid knowledge to knowledge content valid and available for selected users or all users of the KM system. Knowledge approval processes are continuous. It involves a continuous checking and testing for the knowledge contents so as to remove the outdated contents from the KM system and add new contents to the KM system. The continuous activities of knowledge approval can show the organisation demand to collect new shapes of important knowledge that does not exist in the system. This work with the feedback collection from end-users and the system evaluation as discussed earlier in this paper to motivate to new improvements and enhancement of the existing system.

Information security and privacy should be considered when implementing and using knowledge systems. Egbu (2004) encouraged companies to make balance between openness and protection of their knowledge systems. Too much openness may threaten the organisation competitive advantage, while too much protection may negatively affect the innovation process and encourage bureaucracy and hierarchy in the organisation.

CASE STUDY

A case study conducted in the UK construction industry has been carried out to evaluate and validate the proposed method of KM. In the case study, a contractor with many years of experience in highly sophisticated construction project has already implemented and applied a KM system to improve the company performance and customer relationship management. The contractor has found that applying and

implementing the KM system does not guarantee that people in the organisation are willing to use the system and share their knowledge with others. The contractor has decided to follow procedures and methods to enhance the KM system performance by embedding KM activities into the work procedures and processes. A set of objectives have been decided and the KM activities that support them have been chosen. Knowledge activities and roles have been appointed to the organisation employees as a part of their routine work activities. Roles and responsibilities of a KM team have been set up to provide support and encouragement to the employees to effectively use the KM system and share their knowledge with other employees. Other roles of the KM team include reviewing, editing and approving knowledge created and added by the organisation employees to make this knowledge available and valid for other users of the KM system and to remove the outdated knowledge content from the KM system.

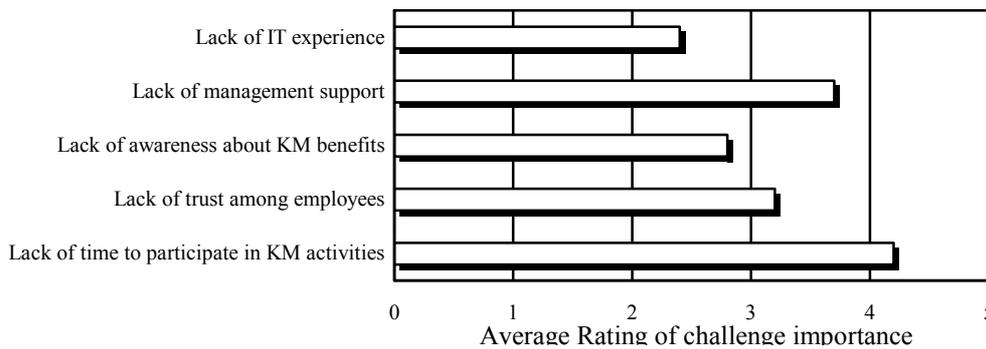


Figure 3: Evaluation of KM challenges

In order to evaluate the effect of applying the new KM method on the KM system performance, a questionnaire survey has been conducted among the organisation employees. The results of the questionnaires provide feedback from the system users about the KM system use and application challenges. The results of the questionnaires show that the new method has encouraged employees to use the KM system and to share their knowledge with others. The results show that 80% of the KM system end-users think that the new KM method help employees to use the KM system more efficiently and effectively. The other 20% are not sure if the new approach is useful for them to improve their use of the KM system. The main reason described by many respondents is that the process of implementing KM activities requires restructuring of the daily work processes. In the short term this may require more effort and time from the employees to learn new methods and procedures. The organisation can overcome this problem by increasing the awareness of employees about the future advantages of applying KM and providing appropriate support and training to reduce the time and effort required for employees to learn new procedures. Nevertheless it shows that the most significant factor negatively affect the use of KM system is that most of the employees feel they lack the time to participate in KM activities. Figure 3 shows how the survey respondents rate the challenges for KM application in the organisation, using five levels of rating scale, where 1 stands for least important and 5 stands for most important. The participants include 32 people of the KM system users from different departments and positions in the organisation - representing a 30% response rate.

CONCLUSIONS

Knowledge management has recently received a considerable attention in the construction industry. Most of the employees in construction organisations have

engineering job duties centred toward implementing construction projects, and many of these employees lack the required background and/or experience to participate in the process of managing the organisation knowledge. It is, therefore, very important to identify a set of activities for managing knowledge in the organisation, and make them part of the other job duties of the organisation employees. This paper presents the development of a new KM model that enhances the process of KM through embedding KM activities into the work activities of the employees in the construction organisations.

Although the adoption and application of KM models facilitate and encourage KM initiatives, the results from the questionnaire survey have showed that there is a need for more effort from the organisation management to enhance the employees' awareness about KM benefits, build trust among employees, provide more time to employees for sharing knowledge and learning, provide the required tools and technologies for KM and adopt a performance appraisal method that appreciates and rewards KM activities. The results have also showed that providing support and training programmes are very important to enhance the process of learning the new procedures and activities associated with the implementation of the new KM method.

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