Knowledge map(K-map) modeling for improving construction project performance with the integration of key construction project resources

KICEM

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Introduction

Knowledge, and its appropriate management, has been increasingly being recognized as a key strategic resource for successful projects and sustainable competitive advantage (Desouza and Evaristo, 2003; Astrid and Peter, 2005; Halawi et al., 2006). This shift has been captured by many academics and practitioners in terms of the knowledge economy (Drucker, 1993; Nonaka and Takeuchi, 1995; Halawi et al., 2006). Within this perspective, many companies are increasingly having interest in the potential benefits of KM and then, they are developing their strategies and capacities to effectively manage knowledge in a purposeful fashion (Nonaka et al., 2000; Bhatt, 2001; Maier, 2002). Davenport et al. (1996), Syed-Ikhsan and Rowland (2004) and Egbu et al. (2005), for example, have stressed that products and services in projects and businesses can be more successfully delivered with appropriate KM approaches which provide project members the right knowledge at the right time.

In the construction industry, projects are delivered by temporary project organizations made up different functional groupings, such as design part, management part and construction part (Cooke and Williams, 2004; Loosemore et al., 2006). This means that specific project-based knowledge is owned and used by each individual organization in the temporary project organizations where the specific project-based knowledge is transferred to the other parts to effectively perform projects to successfully deliver projects to clients (Maqsood et al., 2006; Raidén and Dainty, 2006). Within this perspective, potential benefits of KM have been championed to effectively improve project performance (Soliman and Spooner, 2000; Hoffman et al., 2005; Meroño-Cerdan et al., 2007).

However, in spite of the espoused value of KM, there are a number of problems and barriers in the KM area where the problems and barriers have eroded the actual benefits of KM in projects and organizations. This research foundation based on the KM problems and barriers in organizations has been identified in a variety of areas which are critical for successful KM: knowledge and KM strategy-based problems (Smith, 2004; Meroño-Cerdan et al., 2007); human resource-based problems (Thite, 2004; Stuckenschmidt et al., 2005); KM technology-based problems (Bennet and Tomblin, 2006; Foos et al., 2006); and, process-based problems (Kang et al., 2003; Plumley, 2003).

Particularly, it has been emphasized by few empirical knowledge researchers that the major problem is the effective integration of key project components and technologies for successful KM in projects and organizations (Anon, 2003; Astrid and Peter, 2005). From this perspective, K-maps have been promoted as a key process and means for integrating the key project components and technologies in projects and organizations.

The aim of this paper is to propose the K-mapping concept model and research hypotheses to successfully demonstrate the utilization of K-mapping as an approach to integrating key project resources and technologies for effective project performance improvement through knowledge transfer within and across construction project organizations.

This paper is presented as follows. First, a literature review and synthesis is discussed on the key characteristics of construction project organizations and K-maps. Second, a discussion and research questions about mapping knowledge with key construction resources and knowledge technologies are described. Third, K-mapping concept model and research hypotheses are reported. Finally, conclusions are offered.

Key characteristics of construction project organizations

The construction industry has been argued to be a project-based industry in which construction companies form temporary project organizations to perform and complete projects (Loosemore et al., 2006; Raidén and Dainty, 2006). Within this characteristic, four complementary perspectives are discussed: knowledge-based; construction actor-based; construction process-based; and, knowledge transfer technology-based view.

Knowledge and KM-based view

Value of knowledge has been emphasised as an intellectual capital because knowledge is a real asset of enterprises as it is successfully identified, captured, codified, transferred and used by people in projects and organisations. (Scarbrough, 2003; Halawi et al., 2006). A variety of types of knowledge have been argued as critical strategic resource for effective KM in projects and organizations: explicit and tacit knowledge (Gupta et al., 2000; Li and Gao, 2003); individual and organisational knowledge (O'leary, 1998; Li and Gao, 2003); process-based knowledge (Maier and Remus, 2002; Maier and Remus, 2003); workflow-based knowledge (Kang et al., 2003); human resource-based knowledge (Thite, 2004; Foos et al., 2006); and, project-based knowledge (Poell and Van-der-Krogt, 2003; Liu and Hsu, 2004).

Further, KM processes have been stressed for successful KM. This means that knowledge can be more effectively managed with processes and sub-processes such as knowledge-identification process, knowledge-classification process, knowledge-creation process, knowledge-codification process, knowledge-storage process, knowledge-sharing process, knowledge-use process (Tiwana, 2002; Robinson et al., 2005). Nonaka and Takeuchi (1995) proposed a knowledge creation process model which consists of four variables: socialisation; externalisation; internalisation; and, combination because it needs to understand the dynamic nature of knowledge creation and insisted that knowledge is created and converted in the dynamic and complicated contexts.

Construction project is also a dynamic project-based context where project-based knowledge is created, used, stored and transferred by construction actors and their teams within and across project organisations (Carrillo et al., 2002; Egbu, 2006). The construction industry has recently focused on the fact that the efficient KM leads to the creation of competitiveness and value in organisations, improving project performance through effective project-based knowledge transfer (Kazi, 2005; Maqsood et al., 2006).

Construction actor-based view

All construction project organisations which tend to be different produce different buildings, but they often share similar fundamental construction resources, such as actors, materials, procedures, facilities, methods, equipments and sites (Cooke and Williams, 2004). Construction actors have been particularly being recognised as a necessary component to successfully deliver projects to clients (Hore et al., 1997). Further, construction actors have and use their own basic abilities and specific knowledge, such as

know-how, insights, skills, experiences and qualifications and often share and transfer to the others within and across construction project organisations (Harrison, 1996; Loosemore et al., 2006).

There are a number of construction actors who are taken part in the different construction parts, such as management system part, design part, construction part, structural engineering part and quantity surveying part (Gidado, 1996; Loosemore et al., 2006). This means that multitudes of construction actors are engaged and deployed in project organisations where they always have communications to transfer knowledge with the others (Fryer, 2004; Griffith and Watson, 2004). Within this context, poor communications between construction actors have been emphasised as a critical barrier to successfully perform project because of language, knowledge and skills belonged in their own different parts (Daghfous, 2004; Gorelick, 2005). Therefore, it can be insisted that construction actors are a necessary resource to successfully complete construction projects, as a construction project performer, construction project knowledge owner, knowledge user and knowledge manager.

Construction process-based view

Processes can be defined as a designed sequence of operations, possibly taking up time, space, expertise and other resource, which produces some outcomes (Feynman et al., 1963; Lindsay et al., 2003). This sequence has been seen as a value chain or supply chain where each step adds value to the proceeding steps (Czuchry and Yasin, 2003). Projects which consist of several phases and many processes are accomplished with performing the phases and processes (Lindsay et al., 2003; Jugdev and Mathur, 2006).

Construction project has also been recognised being process-based (Kamara et al., 2000; Sarshar et al., 2004). Tzortzopoulos et al. (2005) observed that different project process models have been developed to improve effectiveness and efficiency of design and construction activities due to the needs and requirements for improving project performance.

Construction project, for example, is decomposed into several phases by the general outline: market demand or perceived needs; conceptual planning and feasibility study; design and engineering, procurement and construction; start-up for occupancy, operation and maintenance; and, disposal of facility (Walker, 2002; Griffith and Watson, 2004). Furthermore, several management systems, such as cost management, time management, risk management, value management and quality management which basically have its sub-processes, are used to effectively manage projects in projects and organisations (Fisk, 2003; Griffith and Watson, 2004).

It has been confirmed that construction project is a conglomeration of processes which can be insisted as an essential unit to effectively manage and implement construction projects.

Knowledge transfer technology-based view

Technology is a key strategy factor for effectively producing products and services in projects and organizations (Bye, 1995; Abecker et al., 1998). Sexton and Barrett (2004) agreed that the term "technology" is widely used as the machines, tools, procedures and systems, work routines used to transform material and information inputs (people, capital, land and raw materials) into outputs (products and services). In the KM area, technologies have been being recognized as a key resource for successful KM, particularly are effective and convenient tools to effectively transfer knowledge within and across projects and organizations (Turban et al., 2002; Foos et al., 2006).

Nevertheless, a few empirical researchers and practitioners have insisted that technologies have not been fully sought for effective knowledge transfer in projects and organizations. Within this perspective, it has been stressed that the limited abilities of storing and processing in human brain can be overcome by technologies which can

persistently provide competitiveness over competing organizations (Turban et al., 2002; Kazi, 2005). The construction industry is also recognizing the importance and need of technologies for effective project-based KM in projects and organizations (Bouchlaghem and Whyte, 2004; Syed-Ikhsan and Rowland, 2004). However, KM technologies are still embryonic in the construction industry (Egbu et al., 2005; Robinson et al., 2005).

Within this context, it has been argued that some knowledge transfer technologies such as mobile technology system, information and communication technology (ICT) are effective tools for knowledge transfer within and across construction project organizations (Robinson et al., 2005; Raidén and Dainty, 2006).

Key characteristics of K-maps

Definition and potential benefits of K-maps

KM holds potential to generate, capture, codify, transfer, share and use to leverage managing knowledge to maximize productivity and competitiveness of enterprises (Rollet, 2003; Sun and Scott, 2005; Halawi et al., 2006). However, KM has many barriers and problems concerning its development and operation, especially integrating key project resources and technologies (Liu and Hsu, 2004; Driessen et al., 2007). Within this context, K-maps have been promoted as a key solution for effectively integrating the key project resources (Eppler, 2001, Henao-Cálad and Arango-Fonnegra, 2007).

It has been insisted that K-mapping is a process, method and tool to effectively visualize the sources, flows, constraints and terminations of tacit and explicit knowledge and also, helps to understand the interactions and relationships between knowledge stores and dynamics in projects and organizations (White, 2002; Driessen et al., 2007). Further, Tiwana (2002) confirmed that K-maps can be used to develop conceptual maps as hierarchies or nets and support knowledge scripting and profiling and provide highly developed procedures to elicit and document conceptual maps from knowledge workers, such as experts. Within this perspective, Kautz and Thaysen (2001) and Speel et al. (2000) emphasized that K-maps must be considered as a key prerequisite and cornerstone for successful KM.

Key purposes and principles of K-mapping

K-mapping is a set of tools and processes which identify and visualise knowledge resources and flows in projects and organisations (Gomez et al., 2000; Kang et al.; 2003, Plumley, 2003). The key objective of K-mapping is to provide people right knowledge at the right time in projects and organizations. However, it must be considered that there are a number of disadvantages and risks, using K-maps (White, 2002; Liu and Hsu, 2004). One obvious drawback is related to possible damage caused by low-quality K-maps, for example in terms of time, misinterpretation of the context or simply the reliance on outdated or incorrect data and information (Eppler, 2001). The key purposes and principles of K-mapping are discussed as follows.

Key purposes of K-mapping are

(1) to generate knowledge and ideas,
(2) to visualise complex structure,
(3) to communicate complex knowledge,
(4) to aid individual and organisational learning by explicitly integrating new and old knowledge,
(5) to assess understanding or diagnose misunderstanding, and
(6) to easily access to relevant knowledge.

Key principles of K-mapping are

(1) to understand that knowledge is transient,
(2) to explain the sanction, establish boundaries and respect personal disclosures,
(3) to recognise and locate knowledge in a wide variety of forms; tacit and explicit, formal and informal, codified and personalised, internal and external and short life

cycle and permanent,

(4) to locate knowledge in processes, relationships, policies, people, documents, conversations, links, context, suppliers, competitors and customers, and

(5) to be aware of organizational level and aggregation, cultural issues and reward systems, timeliness, sharing and value, legal process and protection.

Types of K-map

There are a variety of types of K-maps in the K-mapping area. In the sector, K-mapping can be developed according to different characteristics of projects and organizations, such as objective, type, shape, size and process. The types of K-maps are described below:

(1) Procedural K-map called "process-based K-map" is based on processes and effective to visualize flows and resources of knowledge (Kang et al., 2003);

(2) Conceptual K-map which is for content management of knowledge is used as a method of hierarchically organizing and classifying contents of knowledge (Caldwell, 2002);

(3) Competency K-map which is employed to document the skills, techniques, positions, job experience and even career path of individuals, such as architects and engineering designers, to list and manage competency profile (Bish, 1999); and,

(4) The other key K-maps, for example wed-based K-map, strategy-based K-map and cognitive knowledge map, have been proposed. Particularly social network K-map has been stressed for effectively managing social networks and showing the networks of knowledge and the patterns of relationships between organizations, its members and other social entities (Plumley, 2003).

Discussion

Construction projects are always implemented and completed by many construction actors who are being skilled and functioned. Furthermore, they have and use specific own knowledge and skills to successfully perform projects and businesses (Jashapara, 2003; Thomas and Allen, 2006). From this perspective, construction actors have been recognized as critical project performers, knowledge owners and users within projects and organizations.

As has been mentioned above, construction projects consists of many processes which have been confirmed as the fundamental unit of project performance within construction project organizations (Kamara et al., 2000; Sarshar et al., 2004). Therefore, it can be said that construction processes are a key and necessary component for successful project performance and completion. Further, in the construction industry, it has been insisted that project-based knowledge is transferred between actors and their teams which is important to successfully perform projects (Albino et al., 2004; Foos et al., 2006). Within this context, technologies have been observed as critical tools to more effectively transfer knowledge within and across construction project organizations (Egbu et al., 2005; Robinson et al., 2005).

From this perspective, Kazi (2005) insisted that people, process and technology must be considered as the core components to transfer and study existing knowledge within and across construction project organizations before and after learning (Fig.1). As has been shown in Fig. 1, project-based knowledge learning can be effectively enhanced through systematic knowledge transfer technologies which can effectively improve the ability and skills of construction actors within construction project organizations. Within this context, construction project performance is ultimately improved.

From theses perspectives, it can be said that construction actors, construction processes and knowledge transfer technologies should be considered and adopted as the core K-mapping components for effective knowledge transfer improvement within and across construction project organizations.

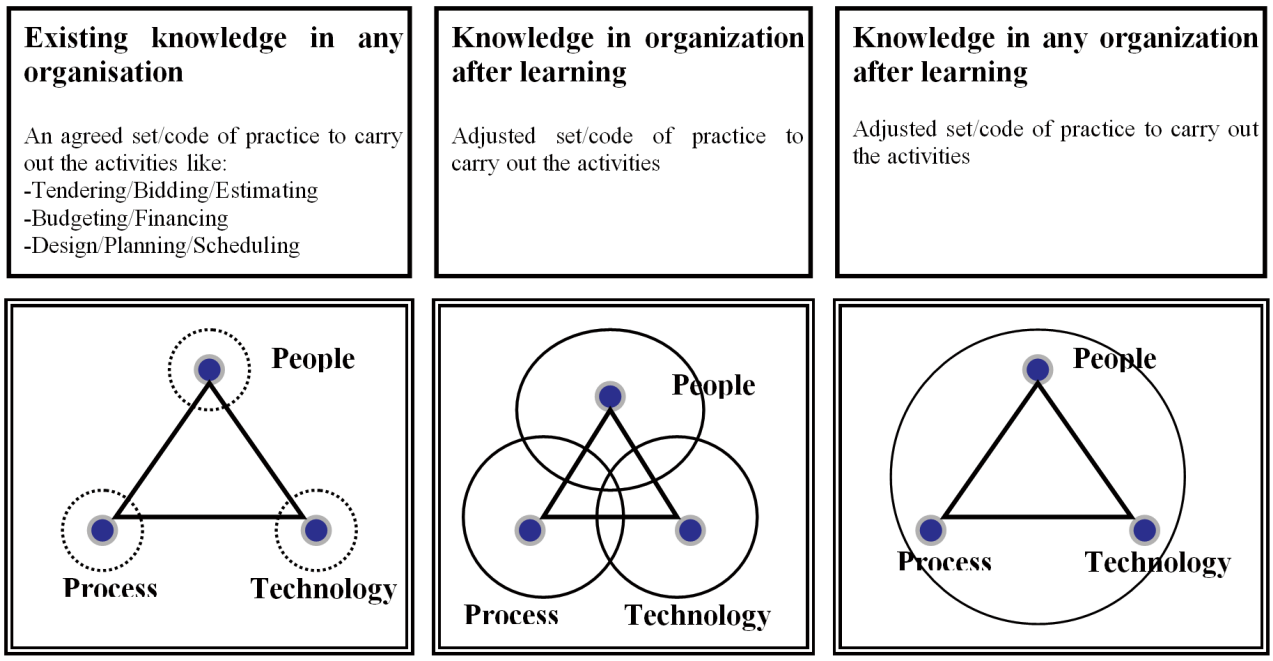

Fig.1 Knowledge transfer within and across construction project organizations after learning

Research questions

As a result of a literature review and synthesis, it has been confirmed that K-mapping offers the potential to be a principal component of KM. Tiwana (2002), White (2002) and Hellstrom (2004), for example, agreed that K-maps can be used to effectively foster generating, capturing, transferring, codifying, storing and using knowledge in projects and organizations.

Furthermore, K-mapping has been discussed as a vital tool and process to effectively integrate project resources and technologies (Driessen et al., 2007), but K-mapping may be difficult to be applied to construction project organizations directly because key characteristics of construction project organizations have not been considered and deliberated.

Therefore, it can be confirmed that a various number of the natures of construction project organizations must be explored and considered in order to successfully develop an appropriate K-map for construction project organizations. Within this perspective, the following research questions which are interrelated each other are proposed to successfully lead this study by the researcher.

■ Research questions

Q1. Is KM an appropriate aspiration for effective project performance and project-based learning in construction project organizations?

Q2. Is K-mapping an appropriate tool and process for successful KM, improving project performance and enhancing project-based learning in construction project organisations?

Q3. In construction project organizations, how can an appropriate K-map be developed for effective project performance and learning?

Q3-1. What types of construction project resources and knowledge transfer technologies should be part of an effective K-mapping approach?

Q3-2. How should the K-map components be integrated?

In order to support and address the above research questions, a systematic and graphic concept model for effective project performance improvement through knowledge transfer within and across construction project organizations is proposed and discussed through a literature review and synthesis in next section. The model could be utilized to more effectively understand and improve practice and particularly establish research hypotheses.

Key research results

This section presents the key results gained from a literature review and synthesis and is structured as follows: a K-mapping concept model and key variables are described (Fig.2); and, research hypotheses are derived from.

K-mapping concept model

As a key solution for successful KM it has been argued that K-mapping is necessary for successfully building and progressing KM and can provide knowledge users a road map of where knowledge is located, who has the knowledge and where the knowledge flow. Fig.2 is a K-map concept model proposed in this study. The key variables and their interactions of K-mapping concept model are defined through a literature review and synthesis.

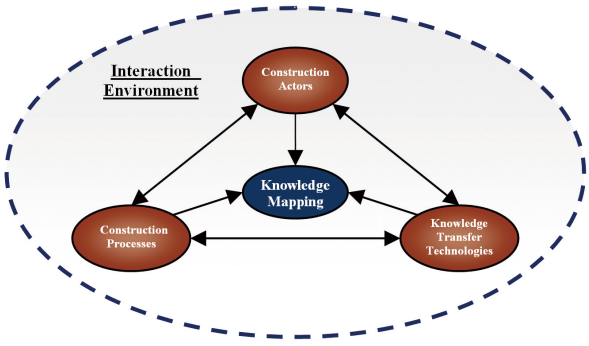

Fig.2 K-mapping concept model

(1) Interaction environment is taken to be synonymous with temporary construction project organizations which require project-based knowledge to effectively perform projects where knowledge transfer technologies are used for effective knowledge transfer between actors and their teams to deliver successful projects to clients.

(2) Construction actors are a key project component, as key project performers, knowledge owners and users within construction project organizations. From this perspective, construction actors can be considered as a critical part of K-mapping approach, classifying into strategic construction actors and operational construction actors.

(3) Construction processes are a key construction project component, as a fundamental unit for project performance within construction project organizations. Within this context, construction processes can be used as a critical part of K-mapping approach, classifying into general management system-based processes and construction work-based processes.

(4) Knowledge transfer technologies are effective and useful tools for knowledge transfer between organization members and their teams within construction project organizations. In doing so, construction project performance can be effectively improved; and, capability and knowledge of organization members are improved. Therefore, knowledge transfer technologies can be considered as a critical part of K-mapping approach, classifying into both explicit knowledge transfer technologies and tacit knowledge transfer technologies.

Research hypotheses

The aim of this study is to investigate the utility of K-mapping as an approach in order to effectively improve corporate and project performance through project-based knowledge transfer between construction actors and their teams within and across construction project organizations. This was pursued through a number of research questions. The research questions and hypotheses are as follows. The research hypotheses for this study are as follows.

■ Research hypotheses

Meta-hypothesis:

K-mapping is more likely to promote effective project performance and learning within temporary construction project organisations when the construction actors, construction processes and knowledge transfer technologies are effectively integrated – compared to K-maps developed without the appropriate development and integration of construction actors, construction processes and knowledge transfer technologies.

1. Project-based resources

Hypothesis 1-1: Construction actors

K-mapping is more likely to be successful when construction actors who are critical and necessary to successfully perform construction projects are effectively integrated into the K-mapping approach.

Hypothesis 1-2: Knowledge transfer technologies

K-mapping is more likely to be successful when the knowledge transfer technologies integrated as a key K-mapping component.

Hypothesis 1-3: Construction processes

K-mapping is more likely to be successful when construction processes are integrated into the K-mapping approach.

2. The interaction between the K-map model components

Hypothesis 2-1: Construction actors and knowledge transfer technologies

Knowledge mapping which integrates construction actors and knowledge transfer technologies will improve project performance and learning within temporary construction project organisations – compared to K-mapping approach which does not integrate these components.

Hypothesis 2-2: Construction processes and construction actors

K-mapping which integrates construction processes and construction actors will improve project performance and learning within temporary construction project organisations – compared to K-mapping approach which does not integrate these components.

Hypothesis 2-3: Knowledge transfer technologies and construction processes

K-mapping which integrates knowledge transfer technologies and construction processes will improve project performance and learning within temporary construction project organizations – compared to K-mapping approach which does not integrate these components

Conclusion

There are still a lot of emphasis and barriers in K-mapping area. Attempts to successfully develop an appropriate K-mapping for corporate and project performance should be appreciated. This means that construction project organisations need to appreciate the implications of K-mapping to effectively identify, adopt, consider and integrate project resources and technologies, and dynamic capabilities for successful K-mapping. These implications of K-mapping are described below.

Strategy-based

K-mapping is a critical process for successful KM, but must be driven by a correspondent KM strategy. Within this perspective, K-mapping can be approached by appropriate KM strategies which have been more recognised as a previous and prior process and question than K-mapping (Hansen et al., 1999, White, 2002, Smith, 2004). Therefore, K-mapping in this study should be aligned to, and effectively based on strategies formulated

within projects and organisations.

Human resource-focused

A number of human resources are engaged and deployed to produce an appropriate product (such as designers, managers, engineers, craftsmen, inspectors and planners) in projects and organisations. Further, it has been argued that human resource-focused views must be strategically considered to successfully produce and develop designs, systems, models or equipments in projects and organisations (Igbaria and Toraskar, 1992, Gottschalk and Khandelwal, 2003, Singare et al., 2005). In the research findings, it has been confirmed that K-mapping should be focused on construction actors whether it is succeed or not because if a K-map is developed without considering of construction actors the K-mapping will be failed or a big cause of poor KM. Further, it was insisted that construction actors must be considered a necessary K-mapping component (as key project performers, knowledge owners and knowledge users) within construction project organizations.

Process-focused

Projects consist of several phases and a number of processes. The research findings identified that construction processes are a basic and critical unit for effective project performance. Furthermore, it was confirmed that construction processes should be considered for successful K-mapping in which the processes must be integrated, classifying into different types of processes: generic management system-based processes; and, specific construction work-based processes.

Technology-focused

Technologies provide a number of benefits in developing models, systems, producing products and designing, particularly managing project-based knowledge in the industry. This study has been focused the technologies based on the KM, particularly in knowledge transfer technologies. Within this regard, the research findings identified that knowledge transfer technologies are very effective and useful tools for knowledge transfer for successful project performance. Based on effectiveness and efficiency, it was confirmed that knowledge transfer technologies must be considered as a critical component for successful K-mapping to improve corporate and project performance through project-based knowledge transfer between construction actors and their teams within and across construction project organisations. Therefore, knowledge transfer technologies should be used as a key K-mapping component; and, in doing so, the K-mapping will be beneficial in transferring project-based knowledge.

Future research issues

In this study, research methodology would be discussed and adopted particularly for performing case study which could provide the findings based on the exploration of a large-sized construction consulting company. Future studies can also be implemented to explore the relevance of theory in small and medium-sized construction consulting companies.

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