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Using IT to Implement a Multifaceted Organizational Learning Model to Enhance Knowledge Management for the Construction Industry

Cynthia Wang and Shankar Sankaran

School of the Built Environment, Faculty of Design Architecture and Building
University of Technology Sydney
1 Broadway, Ultimo, NSW 2007 Australia

Abstract: Although the concepts of organizational learning (OL) and knowledge management (KM) have been around for many years, in-depth research on using information technologies (IT) to support KM and OL in construction is still in the early stage. This paper briefly reviews the concepts related to OL, KM and their relationship. Based on the fact that the ultimate goal of KM and OL are the same, a multifaceted OL model from the literature is adopted to establish IT-enabled KM strategies for construction organizations. The multifaceted model consists of five organizational facets — contextual, policy, psychological, cultural and structural. The five facets are discussed respectively, and how appropriate IT tools could be used to support each of these facets is presented. The paper concludes that technology advancement plays an important role in KM practice, and the proposed IT-based KM strategy should be incorporated with an organization's existing structure to add value to any existing KM practice rather than replace it, and IT usage should be built into a construction organization's daily business process.

Key words: knowledge management; organizational learning; information technology; construction industry

1 Research Background

Although the concept of organizational learning (OL) started to emerge since 1960s, it only gained momentum in organizational literature towards the end of the 1980s.[1-2] The research on knowledge management (KM) started later, but developed rapidly since the 1980s.[3-5] Managers realized the importance of OL for a growing organization; however, the progress of using this concept to push organizations to become learning organizations has been slow. This lack of progress has been explained by the fact that while the concept looked good in theory it lacked clear guidelines for practice,[6] and managers were more interested to know how they could implement OL rather than get involved in theoretical debates. But the idea of OL has lived on and seems to have found new life with the recent emphasis on KM.

It is well known that the construction industry is a knowledge-intensive industry.[7] Because of the nature of the industry (fragmented and project-based), OL and KM are particularly important to maintain an organization's competitiveness. Since the late 1990s, the idea of KM and the many ways it can benefit the construction industry are being increasingly recognized and the importance of KM for the construction industry has been outlined and summarized in many research publications.[8-11] According to some scholars,[12] KM technologies depend heavily on Information and Communication Technology (ICT), and ICT is the main platform for implementation. KM technologies consume about one-third of the time, effort and money that are required for a KM system and the other two-thirds are mainly related to people and organizational culture.[12]

This paper combines IT implementation practice with a theoretical OL model, and attempts to develop

practical guide to enhance KM for construction the industry.

2 Knowledge Management and Organizational Learning

What is knowledge? Can knowledge be stored outside the human mind? More than 30 years ago, it was pointed out that, 'knowledge resides in the user and not in the collection',[13] which implies that knowledge cannot be stored in documents, or computer databases. This view is still shared by some researchers. However, a more widely accepted view is that knowledge can be categorized into explicit and tacit, and while explicit knowledge can be codified and documented, tacit knowledge cannot be and only resides in the human mind. The codified or documented knowledge is sometimes referred to as information.

These concepts of knowledge are at the individual level. For an organization, it is generally agreed that its knowledge resides in the minds of the people that it is made up of. However, it is important to set up an organizational memory system that enables the integration of dispersed and unstructured organizational knowledge.[14] Like individual knowledge, organizational knowledge can be similarly categorized into organizational explicit knowledge and organizational tacit knowledge. Organizational explicit knowledge covers policy, regulations, rules, *etc.*, and organizational tacit knowledge covers an organization's daily routines, culture, *etc.*, which are probably known by all or most of the staff, but are not always documented. The organizational tacit knowledge domain includes the tacit knowledge domain of individual staff, and is capable of producing outcomes which cannot be achieved by individual staff. Some organizational tacit knowledge can be converted to explicit knowledge and documented and, for the purpose of KM, this conversion should be done soon after the new knowledge is generated, as knowledge in explicit format is easier to manage than its tacit counterpart. Figure 1 shows the relationship of organizational tacit and explicit knowledge discussed above.

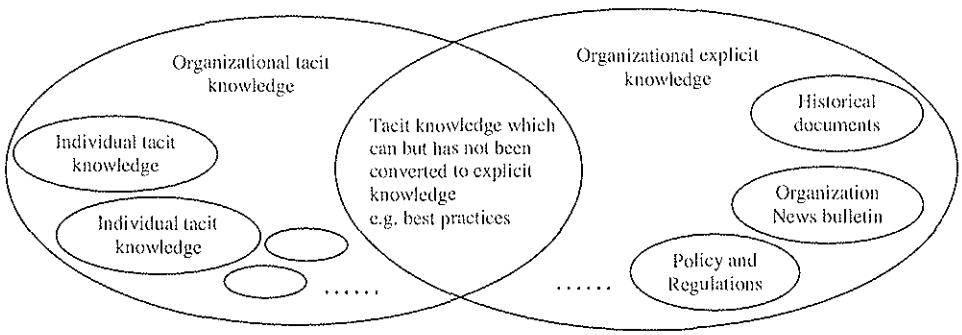

Figure 1. Organizational Knowledge Domain

As tacit knowledge is in people's heads, KM involves managing people and enhancing individual learning. The goals of KM and OL are ultimately the same. While large organizations focus more on long-term benefit, smaller organizations are eager to see short-term outcomes.

To achieve short-term outcomes, an organization may set very specific, task-related goals for KM, such as faster time to deliver project outcomes, or to solve a particular problem occurring in one project, *etc.* In these situations, the first step of KM is to identify the key areas of focus, and then to establish specific goals. Appropriate technologies can then be used to support the task and achieve the goal.

To gain long-term benefit of KM, an organization aims to improve efficiency and productivity, and stay on top of the market competition. For example, at Arup, they found that the size of the firm had made it increasingly difficult to 'know who knew' the answer to a particular problem. In response, a web-based knowledge sharing tool was developed that now allows Arup to locate experts among its 7000 staff in a matter of seconds. Every employee can quickly and easily share their interests and expertise with the rest of the organization.[15]

Only after the goal of KM is set, the activities of KM can be planned and justified. This paper uses an established multifaceted OL model to help set up KM implementation strategies. As this multifaceted model covers all the aspects that KM needs to consider, proposals on how to meet both short-term

and long-term goals can be made. As stated previously, information technology plays an important role in KM implementation, and its use in all the facets of the multifaceted model will be discussed.

3 The Multifaceted Model of Organizational Learning

It is well known that both KM and OL are complex phenomena and need to be looked at from many different perspectives, *e.g.*, contextual, personal, culture, *etc*. Such a multifaceted model of OL has been proposed in the literature,[16] and is illustrated in Figure 2.

There are five organizational facets (contextual, leadership and policy, psychological, cultural and structural) in this model. The elements of the various facets shown in the model are discussed along with the KM implementation strategy in the following sections.

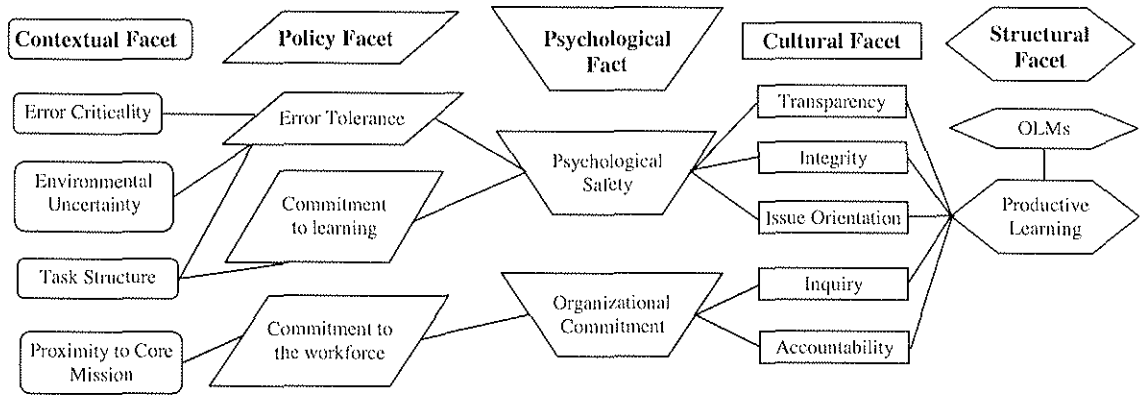

Figure 2. Facets of Organizational Learning[16]

4 The structural facet

The structural facet of the multifaceted model looks at structures that help learning through the collection, analysis, dissemination and application of information and knowledge. These structures are called organizational learning mechanisms (OLMs),[16] and consist of two types – integrated and non-integrated. Integrated OLMs are those where members of an organization who process the information also apply this to new knowledge. Non-integrated OLMs are where the learning is carried out by different individuals. Examples of integrated OLMs are after-action reviews (AARs), communities of practice (CoPs), debriefing, peer-assists, post-project assessments. Examples of non-integrated and designated OLMs are strategic planning, auditing and quality assurance processes.

Although not explicitly stated, there are two types of information systems developed in the construction industry facilitating the above two structures.

Web-based project management (PM) systems are becoming more and more widely used in the construction industry. Two types of web-based PM systems can be found in the market for the construction industry. One is project-based, usually offered by a third-party company, and construction organizations pay for the service for the period of the project. Once the project is finished, the data in the system can be archived on CD disks or in other format and handed over to the construction companies, and the computer system's service finishes. This type of system facilitates knowledge and information transfer during the project period, mainly for the project participants. It fits into the integrated OLM. Examples of this type of system are Aconex, Project Centre, *etc*.

The second type of web-based PM system is organization based and it is usually adopted by large construction organizations, like Bovis Lend Lease. The system is maintained and owned by the construction company, and the company will enforce all its sub-contractors to use the system too. Information from individual projects can be integrated into other projects run by the company,

and the decision maker of the company can use the integrated project data for strategic planning, auditing and quality assurance processes. This type of system facilitates knowledge and information transfer both during and after the project period. Therefore, it facilitates both integrated OLM and non-integrated OLM. Examples are Bovis Lend Lease's Project Web, and Prolog Manager.

The OLMs, the facilitating computer systems and the corresponding KM functions are summarized in Table 1.

Table 1 Computer Systems to Support KM Functions and OLMs

Types of OLMs	KM functions	Types of Supporting Computer Systems	Examples of Commercial Software Systems
Integrated	Share, package and store knowledge (Mainly for project participants)	Project based information management systems	Project Centre; Aconex
Non-integrated	Reuse and revalidate knowledge (For both project participants and non-participants)	Organizational based information management systems	Prolog Manager; BLL's Project Web

5 Cultural facet

Traditionally, the construction industry is slow in picking up information technology. Due to the nature of the industry, construction professionals work on site without computer access. With regards to knowledge management, the professional culture is more interested in problem solving than knowledge sharing. This is due to the fact that a construction project is subject to many unexpected situations (*e.g.* bad weather conditions) and managers have to make quick decisions on site. The nature of the industry is such that construction professionals do not usually have time to go to a computer system to seek information and knowledge. Therefore, it is important to have simple-to-use systems and build the use of technology into daily process.

At the management level, the idea of KM for an organization is usually well supported. However, how to implement it into daily practice is a much more challenging issue. The advancement of information technologies has changed the way people live, work and entertain themselves; it has equally changed the way that construction professionals work.

The cultural facet introduces several complexities due to issues with organizational, professional and international culture difference.

The following table shows how IT tools contribute to KM and the change of culture in daily construction activities.

Table 2 Technologies to Support KM Levels

KM Strategies	Supporting Technologies	Cultural Effect
Awareness	Email alert. SMS messages. Internet-based news items.	Supporting People
Information and knowledge sharing	Email, web-based document management system and services	Supporting People and Project
Package and assemble knowledge	Information-refinery tools; push technology; customized discussion groups	Supporting People, Project and Organization
Reuse and revalidate knowledge	Customer-support knowledge bases; project databases and communities of practice	Supporting People, Project, Organization, and sometimes the whole industry
Create and apply new knowledge	Collaboration support tools; workspaces; groupware; rationale capture tools; externalisation tools	Support People, Project, the Organization and the Industry or even has cross-industry value

6 Psychological facet

The psychological facet[16] to support productive organizational learning is based on the degree of psychological safety, *i.e.* engendering trust and enabling people to face the risks of inquiry, transparency and accountability, and a commitment to the organization to counteract the dysfunctional effects of politics and game playing on learning.

At first glance, it looks like computer tools cannot help much in this respect. However, people can be surprised by how much the right IT tool can help them psychologically.

People usually are reluctant to share knowledge freely, as they believe "knowledge is power"; that it is the knowledge they have that gives them professional competitiveness. Therefore, individuals can only be encouraged to share knowledge if their contribution can be recorded and recognised.

A computer-based information and knowledge management system can help greatly in this regard. A computer system can have good tracking capability, which means the contribution of knowledge is recorded and can be tracked at any time. This can lead to a fair reward system in an organization. For example, a person who contributes more of their knowledge through the system to help others can accumulate more 'points', and can then be rewarded by promotion, pay rise, *etc.* and also gain respect from peers. Moreover, the 'expert advice' that comes through a computer system is usually in written form, and this makes the advice-seeker feel more comfortable and confident to take the advice.

7 Leadership and policy facet

The leadership and policy facet denotes formal and informal steps taken by management to support organizational learning. Such steps include learning-oriented leadership and policies that provide a clear commitment to learning, a tolerance for errors and a commitment to the workforce.

Leadership and organizational policy may not be created by IT tools, but good IT systems will definitely help leaders to promote, monitor and improve knowledge management practice. Examples of the use of IT for this facet include the above-mentioned "point system" to encourage employees to contribute knowledge, a computer-based decision support system to enhance leadership, a log-in tracking system to monitor employees' working status, *etc.*

8 Contextual facet

The contextual facet of the model focuses on exogenous factors that are beyond the control of management, such as the degree of environmental and task uncertainty, task structure and proximity of the learning to the organization's core tasks and cost of errors.

Uncertainty due to the rapid changes in the supply chain, global market, labor conditions, *etc.*, provided the impetus for introducing KM in the construction industry. There is no doubt that information technology, especially web-based technology, helps greatly in providing necessary information in time for managers to make decisions and reduce uncertainty. Various web-based technologies are used in the construction industry to share knowledge and provide useful contextual information for construction managers. The examples given below are from the literature. They show what these technologies are and how they can be used in KM for construction organizations.

Some[17] have developed an activity-based KM system, which maps valuable information and knowledge into activity units during the construction phase of a project, and by using a web-based interface this captured knowledge can be reused by others. Some[18] have studied the diffusion of technologies in the construction industry via Communities of Practice based on computer groupware. Others[19] have discussed using web-based technology and collaboration to promote organizational knowledge sharing in the AEC industry. And some[20] have proposed the concept of the Dynamic Knowledge Map which was presented as a web-based knowledge navigator, and could be used to search for experts and facilitate communication with those experts.

9 Concluding remarks

KM and OL are usually supported from the top in the construction industry; however, managers at the construction site may view it from a different perspective as they may not immediately see the value form these processes. This paper tries to provide an overall view of how IT can be used to support all aspects of KM based on an existing OL model. It is obvious that technology advancement plays an important role in KM practice, and now construction organizations have the choice of a wide range of tools to address different issues.

To promote knowledge management in the construction industry, organizational culture, structure, policy and standard, and staff's skills

should all be enhanced by appropriate IT tools. Based on the fact that most construction organizations already have some elements of KM in place, whether or not they are supported by IT technologies, the proposed IT-based KM strategy should be incorporated with an organization's existing structure to add value to any existing KM practice rather than replace it, and IT usage should be built into a construction organization's daily business processes.

As the trend is to use IT tools more and more to improve KM in construction organizations, it is important that managers consider the overall effects of this trend on the organization by looking from different perspectives and making sure all aspects can be enhanced together.

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