

A KNOWLEDGE MANAGEMENT STRATEGY FOR THE CONSTRUCTION ORGANISATIONS AND THE COMPUTER MODEL DESIGNED FOR SUPPORTING IT

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ABSTRACT

The concept of knowledge management (KM) and the enabling technologies for it have been around for many years. However, research on using computer technologies to support KM in construction industry is still in the early stage, and KM in construction industry still faces many problems and challenges. This paper presents some common problems of KM in construction organisations, and proposes a KM strategy to help to solve these problems. A computer system, which can be used to support the KM strategy, is proposed, and the computer model is presented.

KEYWORDS: Knowledge management, information technology, knowledge management strategy, computer model

BACKGROUND AND LITERATURE REVIEW

As well known, the construction industry is characterised as a project-based business that delivers one-of-a-kind products. The industry suffers from supply chains and relationships that are dynamic and transient as a direct result of the project-based business, which results in a poor communication structure. To improve communication between project participants and information transfer, computerized systems have been seen as effective tools for documenting and exchanging information. Up to now, the development of computerized systems in the construction industry has gone through several stages (Wang 2004). As more

and more projects involve team members from distributed sites and organizations, the low-level information systems that only support data storage and document exchange can no longer meet the industry's requirement, the industry requires ways to support team members to manage and share their knowledge across distance.

The concepts of knowledge management (KM) and the enabling technologies for KM have been around for many years (e.g. from Machlup 1980. to Holsapple 1995, etc.). Recently, The idea of KM and the many ways it can benefit the construction industry are being recognised. The importance of KM for the construction industry have been outlined and summarized in many research publications (Egan, 1998, BSI, 2003; Dent and Montague, 2004, Palmer and Platt, 2005).

In depth research of KM in construction is still in the early stage. Only very recently some important research on KM in construction industry has emerged. Glance *et al.* (1998) presented a Knowledge Pump prototype system, which is to facilitate getting the right information to the right people in a timely fashion, and to map community networks and repository content. Chen et al. (2005) presented an integrative knowledge management model named E+ for environmental-conscious construction. The model has not been implemented to a computer software environment yet. Tserng and Lin (2005) proposed a construction activity-based knowledge management (ABKM) concept and system for general construction contractors, and a web-based system was developed to assist and present project-related knowledge by providing keyword and map search. In Australia, Maqsood, Finegan and Walker (2006) reported an investigation of the issues concerning project histories for one leading construction company, and suggested to use KM strategies to apply project histories and conduct project learning in an efficient way.

KM in construction industry still faces many problems and challenges, and the commercial software for KM in construction is yet emerging. The author of this paper is to present a KM strategy focus on some common problems of KM in construction organisations, and then propose a KM model which could potentially be developed into a commercial software system.

THE KM PROBLEMS IN CONSTRUCTION ORGANISATIONS

As well known, there are two kinds of knowledge: explicit knowledge and tacit knowledge (Nonaka and Takeuchi, 1995). Explicit knowledge can be easily codified and transmitted in a systematic and formal language. This kind of knowledge may be stored in databases, documents, policies and procedures. Explicit knowledge is often mixed with information, as they can be documented and managed in a similar way.

Tacit knowledge is more related to personal experience, it is difficult to formalize, record, or articulate; and it is stored in the heads of people. Some tacit knowledge can be effectively extracted into information but some cannot (*e.g.*, knowledge that exists as an intuition). The latter kind of knowledge can only flow from people to people, and in this case, knowledge flow channel is more important than the knowledge storage techniques.

This paper is to present five common problems of KM in construction organizations. These problems may be related to explicit knowledge or tacit knowledge, thus the way to handle them varies, as discussed in later sections.

Wasted effort in reinventing the wheel

As mentioned previously, most works in construction industry are executed as projects that have defined beginnings and ends. Construction teams are often disbanded at the end of the project, and the knowledge generated in the project is difficult to be tracked. This KM challenges faced by project-based companies were pointed out by Dent and Montague (2004): “The problems associated with knowledge capture and transfer within companies operating on discontinuous projects are of particular concern, and have generally been overlooked in previous studies.”

According to a survey conducted by Tserng and Lin (2005), most engineers and experts agree that KM is necessary and expect that knowledge management may benefit a construction project. However, no suitable platforms exist to assist senior engineers or experts in sharing and collecting their know-how and experiences when general contractors execute a project. Historically, people have

often had to reinvent the wheel, and repeat the same discussions and decisions over and over again. This situation represents a major loss of knowledge from project teams.

How to encourage knowledge sharing

Knowledge management deals with the management of both organisational and personal knowledge. For an organization, the organization culture is usually the most influential element in designing an effective KM strategy and follow-up plan for implementation.

For personal knowledge, Wasko and Faraj (2000) suggest that knowledge is a private good that is exchanged in the expectation of a commensurable return. Hall (2003) also argues that knowledge is a private commodity and it is up to the owner to decide whether to share it or not. To entice people to share their knowledge as part of a social exchange transaction, they need to be persuaded it is worth doing so. In another word, how to encourage people to share or contribute their knowledge is one of the key problems when set up a KM strategy.

Difficulty in finding out who's who

In order to locate experience or knowledge in a large organization, the only readily available method is to send email messages to all professional staff asking, "Does anyone know anything about...?". While this method maybe reasonably effective, such messages can tend to clutter up the email system and serve as distractions to the majority of recipients who are not knowledgeable in the topic in question. In another aspect, the knowledge seeker in this situation is in a passive position who can only wait for the response.

Inconsistency in Document Format

As each project is usually managed by different people, and the project participants can be from a quite difference discipline background. The document format and style can be quite different from project to project. This inconsistency in document format can make information and knowledge flow between projects very difficult.

Is the technology robust enough?

The construction industry is infamous for its slowness in adopting new technologies. There is a strong argument that the technology has reached a level that it can support almost every task that we want to do, the problem is on the human side, people need to change to adapt to the new technology. However, is the IT really robust enough to provide what we want? Construction industry features quite differently from the financing industry or other industries that have successfully adopted IT for long, it may require more advanced technology and better designed system to satisfy construction professionals' needs. In fact, many computer systems for construction industry are still difficult to use, and it requires prolonged training for the new users.

KNOWLEDGE MANAGEMENT STRATEGY

Based on the problems presented previously in KM for construction industry and the nature of knowledge, the following KM strategies are proposed.

Reuse knowledge

If an organisation could capture and use lessons learned in one project more effectively, the management of project-generated knowledge can financially benefit the company. Problems encountered in one project can often be similar to those on a project completed several years earlier. One solution to this problem is to introduce a global information sharing system that allows all project-based documents to be shared across multiple offices.

To make the knowledge more accessible, organisations can identify specific areas relevant to a discipline, and set up standard (non-project-specific) documents. This makes it possible to collate the accumulated knowledge from many projects in one accessibly repository. These documents must be updated to reflect the evolving knowledge of the organization. This approach can be of particular benefit in capturing project-generated knowledge and accumulated to a specific topic/discipline area.

The problem encountered and lessons learned in the construction projects should be published, and the dissemination of this kind of knowledge should not have to wait until the completion of a project. During the life cycle of a project, reports can be treated as a knowledge newsletter. When the project is completed, all knowledge newsletter prepared during its course can be reviewed and the final copy be fed into the company-wide knowledge sharing system. After-action reviews should also be documented. It is beneficiary to ask systematically at the end of each project: How well did we achieve the planned goals? What problem we had? How could we improve next time? This gives the team an opportunity to reflect and learn, instead of moving straight on to the next project.

Encourage Knowledge Transfer

Organisations should have policies to recognize and reward knowledge transfer, and some strategies can be used. Mentoring and coaching programs can provide formal links between younger employees and senior staff. These programs can be used to encourage experienced employees to work alongside their junior colleagues in order to offer support and advice to them. Formally established mentoring and coaching program are more recognizable in terms of workload.

Communities of practice is another important way to bring people together. Groups of people with similar interests could be brought together to ask questions and learn from each other.

Workshops and Seminars are good means to exchange knowledge. These workshops and seminars offer opportunities for knowledge sharing between projects and for experts on particular issues to showcase their expertise amongst their colleagues and peers. They can be attached to social events to encourage the informality of the knowledge exchange.

Finding the right person in the organisation

Expertise of staff should be formally recorded, and a searchable trade directory of all organisation's employees should be set up. The staff experience database is also a good source to find relevant knowledge. To help cement social links

between employees, this directory may include photos and list out-of-work interests.

A client database or external expert directory should also be established. Good access to information about past clients has obvious applications for technique advice as well as financial control and marketing. It may also be useful for operational and strategic planning. External experts may give more information about how the markets are evolving, or how the company can beat competitors.

Document Format

Document format plays an important role in information and knowledge management. Ideally, the whole industry should have a standard coding system for document filing and information transfer. While this may not be practical for the time being, for an organization, an inbuilt coding system should be used to facilitate understanding of updates of documents and how changes have subsequently affected the project. To facilitate information and knowledge transfer, a standard form or template should be used for knowledge newsletter and other documents.

As non-standard terminologies may result in difficult keyword search, guided keywords should be used in filing documents. In addition to using the more obvious keywords such as project title and client, the content of each “lesson learned” and “problem encountered” needs to be identified by the discipline involved, for example, project management, marketing, technical (specific discipline), contract administration, QA, and additional keywords for specific details covered (*e.g.*, relevant technical terms).

Information Technologies for Knowledge Management

There are knowledge management strategies without using any IT support. However, using IT system to facilitate knowledge management is certainly beneficial, and it may be linked well with the existing office software systems.

Successful KM Strategy requires supporting mechanisms that allow knowledge creation, sharing, and transfer. This calls for a suitable technological infrastructure that allows people to seamlessly share communication without loss through

translation, and the transcription of explicit information and knowledge for later reuse and reference.

As teamwork situation is the norm in construction projects, computer groupware becomes an important technology for KM, and it can virtually link construction professionals for solving difficult problems and coordinating their knowledge-related activities. Computer groupware typically contains capabilities such as electronic audio/or video conferencing, electronic document sharing, voting, and diary synchronisation. The Internet, intranets, and extranets are the vehicles and enablers of the groupware.

In fact, no single application or technology holds the knowledge from individuals within an organization. Rather, it requires a collection of people and many application types, for example, databases, spreadsheets, word processors, CAD systems, multimedia, workflow, document management, and email. Other more advanced KM technologies include data mining, data farming, knowledge agent, *etc.* can also be used to improve KM.

KNOWLEDGE MANAGEMENT MODEL

Based on the proposed strategy, a prototype KM computer model is built. The model is briefly presented here to show how it supports the strategy, and it will be further improved along the time in the implementation process.

Organisation-based and User-Centric System Structure

As mentioned in the proposed strategy, a global information and knowledge sharing system should be set up that allows all project-based documents to be shared across multiple offices. It is very obvious that using a browser-based interface enables the widest possible access to the system from practically anywhere. There is no reliance on client-side software, and the system can be accessed both from within an intranet or across the public Internet using a low-bandwidth connection, a pre-requisite for many remotely operating construction workers.

How to design the system structure is the most important issue for a computer system. As mentioned previously, the construction industry features project-based

business, thus a project-based system structure seems logic, and in fact, most of the existing web-based information system for the construction industry are project-based (Wang, 2004). In these systems, personnel and information are grouped by project, as illustrated in Figure 1.

This system structure reflects the real-world situation and also provides flexibility for organizations to decide whether a project would use the web service or not, and then can impose the cost on the project. Thus the project-based structure is an appropriate structure for general web-based information transfer services. However, such a system structure is not suitable for knowledge transfer. Knowledge is different to information. While information can be grouped well within a project, knowledge cannot be. Isolated project information and expert knowledge in one project will make it difficult to be reused.

The proposed computer model adopts a user-based or user-centric logic structure to facilitate KM, as shown in Figure 2, in comparison with the project-based structure illustrated in Figure 1.

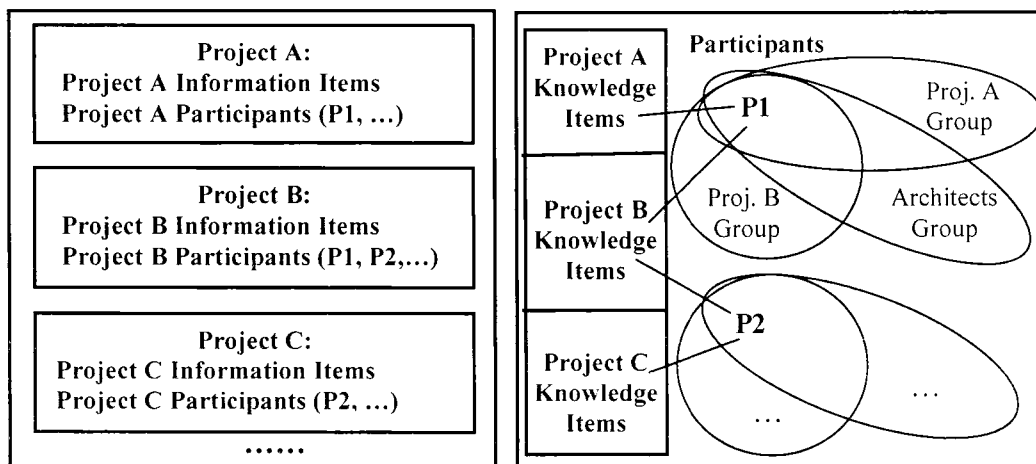


Fig.1 Project-based system structure

Fig.2 User-Centric system structure

The logic structure of the proposed system is more flexible. In such a system, the user may access all the projects in which he/she participates, and the system can assist in coordinating all his/her tasks in different projects. All the information related to one particular project can be easily identified in the system, and be easily extracted by the user.

In another aspect, knowledge transfer is also easier to happen in such a system. As it is user-centred, the user can join different groups, *e.g.* project group, coaching and mentoring group, community of practice, professional group, *etc.*, to share their knowledge with other members in these groups.

Computer supported knowledge transfer

The system should be designed to encourage users to share the knowledge with others. The overall look and feel of the computer system is one of informal encouragement, rather than dictatorial enforcement. Thus the interface of the system will be simple and easy to understand. This helps to make people feel comfortable with using the system, and leads people to contribute knowledge and promotes ongoing usage of the system. The terminology that the system uses is very flexible, ensuring it is in line with what already in common use within the organization and within the construction industry, rather than forcing people to adopt unfamiliar and difficult phraseology.

To support mentoring and coaching program, “eMentoring Project” can be set up in the system. The computer system can help to record the mentoring plan, progress, and let the mentor to monitor the junior employee’s activities in the projects. eWorkshop and eSeminar can also be put into the system to support knowledge flow. Although the events should physically take place, the system can be used to inform people of the events, to post the topics and documents related to the workshop or seminars, to provide after-event discussion, and to find the right people to ask for further information or help. It gives the people who missed the events a place to find out what the workshop and seminar were about.

Electronic People Finder

Computers can do great job to help knowledge seeker to find the right person. In the proposed system, expert directory and project database are to be set up, and they can be easily searched and help to locate the right person the user wants to contact. More importantly, the proposed computer system is not only a reactive system, which is driven by user searches, but also provides proactive support through the use of dynamic profiling to highlight other people in the system who

have similar interests and areas of expertise. News about experts in the users' interested area will be automatically forwarded to the user.

Document Format and Coding System

In the proposed system, the information and knowledge are saved in project units. This is because it is a convention in the industry, and thus makes it easier for the users to search and refer to the related activities in the past projects. However, all the information and knowledge items in the system are marked by an in-built coding system, and this makes them also accessible in discipline/knowledge categories. This facilitates knowledge flow in all possible routes. The system also provides standard keywords, standard document, and template for storing information and knowledge, and this ensures the consistency of document format across all the projects.

Other Functions

Other functions of the proposed system include: distinguish communities by type; manage community membership; create sub-communities (to any level); distinguish between different members and visitor roles; and provide personalised contact management functionality, *etc.*. These features help knowledge groups/communities flourish and provide a supportive environment for KM. The visibility of these communities means that management can ensure that they are aligned with the needs of the organization.

CONCLUDING REMARKS

The proposed KM strategy and model are built on the industry's existing structures and facilities. The implementation of the proposed system will lead to a computer system that focuses on collaboration support and knowledge sharing. The goal of such a system is to help construction professionals to spend more of their time adding value to their company/project rather than searching for information or expert knowledge. The implementation of the proposed system is taking place. The details of the technical design of the system may evolve along the implementation process, and this will be reported, as well as the system's performance, in later papers.

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