APPLICATION OF KNOWLEDGE MANAGEMENT IN CONSTRUCTION ENTERPRISES

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Abstract: With the coming of knowledge economy, more and more importance has been attached to knowledge management in construction enterprises. First, this paper discusses knowledge spiral model and knowledge classification model, which are the bases of the application of knowledge management to construction enterprises. Then this paper discusses difficulties and countermeasures in the application of knowledge management in construction enterprises. Finally this paper analyses the framework of knowledge management in construction enterprises, including the process of knowledge capturing, knowledge storing, knowledge applying, knowledge creating and knowledge sharing.

Keywords: Knowledge Management; Construction Enterprises

1 Introduction

With the rapid development of global economy and new technology, knowledge management has been drawing more and more attention in varied fields. Knowledge management, especially as a management method, including capturing, storing, creating, applying and sharing knowledge, has been playing an important part in modern enterprises. It has been thought that knowledge management is “A New Management Revolution” after “Thaler’s Management Revolution” during the industrial revolution (Wang 2003). Research on knowledge management has become the focus home and abroad. According to the database ABI/Inform, the number of articles in the area of knowledge management increased rapidly every year during the 10 years from 1988 to 1998 (Charles 2004).

![Figure 1 No. of articles in the area of Knowledge Management](image)

Researchers on application of knowledge management in construction enterprises are concentrated on two subjects oversea. One subject is how to capture tacit knowledge and transform it to explicit knowledge. Explicit knowledge can be codified and expressed in formal language, while tacit knowledge is formed in human’s brain, rarely to be captured. So it is difficult to manage tacit knowledge. Some literates develop the dynamic knowledge map to identify where experts’ tacit knowledge is (Jeong-Han Woo et al. 2004). With the help of knowledge map, project management staff can connect the experts with related knowledge and experience by telephone, E-mail and Internet as soon as possible. The other subject is how to develop knowledge management system in construction enterprises. So a theoretical model of knowledge management in construction enterprises has been put forward, for the example of the application to a highway project (H. Ping Tserng 2004).

The researches and applications of knowledge management in China are mostly in the fields of IT industry, research institutes and consultative enterprises, rarely in construction industry. Researches mainly focus on the following aspects: The first is how to classify the knowledge used in project management (Wang 2004);
the second is how to apply knowledge management in project consultative enterprises, design enterprises and so on (Huang 2003; Jiang 2004); the third is the application framework of knowledge management (Li 2004).

2 Theoretical Background

2.1 Knowledge and Knowledge Management

Though there are many different definitions for knowledge, generally speaking, knowledge seems broader, deeper, and complex in most people’s opinion. In order to understand the conception of knowledge, we should compare knowledge with data, information and intelligence. Take the knowledge original model put forward by Verna Allee (1997) for example (shown in Figure 2).

Figure 2 Knowledge Original Model

_Data_-Data is a set of discrete, objective facts about events (Davenport 1998). In an organizational context, data is most usefully described as structured records of transactions and is usually stored in information systems such as database.

_Information_-Davenport (1998) view information as a message, which is usually in the form of a document or an audible communication. As a message, information has a sender and receiver. Information moves around an organization through hard and soft networks.

_Knowledge_-Knowledge is neither data nor information. Knowledge is a fluid of framed experience, values, contextual information, and expert insight that provide a framework for evaluating and incorporating new experiences and information (Davenport 1998).

In organizations, knowledge often becomes embedded not only in the documents or repositories but also in organizational procedures, processes, practices, and norms (Tin 2002). Knowledge can answer the following questions: what, when, how, where and why. It exists during the whole processes of a problem’s lifecycle, from problem’s occurring to solving, including the methods used, objects and subjects related even the anticipative results.

_Intelligence_-It is the power of learning, understanding, reasoning and the mental ability. It indicates the ability of capturing, storing, creating, applying and sharing knowledge and the forecast of things.

The differences between information and knowledge are listed in Table 1.

Table 1 Comparison between Information and Knowledge

<table>
<thead>
<tr>
<th>Information</th>
<th>Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have nothing to do with action and decision</td>
<td>Have something to do with action and decision</td>
</tr>
<tr>
<td>Change configuration</td>
<td>Change mentality</td>
</tr>
<tr>
<td>Transformed easily</td>
<td>Transformed after learning</td>
</tr>
<tr>
<td>Can be copied</td>
<td>Can not be copied</td>
</tr>
</tbody>
</table>

_Knowledge management_ actually is a management process of capturing, storing, applying, sharing and creating knowledge in an organization. The goal is not only to improve worker’s efficiency, but also to
enhance the speed of reaction, thus the core competitive ability.

The connotation of knowledge management is listed below: The object of knowledge management is knowledge itself, while the subject is human beings. Both of them can not be divided; The main tool of knowledge management is IT; The goal of knowledge management is to create value from an organization’s intangible assets; The principle of knowledge management is to recognize knowledge as the most important resource and the key factor to enhance the competitive ability.

2.2 Knowledge Spiral Model

Polanyi (1967) presented the first theory concerning tacit knowledge in his book, *Tacit Dimension*. The knowledge can be classified as either tacit or explicit. Tacit knowledge is the conceptual knowledge embodied in our minds, with difficulty to express and cannot be documented in formal language. Explicit knowledge is that which has been codified and expressed in formal language; It can be represented, stored, shared and effectively applied. Nonaka and Takeuchi (1995) propose a knowledge spiral model (shown in Figure 3) that explores how individuals and groups transform tacit to explicit knowledge, explicit to tacit.

![Figure 3 Knowledge Spiral Model](image)

- **Internalization** - explicit to tacit. This is learning by doing, sharing models and technical know-how.
- **Socialization** - tacit to tacit. This involves sharing experiences with others.
- **Externalization** - tacit to explicit. This involves transforming tacit knowledge into explicit knowledge, a process that involves dialogue with others.
- **Combination** - explicit to explicit. This involves processing and combining explicit knowledge to integrate it with and update existing document schema.

According to knowledge spiral model, application in construction enterprises should pay more attention to the followings:

- Both tacit knowledge and explicit knowledge are the property of an enterprise. However, explicit knowledge can be easily captured with using information and web technologies during the construction phase, while tacit knowledge can not. Transforming tacit to explicit knowledge will be the key factor to carry out knowledge management effectively.
- As tacit knowledge appears in three of the four blocks above, it is not surprising that people are the key players.
- A soft platform, which contains harmonious atmosphere, bright corporate culture, should be set up in order to accelerate the transformation.
2.3 Knowledge Classification Model

Almost all the activities in an enterprise are related to knowledge management. The axis X indicates degree of codified knowledge, while the axis Y indicates density of transformed knowledge. Take inner consultant for example, it seems hard to be codified, but knowledge flows frequently from one to another. Actually tacit knowledge can be easily coded, while explicit knowledge cannot. Activities with low density of transformed knowledge are usually informal, for example no-topic communications between workers. However, activities with high density are usually formal, with definite topics, annual reports for instance.

The model shows that different activities with different knowledge will be treated differently in an enterprise. As a result various knowledge management tools are used.

3 Application Statement of KM in Construction Enterprises

Construction projects are complex and time-consuming, which have usually been characterized by their complexity, diversity and the non-standard nature of the production (R.H. Clough 2000). So engineers’ experience is of great importance during the construction phase of projects. The following difficulties might exist if a construction enterprise carries out knowledge management.

- When the engineers and experts complete projects or leave the enterprise, they normally take domain knowledge with them and leave little or nothing that will benefit subsequent projects or the enterprise (Tserng 2004).
- Most participants have an intuitive sense that knowledge is broader, deeper, and more complex. As a result they regard KM as anything or nothing.
- Knowledge can be classified as either tacit or explicit. In fact tacit knowledge can not easily be captured. Meanwhile, explicit knowledge is saved incompletely or partly because of the poor application of IT in construction enterprises.
- Among knowledge management processes of capturing, storing, applying, sharing and creating in a construction company, KM workers usually do well in capturing and storing, poor in applying, sharing and creating.
- KM calls for harmonious atmosphere to promote the transformation of tacit knowledge to explicit. In fact engineers regard tacit knowledge as the core competitiveness of themselves, they aren’t glad to share experience with others at the beginning of carrying out KM. In their opinion, tacit knowledge depends not only on manpower but also on the spending of much money and time.

Nevertheless, knowledge management is of great benefits to construction enterprises:
Reduce the time and cost of solving problems and improves the quality of solutions during the construction phase. If experience and knowledge are shared, then the same or similar problems in construction projects do not need to be repeatedly solved.

Increase innovation ability of construction enterprises. There are never two of the same projects in the world, thus different projects require different technologies and different knowledge. A general contractor may make innovative use of knowledge generated and accumulated through project activities, and share it across related projects (Tserng 2004).

KM also can improve job effectiveness. During the past time workers spent a lot of time in finding where papers and electronic format were. With the help of knowledge management staffs will find drawings, contracts, specifications and reports as soon as possible. On the other hand they can connect experts with related experience quickly.

4 The Proposal Framework of KM in Construction Enterprises

According to the analysis above, there are three steps for construction enterprises to carry out knowledge management: Firstly, the level of enterprises’ IT should be promoted constantly, which is the hardware support to knowledge management; Secondly, more attention should be drawn to enterprise culture, which is the soft support; Thirdly, the framework of knowledge management should be set up, which is the system support. However the forward two steps seem difficult to carry out, they will spend a lot of money and a lot of time. To set up the framework of knowledge management may be the indirect and effective method. Based on the models of knowledge spiral and knowledge classification, a proposal framework of knowledge management is given (shown in Figure 5).

![Figure 5 The Framework of KM in Construction Enterprises](image)

4.1 Knowledge Capturing

A project participant can capture knowledge in many ways: the first approach is to capture tacit knowledge from KM office, where participants can communicate with experts, experienced engineers and knowledge management staff; the second approach is to capture explicit knowledge from KM bank, which largely depends on IT technology.

Jeong-Han Woo(2004) put forward a dynamic knowledge map, which is a Web-based knowledge navigator that searches for experts and facilitates communication with the experts by using Internet technology. In this way participants can capture tacit knowledge quickly.

4.2 Knowledge Storing

Knowledge has been stored in KM bank, under a safe environment, which contains data, information, drawings, reports, contracts, problem-solutions, experience, skills and innovations. The source of KM bank includes the knowledge transformed from tacit knowledge, such as experience, skills. It also includes the explicit knowledge that might be stored in KM bank directly, such as information and electronic drawings. The operation of KM bank largely depends on the level of IT.
During the daily operation of KM bank KM staffs should pay more attention to the followings: Firstly, knowledge should be stored as soon as possible, especially tacit knowledge, which might be forgotten soon. Secondly, the knowledge to be stored is dynamic under the complex construction environment. So the knowledge stored in KM bank should be updated in time to represent the latest statement of knowledge used in the activity-based projects. Thirdly, knowledge should be stored in standardization. If condition permits, knowledge should be coded in order to be searched for efficiently.

4.3 Knowledge Applying

Knowledge applying is the process of project participants to apply the existing knowledge either from KM bank or from KM office to other projects, which is also the realization of knowledge value. There are two approaches, in which knowledge applying realizes the value. One is to solve problems quickly and directly, realizing the perceptible value. The other is to combine knowledge with enterprise idea, culture, and business process, whose value could not be easily felt directly but exert a subtle influence on enterprises’ competitive ability.

4.4 Knowledge Creating

Knowledge applying realizes the value of knowledge, while knowledge creating increases the value of knowledge. According to Figure 5, knowledge creating, whose source is knowledge applying, is the process of workers at sites, project managers and officers to analyze, integrate and create new knowledge. Knowledge creating increases not only quantity, but also quality. Knowledge managers should encourage more and more staffs in creating knowledge and turn the construction enterprises into active Learning Organizations. Then the innovation ability of an enterprise has been enhanced.

4.5 Knowledge Sharing

With the help of knowledge sharing, knowledge flows freely and frequently from one to another. Knowledge flowing depends on two factors. One is that KM bank has a steady and ample knowledge source. The other is how to improve efficiency and frequency of visiting the KM bank. Difficulties that knowledge sharing has faced with are listed:

- Lack of credit of knowledge sharing with other workers
- Not yet realize the value of knowledge staffs have
- Lack of hardware that supports the operation of KM bank

5 Conclusion

Knowledge management will play an more and more important role in construction enterprises in the coming years with the rapid development of information technology. The major contributions of the study are follows:

- This paper has compared knowledge with data, information and intelligence. Knowledge is neither data nor information, which exists during the whole processes of a problem’s lifecycle.
- According to the knowledge spiral model and knowledge classification model, knowledge can be classified as either tacit or explicit. Actually individuals and groups can transform tacit knowledge to explicit, explicit to tacit. Meanwhile, different activities with different knowledge should be treated in different ways.
- Based on the forward two models, a proposal framework of knowledge management in construction enterprises has been put forward, which includes a management process of capturing, storing, applying, sharing and creating knowledge in an organization. KM bank, which contains both tacit and explicit knowledge, largely depends on the level of IT.
- A number of areas for future research in knowledge management in construction enterprises include:
- Develop web-base techniques for KM bank in construction enterprises.
How to measure value-added benefits of knowledge management in construction enterprises.
Explore ways of the collaboration in a knowledge-based organization.

References

Http://www.simulations.co.uk