A Framework of Information Management System for Construction Projects

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Summary

A comprehensive framework of information management system for construction projects in China has been established through extensive literature survey and field investigation. It utilizes the potential information technologies and covers the practical management patterns as well as the major aspects of construction project management. It can be used to guide and evaluate the design of the information management systems for construction projects in order to make the system to be applicable to a wide variety of construction projects and survive the changes in project management.

1 Introduction

With the rapid development of computer science, information technology has experienced increasing application in Architecture/Engineering/Construction (AEC) in the recent years in China. Even in construction, some information management systems have been used as well as some software for scheduling and drawing etc. However, the information management systems can hardly spread widely in construction projects due to the diversity, the complexity and the rapid change involved in project management in China. In order to improve the applicability of information management systems for construction projects, it is necessary to investigate the project management in a wider view and establish a comprehensive framework for the information management systems.

Concerning the framework of information management systems for construction projects, Froese et al. established a process model for the information management in construction projects (Froese et al. 1996). Rezgui et al. presented an overall approach to integrating ICON (Information for CONstruction) results and STEP (STandard for the Exchange of Product model data) methodology in the COMMIT (COnstruction Modeling Methodologies for InTelligent information integration) project (Rezgui et al. 2004). Stumpf et al. set up an object-oriented model for integrating the information in the design phase and that in the construction phase (Stumpf et al. 1996). A remarkable characteristic of these studies is that they established the system models by concentrating on the management activities. These studies dabbled into but did not cover all the facets of project management. Especially, the management patterns have not been clarified in these studies.

Based on literature survey and field investigation, this paper focuses on the existing project management patterns in China and try to formulate a framework of information management system used by the general contractor companies by covering each aspect of project management and considering other relative aspects comprehensively. The framework is intended for being used in the design of information management systems for construction projects with wider applicability and in the evaluation of the existing information management systems for construction projects.

2 General view of the framework

The detailed purpose of establishing the framework should be two-fold. One is to help the developer to understand the range and aspects related to the information management system. The other is to establish evaluation criteria for the project managers to use when they want to introduce such a system.

As a result, generally speaking, the framework should cover the following four aspects, i.e. the management pattern of projects, the integrated utilization of potential information technologies, the utilization of existing software products and the evaluation criteria for the information management systems, as shown in Fig. 1. Among these aspects, the former three aspects reflect the major issues on an information management system, and the latter represents the criteria for measuring these major issues.

The four aspects will be analyzed one by one in the following. In doing so, the EXPRESS-G will be used to present the models, since it is a widely used presentation tool.

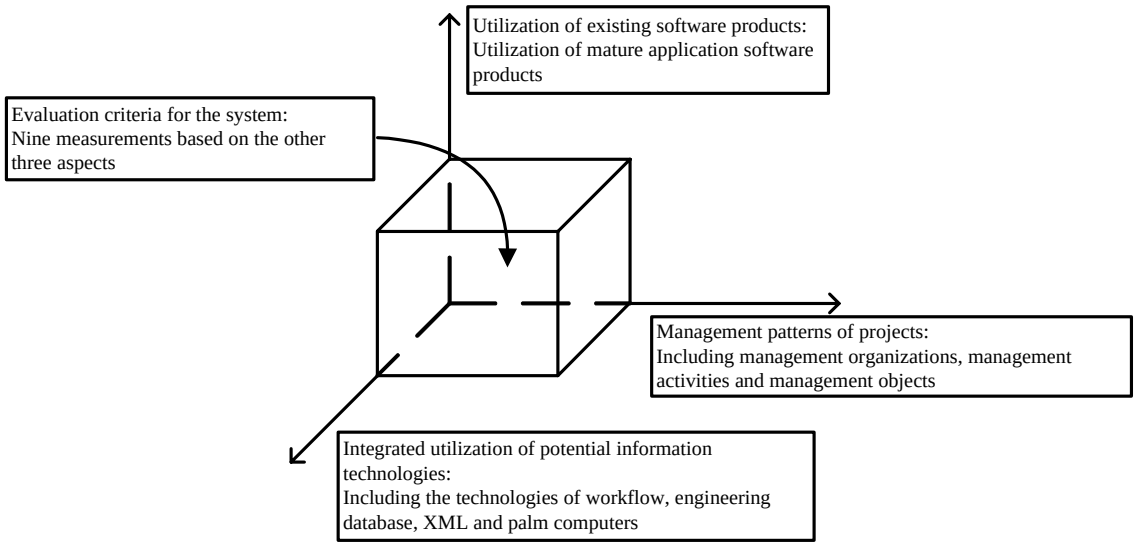

Fig. 1 The general view of the framework

3 Project management patterns

As a requirement, a construction project should be managed to realize the final objective of the project by using the advanced management theories and technologies based on the characteristics of the project. Project management patterns show how construction projects are managed in practice. It consists of three dimensions, i.e. management organizations, management activities and management objects, as shown in Fig. 2. All management work should fall into the space formed by the three dimensions (Wang 2001).

3.1 Management organizations in construction projects

Normally, construction projects involve five types of participants, i.e. owner, general contractor, subcontractor, engineer, supplier and relative agency. Theoretically, many varieties of organizational hierarchy for management are possible by combining these participants in different ways. Fig. 3 shows two typical hierarchies of management organizations in China. In the first hierarchy, the general contractor signs a total contract with the owner, and then signs subcontracts with the subcontractors, while in the second hierarchy, the owner signs only a contract on the major parts of the project with the general contractor and signs contracts on the left parts with other contractors. In the latter case, it is normal that the contractors have to conform to the coordination of the general contractor in the process of construction.

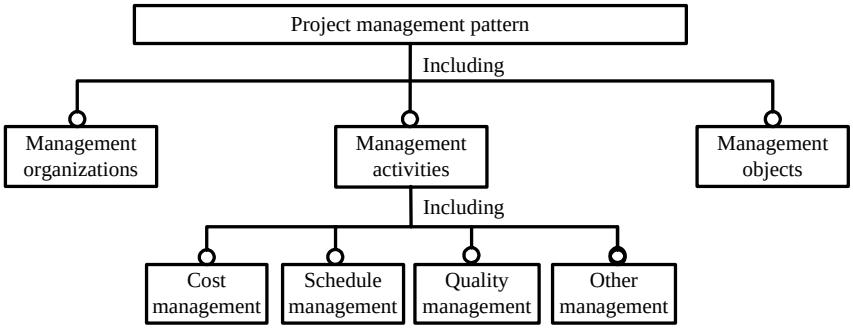

Fig. 2 The structure of project management pattern

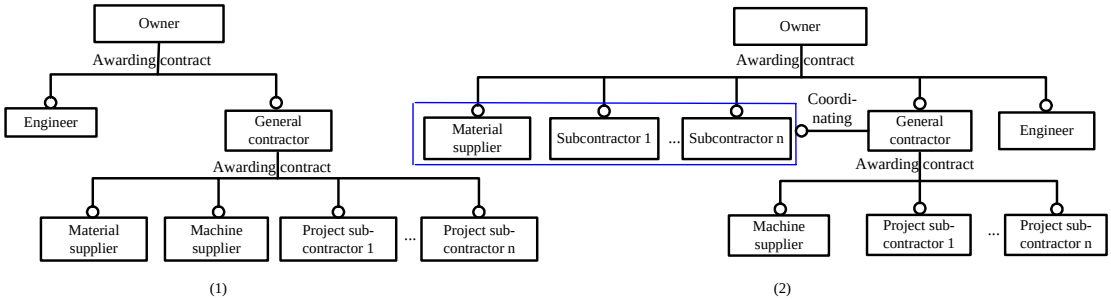

Fig. 3 Two typical hierarchies of management organizations

In China, normally the general contractor companies set out to seek construction projects and establish a project team headed by a project manager to implement the project after a project is awarded. In the process of construction, the company side will monitor the project and assist the project team, while the project team will carry out most of the management works. In this sense, the project management organizations in a general contractor can be divided into two levels, i.e. enterprise-level management organization and project-level management organization. Both levels of organization can be subdivided into different departments or groups. For instance, corresponding to the quality management, there is often a department in the company and a group in the project team, and the department is in charge of the quality management of all projects in which the company is involved and the group is in charge of that of the project only.

3.2 Management activities in construction projects

Since the information management system on which this study focuses is for the general contractor, only the management activities in the general contractor side are analyzed. Although the other participants such as the engineer and the subcontractors can be accommodated by the same system technically, the corresponding functions are better left to other specific system for the sake of separation of concerns (Ma et al.).

The management activities are carried out on management objects and can be classified in different ways. According to the managerial aspects, they can be classified as the management activities on schedule, cost, quality, safety, contracts, material and machines, human resources etc., respectively, as already shown in Fig. 2. According to the execution level, they can be classified as enterprise-level management activities and project-level management activities, respectively.

The normal practice on each managerial aspect is to carry out the management according to “Plan-Do-Check-Act (PDCA) ” sequence. As an example, Fig. 4 shows the outline on cost management. Obviously, each management activity can be conducted by a person with the help of an information management system. For instance, the comparison of three figures can be

carried out by a person through using the corresponding function in the system. In case that a certain activity has to be assigned to different persons in different stages, the activity is better decomposed into atomic task items. Fig. 5 shows a conceptual model of decomposition of management activities.

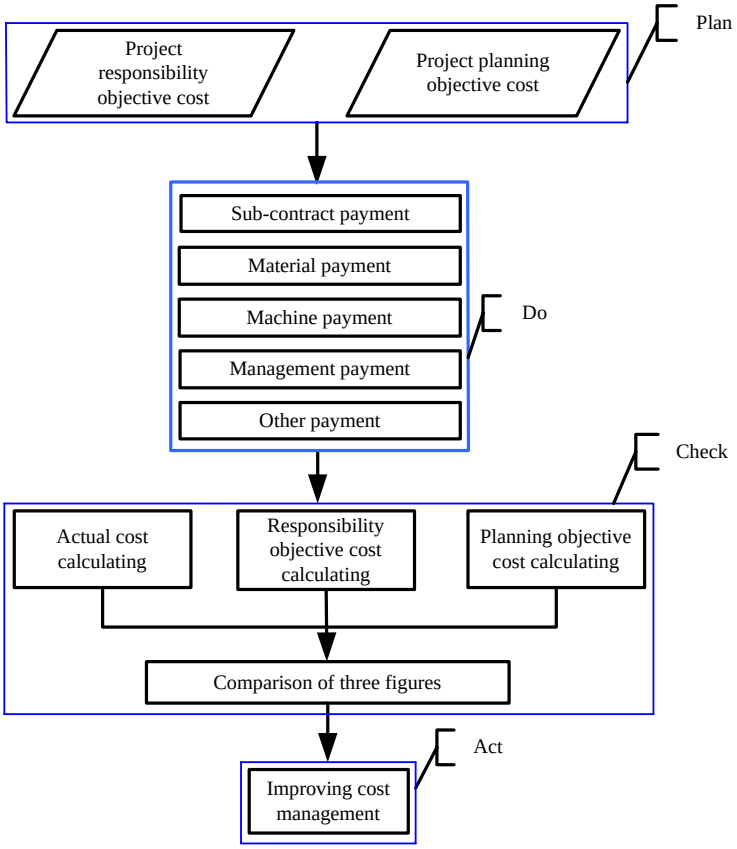

Fig. 4 The outline of construction cost management (periodic work)

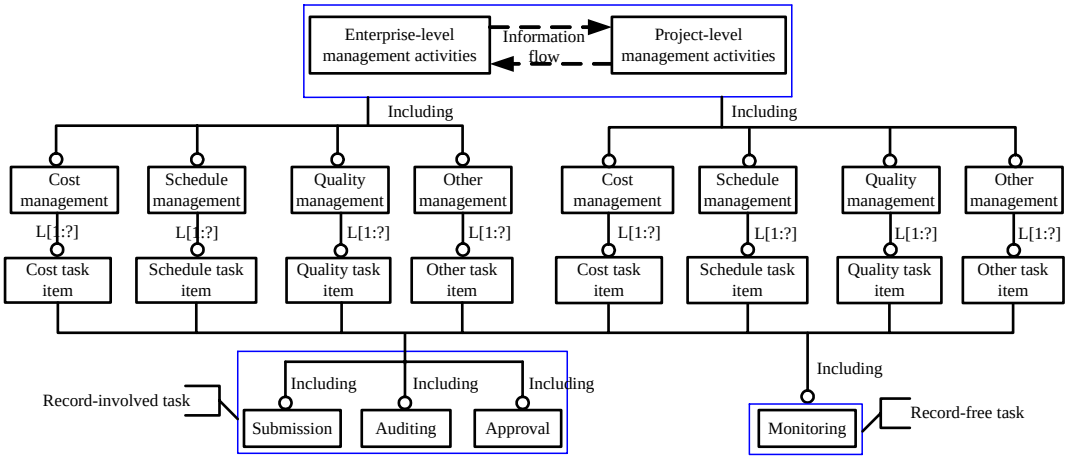

Fig. 5 Conceptual model of decomposition of construction management activities

In addition, in the view of information management, the task items of the management activities may fall into two categories. One is the record-involved task, which needs the person to input some information, such as making plan for cost management. This category of task often contains a series of processing, such as submitting, auditing and approval. The other is record-

free task, which needs no input of information, such as monitoring the result obtained by running the information management system. Record-free task may turn to record-involved task under certain circumstances. For example, when abnormal result is observed, the observation result may have to be recorded.

It deserves to note how to separate the enterprise-level from the project-level management activities or tasks. Generally, the enterprise-level management activities or tasks include that for preparing the responsibility objective cost for the project team, that for monitoring the progress of the project and that for coordinating the projects in which the company is involved, while the project-level management activities or tasks covers the rest of the necessary management activities. However, the detail is dependent of the regulations of the general contractor company. In China, there are two categories of regulations on project management in general contractors. One is called “Project Manager’s Contract (PMC)” and the other is called “Project Manager’s Responsibility (PMR)”. In the former kind, the project manager takes unlimited responsibility on the project based on the responsibility objective cost, no matter the project turns out to be a surplus or a loss. According to the principle of high return with high risk, the project manager is subject to less constraints from the company, for instance, he can decide on such important issues as the procurement of materials and the subcontracts without reporting to the enterprise-level management in advance. In the latter kind, the project manager just takes limited responsibility and his decision on important issues such as the procurement of material has to be audited by the enterprise-level management in advance.

3.3 Management objects of construction projects

The management objects correspond normally to the construction objects. A general construction object may be divided into smaller objects including individual projects, unit projects, work pieces, item projects and inspection lots in a hierarchical way. Each object has its managerial aspects of cost, quality, schedule etc., as shown in Fig. 6. But the managerial aspects may correspond to objects on different level. For example, while the cost is concerned with from the work piece up, the quality is concerned with from the inspection lot up.

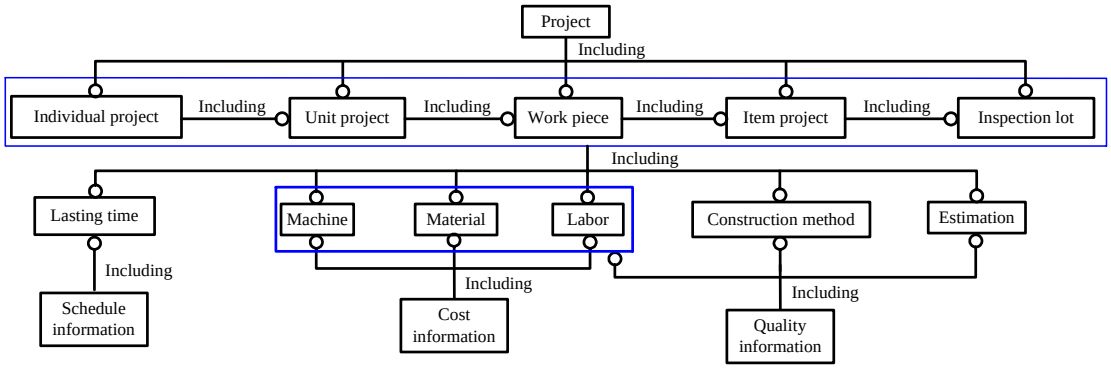

Fig. 6 The Structure of project management object

4 Integrated utilization of potential information technologies

Integrated utilization of potential information technologies is a critical issue for the successful development of information management system for construction projects. The following describes the potential information technologies to be used in the information management system for construction projects.

(1) Network technology. It supports the collaboration of distant users in such ways as information sharing, workflow etc. so that not only the members of the project team can

work in the same computer environment to share information, but also the enterprise-level managers can collaborate with the project team easily and rapidly. For example, when a staff in the project team reports on an issue to an enterprise-level manager through the network, the latter can receive and reply it almost at the same time if he is online. Especially, Internet makes the network connection easier and cheaper and thus is better suitable for project management.

(2) Workflow management technology. It supports the users to define and to manage the workflow based on the practical situation, and enforce the workflow in the system when the users use the system. Since there exist many fixed workflows in project management, by adopting workflow management technology in the information management system, it is possible to strengthen the management and to enhance working efficiency.

(3) Engineering database technology. Normally, engineering database handles geometrical, physical, skillful entity characteristics and their relationship (Wan Yankai 1999). Since a lot of data in the form of documents and graphics have to be handled in project management, it is necessary to adopt the methodology of engineering database.

(4) XML technology. The information management system for construction projects has to exchange information with other systems. In order to keep easy exchange of information among different systems, the information must be in accord with some data exchange standard. XML technology represents information structures by the marks and the mark content in an XML document, and support to operate on XML document as on a database. It thus greatly facilitates document information management, so it is appropriate to be used for representing information exchange standard (Ma et al. 2002).

(5) Palm computer technology. Palm computers are portable for the site managers and thus can be used as a jobsite information terminal. They can be integrated with an existing information management system to collect data in jobsites and to obtain information support by accessing the database server through wireless communication from jobsites (Ma and Zhu 2002).

5 Utilization of existing software products

Although it is tempting to develop every part of an information management system for construction projects, it is not necessary to do so. Many application software products are so mature and so cheap that they can be utilized directly or can be utilized in the form of components easily. At present, the applicable software products can be included as in the following.

(1) Office application software products. They are mainly used to deal with word processing and data calculating, for instance, printing documents, correspondences and forms, compiling project financial statements, etc. This kind of application software is essential in project management. Microsoft Office is typical of this kind of products.

(2) Application software products for scheduling. They generally provide the functions for both static and dynamic schedule management, and also can optimize resource management. Microsoft Project is typical of this kind of products. But only the functions corresponding to the static schedule management is used for drawing schedule diagrams in project management in most cases now.

(3) Application software products for drawing. They are used for preparing the shop drawings and the site plan for construction projects. Autodesk AutoCAD is typical of this kind of products.

6 Evaluation criteria for the system

Many indexes, such as applicability, maintainability, expansibility, portability, etc. can be used for evaluating if an information management system is suitable or not. Similarly, it is helpful to have specific criteria for the evaluation of the information management system for construction projects.

Based on the above analysis, the concept of “functional measurement” is put forward in this study and a set of nine functional measurements is summarized to represent the functional characteristic of the information management system for construction project . Obviously, the more the system conforms to these functional measurements, the more it is widely applicable and is able to bring along advantage to project management.

(1) Major project organization patterns are considered. This measurement is to ensure that the system can adapt itself to different organizations of project management.

(2) Major kinds of regulations on project management in general contractors are considered. This measurement is to ensure that the system can cope with the variety of project management due to the difference in enterprise culture.

(3) It is possible to set and modify the workflows. This measurement is to ensure that the steps and the actors in the workflows can be set or modified to reflect the real management procedure instead of its being hard-coded in the system.

(4) It is possible to integrate popular existing software products such as Microsoft Office easily. This measurement is to ensure that the system is open so that mature application software products can be utilized easily.

(5) It covers the major managerial aspects, such as schedule management, quality management, cost management, safety management, contract management, material management, machine management and human resource management etc., by itself or through integrating existing software products. This measurement is to ensure that the major management work can be improved by using the system in multiple managerial aspects.

(6) It facilitates setting and modifying the formats of exchanged document conveniently. This is to ensure that the system is easy to adapt itself to the change in the form and contents of the exchanged documents.

(7) It integrates the potential information technologies as mentioned in the above. This measurement is to ensure that the potential information technologies can be utilized fully in the system to increase the effectiveness and efficiency of the project management.

(8) It provides the user with the necessary interfaces to cope with various situations in practice, such as importing the information from documents of different format, or having to provide output in paper form. This measurement is to ensure that the system can cope with the current practice.

(9) It facilitates the reusability of information. This measurement is to ensure that the information is collected and stored in the database of the information management system can be exported properly for information reuse.

7 Conclusions

This paper focuses on the construction project management in general contractors and established a comprehensive framework of the information management system for construction projects. The framework can reflect the utilization of the potential information technologies in the system and can cover the practical management patterns as well as the major aspects of construction management. It can be used to help the developer to understand the range and

aspects related to the information management system and to help the project managers to evaluate an existing information management system for construction projects when they want to introduce such a system.

8 Acknowledgement

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