

DEVELOPMENT AND MANAGEMENT OF A QUALITY INFORMATION SYSTEM ON CONSTRUCTION SITE

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ABSTRACT: Many kinds of quality information are daily produced and shared among the engineers in a construction site. The information, which is usually stored in hand-written document or electric files, are not well reused for improvement of the project in the latter stages. This paper presents a method of sharing quality information to manage the useful knowledge created in the construction process. The supervisor gives written instruction about correction and approval as regards to the report from the construction manager. Agenda is processed in every meeting held weekly. These documents contain the knowledge of the supervisor, construction manager, and site engineers. The authors offered an electric format to memorize the quality information and developed a BBS system on the web to share the information in the project through the Internet. An application to a real building project will be also reported.

KEYWORDS: ISO9000s, quality management, decision making, knowledge management.

1. INTRODUCTION

1.1 Background

The improvement of the quality control and the efficiency of management work are requested in the building project. The firms related to construction industry of Japan are now acquiring the certificate of ISO9000s that is considered to be an international standard of quality control. However, the problem on the operation side is pointed out as ISO9000s increases the load of making the documents. Especially, the authors has pointed out that it is important to examine correspondence to ISO9000s based on the improvement of the management work for public owners who holds on-going building projects in all time.

The necessity of the information sharing between organizations was clarified, for instance the owner and the contractor use various documents demanded with ISO9000s independently though the contents are mutually common. Recently, information technology has also progressed in construction industry of Japan, but the efficiency of the systems has not been established in the field of construction management. The ones which have been proposed up to now can be divided roughly into three systems: general management system or software, construction management and information sharing in a single organization, and standardization of procurement and drawing information such as CALS. However, information technology is not necessarily satisfactorily reflected, as there are still problems in each trial. General management system or software does not always suit the style slightly different according to each building project. Construction management with information sharing has not been expanded into two or more organizations. The standardization is not



examined to the business form of the work place of the reality.

1.2 Research purpose

The purpose of this research is to develop the management system that supports the information sharing between the organizations in the building project, and to improve the efficiency and quality of the building project.

System development in this research is based on the characteristic and realities of non-general-purpose type system but building project. And the target is the improvement of existing work by the information sharing among organizations and ideal way of management work. As for a series of system development, it is a point to give generally concerning one owner, and to enable the development in future with other projects.

1.3 Scope of the paper

This problem is an ill-structured problem that contains the system development. So it is important to grasp the problem from a whole area located to integrate the system correctly. The framework of the research is structured as shown in Figure 1. In this paper, in the part of items 3, 4 and 5 will be focused. Items 1 and 2 are already presented in former papers. And items 6, 7, and 8 are problems in the future study. In this paper, the "building production information" is first discussed in Chapter 2, then the idea and the system design are described in Chapter 3. The development of the system is proposed in Chapter 4, and the application to a real project is reported in Chapter 5. Finally, the effect and the problem obtained from the trial are discussed in Chapter 6.

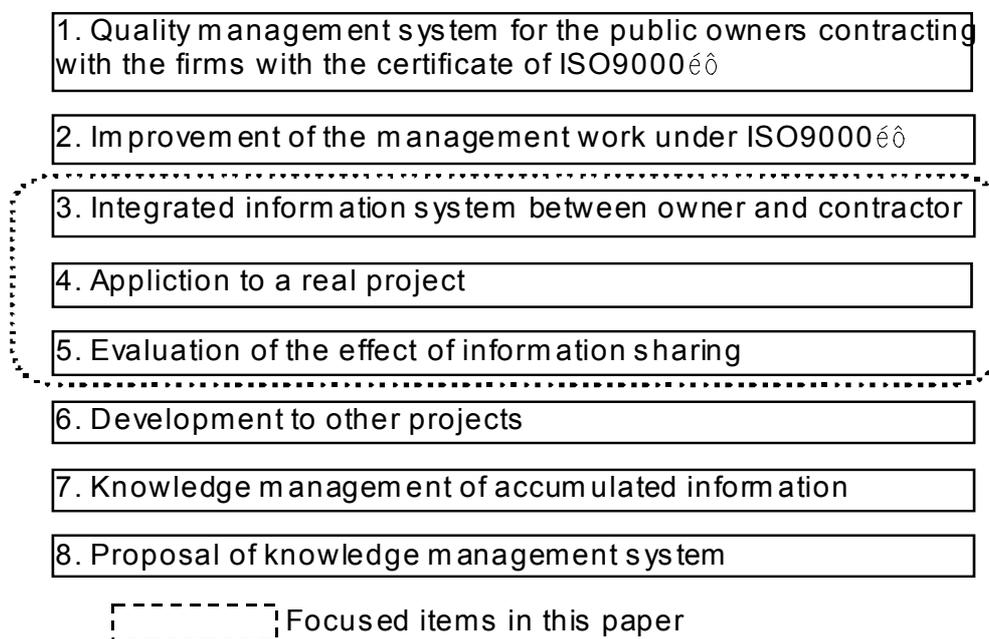


Figure 1 Framework of the research

2. BUILDING PRODUCTION INFORMATION

The quality of documents affected with construction management came to be guaranteed in each enterprise by the ISO9000s certificate. Therefore, it is assumed that the document in ISO9000s format can be substituted for the one demanded by the owner, if that was provided from a contractor with high ability of quality control. As a result, the owner can emphasize

management items for quality control. "Building production information" is defined here to be an information exchanged between the owner and contractor when the management items are executed. The content of building production information was discussed in former papers [Ohta; 1999, Tanaka; 1999]. In this paper, building production information is divided into the three kinds as follows:

Mutually transmitted information: building production information that comes and goes in various briefing between owner and contractor. It is transmitted through oral, telephone, FAX, and so on. Immediate transmission with credibility and the retrieval of accumulated information are demanded.

Diffusing information: the document submitted by the contractor to the owner in each phase of the project concerning the inspection and the delivery. Because the owner often requests to submit in a fixed format, single information is converted into various formats. A similar document is occasionally made for an in-house submitting, so work time is also doubled in the contractor. The function to transform the format is demanded.

Accumulated information: building production information that is accumulated as so-called know-how for specific users. For instance, the Ministry of Posts and Telecommunications of Japan makes each supervisor report the data of the improvement case and the trouble case caused at an actual construction site. It is provided to the supervisors as a technical data. Many of construction firms have similar feedback system. Incentive and retrieval of accumulated information are demanded.

3. INFORMATION SHARING AND KNOWLEDGE MANAGEMENT

The way of sharing building production information is described invoking some concepts that are related to effective use of knowledge in an organization.

- Mutually transmitted information will be integrated with a group-ware which is a communication and transmission tool with e-mail and file transfer. As the credibility and the retrieval will be assured, the efficiency of management work in a project will be improved even if the synchronization of the transmission is left with several problems. Moreover, the interaction of the members is reinforced as introduced in the team net theory, which brings powerful, speedy, and flexible management. If information sharing maintained in each project is applied in other projects of the same owner, the contractor can adequately understand the owner's management policy. It comes to be able to smooth construction management.
- The efficiency of the management work will be improved by the use of peculiar information on the counter party organization about diffusing information. There are various documents, specification, business procedure, and management procedure as peculiar information on the counter party organization. It is possible to secure the quality of the project consequentially by decreasing the work which is not important for the increase in quality like the hand-written copy of the document by using such information between the organizations. The database can support the conversion corresponded to peculiar information. The case applied to the scene of diffusion across peculiar information of building project, especially the plural. Actually, organization is few though the conversion of output information is only an extremely basic function for the database. This depends on a fundamental factor that the team organization is changed in every project. The document production support system is constructed to share the information in this research.

- Accumulated information is put to practical use by offering the scene where member's tacit knowledge can be expressed into written knowledge. The effect of the knowledge creation of expressing the knowledge can be expected according to the said to the knowledge management. The knowledge should be easily made in connection from the one to another member. In this paper, a flexible environment was proposed by setting the scene of the information service from the owner to each contractor including the knowledge of the improvement case and trouble case. The search key concerning the building project is originally designed open to the Internet.

The information sharing brings the increase of quality in the project as shown in Figure 2. Information sharing generally brings the effectiveness of management work to owner and contractor. So they can concentrate on their resources to work for quality control. Accumulated information supports more adequate decision-making.

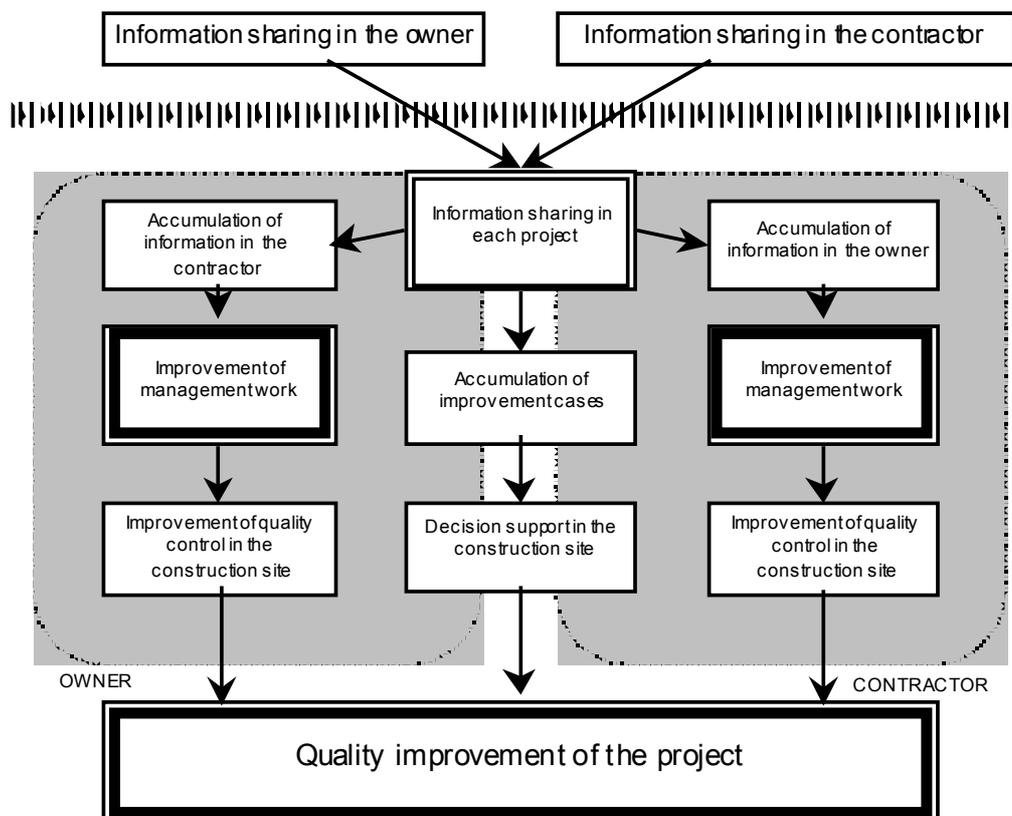


Figure 2 Information sharing to quality improvement

4. DEVELOPMENT MANAGEMENT SYSTEM

4.1 Perspective of proposed system

The management system proposed in this research is composed of six subsystems. As a group-ware that treats mutually transmitted information, "construction briefing bulletin board system" and "formal agenda production system" are developed. The former is a bulletin board for report between owner and contractor. The latter is used to save decided matter as a written document. Next, as the database that treats the diffusing information, "formation of document support system" is developed. And as the system of the knowledge management by which accumulated information is treated by owner's information service, "construction information feedback system" and "improvement case suggestion system" are developed. The system is

linked through the server computer in Kyoto University which could be accessed from the supervisor's office of the owner and the site engineers as shown in Figure 3.

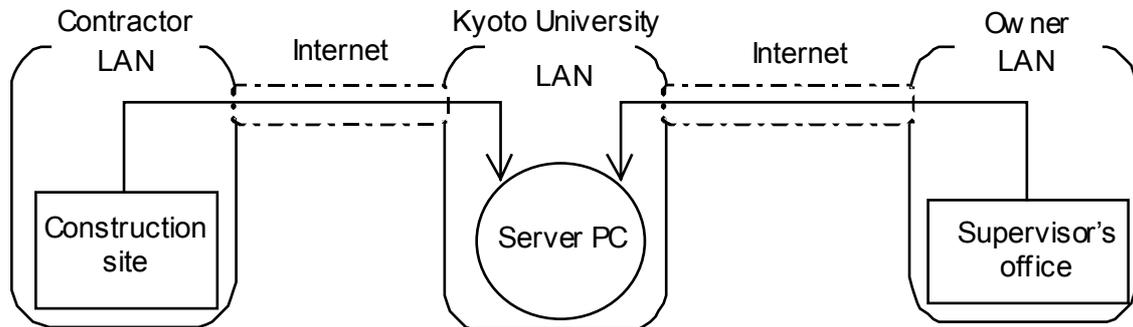


Figure 3 Environment of management system

4.2 Construction arrangement report bulletin board system

gIBIS [Conklin; 1988] is known as a model of discussion. , Construction briefing can be modeled as procedure of (question-answer) and (request-confirmation). The briefing is assumed these repetitions. To show the history effectively, the electronic bulletin board system of the thread format was constructed along with the list in the order of input time. The bulletin board system is composed of the Web server and CGI script. The input and viewing are processed through the Web browser. Since CGI program does not depend on a specific application, it was originally made in the Perl language considering future customization. Main features of the system are as follows:

- The written content is classified as owner and contractor in order to confirm whether concerned members read the content.
- The content is displayed in thread and in the order of written time.
- Search by key word is provided to the title and the text.

This system may be used just like daily report at construction site when they notice something to report. It may be also used as draft of the formal agenda production system.

4.3 Formal agenda production system

It is necessary to keep an important matter of the design changes that affect the amount of construction price in the contract occurred in the briefing. The owner negotiates interactively with the contractor on the network in this system, then the document as a formal agenda is automatically created. After finally confirmed, the formal agenda is published. The system development and its operation are similar to the above-mentioned system. Main features are as follows:

- The situation of response can be distinguished from the list.
- The matter that is requested to respond can be distinguished from the list.
- The content is classified as owner and contractor.
- The confirmation check box for the concerned members is provided.
- The content can be printed to a hardcopy in the requested format.

This system can be used not only automatically from the beginning but also after the content is transmitted by oral.

4.4 Formation of document support system

It is a system that can reduce the time to make a hand-written copy of the document by dealing electronic data. For instance, there is a lot of common information in the format of owner's receiving check data and the format of the quality record of the contractor as for the strength examination of concrete. The relation between them is considered to be multiple

views installed for single data set. Therefore, various formats with paper were replaced with view. The system was developed customizing the database application for the personal computer. Because the output format is able to be set freely, the electronic format of the document demanded by the emphasized management items is designed for input and output. The site engineer inputs data and prints the document in accepting materials or in inspection.

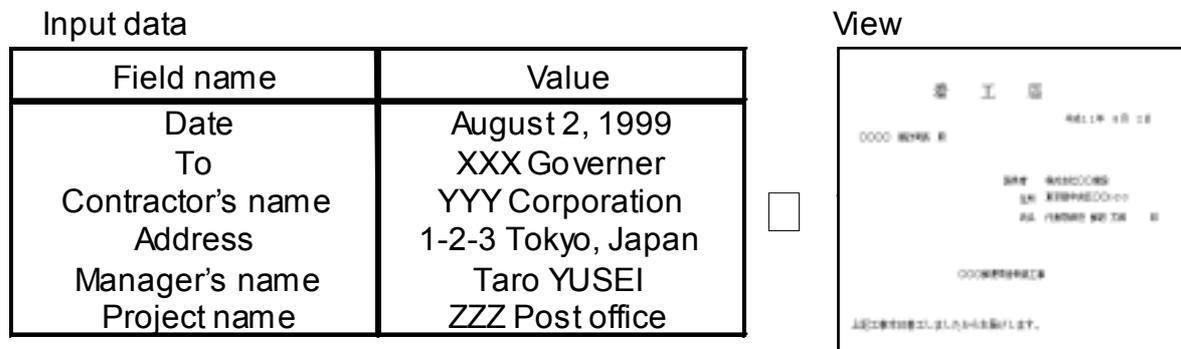


Figure 4 Electronic format and view

4.5 Construction information feedback system

To indicate information, which a certain specific owner had already accumulated, new database is developed for the contractor.

For the efficiency of the retrieval and flexibility of the input, the item designed in the database is consisted of sentences in free format and in specified format. It deals, for example, the introduction of new materials and construction technology, the improvement proposal, and the trouble cases. The database application with an original CGI function is installed in a Web server. This application can read general format such as CSV files.

4.6 Improvement case suggestion system

It is a system for the contractor to suggest improvement case. The owner can share information proposed from the viewpoint of the contractor. This system admits rewrite though the system configuration is also similar to former one. Input and search function is provided in the Web with the database application. Input item was designed referring to example of several construction firms. The information can be accessed with 8 purposes , key word, building element, construction methods, and the evaluations.

5. APPLICATION TO REAL PROJECT

5.1 Outline of project

The management system was applied to an actual project. The outline of the project is as follows:

- Post office building of Regional Postal Services Bureaus
- 23,290 m² of total floor area
- Reinforced Concrete Structure with 4 stories
- Construction term: from March 25, 1999 to September 20, 2000
- Joint venture of 3 general contractors
- 2 supervisors and 10 site engineers

5.2 Construction briefing bulletin board system

The case actually filled in on the bulletin board is as follows:

- Report demand from owner to contractor

- The question from the contractor to the owner about the inspection and the adoption of material

The following comments were given as an effect of the introduction of the system.

- Easy confirmation of the content regardless of the time zone
- Integrated control in the exchange of construction information
- Decreased misunderstanding compared with the communication by oral because the person himself input the content with confirmation

5.3 Formal agenda production system

In the formal agenda production system, the document to be recorded as a certificate was stocked among the questions and the answers from the contractor to the owner. It is pointed out that users other than the person in charge can also confirm the content of a formal record as an effect of the system introduction. There was a result that exceeds a first purpose. However, it is demanded that there must be an authorized stamp in the paper document from regulations on the audit. This respect becomes a operational problem in the future though there was an agreement to admit the effect even if it is on the electronic data during construction term in this project.

5.4 Formation of document support system

This was used to make the document for submitting to the Ministry of Posts and Telecommunications. The reduction of the workload of supervisors was found as an effect of the system introduction. However, since this evaluation at present is subjective and qualitative, it is necessary to verify the effect through the man-hour survey and the analysis of the daily report in the future.

5.5 Construction information feedback system

About 200 of owner's construction information feedback for three years were indicated to the contractor. Though the period from the implementation was only about one month, the forecast of the adoption or rejection of the improvement case became possible as the effect of the system introduction, which causes the motivation for suggesting the improvement case. In indicating to the contractor, a part of the case information should be made anonymous as an operational problem.

5.6 Improvement case suggestion system

Integrated management of information with the server made it possible to input the improvement case regardless of the place preventing the information from getting scattered and lost, though the period is one month. The improvement is required about setting the item of information in the future because it is inconvenient for search if the item is not specified well. But it becomes difficult if the item is set in detail too much. It is a common problem to such a database.

6. DISCUSSION

6.1 Effect and problem of system

Certain appreciation has been received about the management system proposed with this research from the supervisors and site engineers of the applied project. However, some problems for the development to other projects in the future are left as follows:

Drawing information

The drawing and the sketch are often used for communication in the briefing. If these kinds of information should be transferred into electronic data, the methods might be as follows:

- Creating electronic files with CAD and the spread sheet software

- Reading hand-written drawing with the scanner

However, the work increases as for each method. At this time, the drawing were corresponded by transmitting with FAX as an attached paper.

System availability

The briefing was done with oral and the telephone when the content of the briefing was negligible. In that case, they did not fill the agenda nor renew the content to the system. To decrease neither dependence nor use to the system, the operational idea is requested though it is natural as the system which aims at the efficiency improvement of the management work.

System environment

Two personal computers were equipped at the work place of the trial project for ten staffs. Consequently, almost specific person became involved in the input and the check of the system. The accessibility to the system at the work place should be increased in the future to prevent the load being distributed unevenly, and to achieve the information sharing as the team net.

Improvement of incentive

The profit by using the system should be acquired so that the owner side supervisor and contractor site engineer may actively input valuable information to this system. The input will be positively promoted when it is possible to obtain the experience that necessary information cannot be found before using this system. New framework of the construction management is also required in order to spread the information system along with expanding the amount of information and retrieval method.

6.2 Problem in the future

There are the following problems for the research in the future.

- *Development of method to make expressed knowledge from accumulated information*
Necessary information should be searched from a lot of information so that the information will be well used and built in as knowledge in persons or an organization. It is necessary to examine the retrieval by the thesaurus in the building project, though the category classification according to attribute information on the kind of construction is used with the text search in the improvement case suggestion system proposed with this paper.
- *Accumulation and use of object-oriented description*
When information is described in the scene of building production, the natural-language is not necessarily suitable. The information cannot be transferred only by the natural-language but also by the drawing. It is effective if information can be described by object-oriented.
- *Systematic problem for the information sharing among multiple organizations*
There exists information that cannot be indicated exists outside the organization when the information is shared among the organizations. Even if the patent information and cost information are limited to share, useful information should be open to each other for mutual profits. As this system will be applied to two or more projects in the future, a standard for the information sharing is requested.

7. CONCLUSIONS

In this paper, the information sharing between the organizations is aimed at in the building project. The system that aimed to improve the efficiency of the management work and the project quality was developed. In addition, the application result in a real project was discussed. The obtained findings are as follows:

- The current state of building industry of Japan when ISO9000s is widespread is grasped. Then an original method is given to the ill-structured problem that the quality of the

project should be increased under ISO9000s.

- Building production information is comprised to three kinds. Each one is shared and supported by the management system that is designed in this research.
- The system specialized to the building project is originally implemented by using the information technology with a high flexibility, and the prototype is developed.
- The prototype is applied to a real project. The evaluation from the user is obtained about the contribution of the improvement of management work. The problem on the business is examined.
- The problems in the future are presented from discussion through development and operation of the system.

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