

Quality management through construction process in China

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Abstract:

This paper introduces the result of a survey aimed at identifying the factors that affect the quality management system of construction process in China. This research was carried out to analyze the factors and to rank them according to their degree of importance. Two phases (design phase and construction phase) of construction's life cycle are identified. The perceptions of different participants are obtained by means of a questionnaire survey. Special focus is given to the impact that quality management system is the link among the owners, the designers, the supervisors and the contractors. It is anticipated that discussion of these factors will provide a basis for future strategies to promote the development of quality management in China, and also provide useful reference for the foreign countries to understand Chinese style of management.

Keywords: Quality management, Construction process, Factors, China

1. Introduction

During the last decade, the activities of quality assurance in most of the Chinese construction contractors have been limited to meet the technical specification of final products, with a strong dependency on the owner's inspection. In recent years this approach is hanging rapidly and several owners are now transferring the responsibility for quality assurance to the supervisors or the contractors [1]. However, relatively speaking, the quality of construction is still at low level now. A number of quality management problems remain unsolved [2].

After reviewing the literature related to quality management of China, it is very clear that little research has been conducted in the area of quality management system (QMS) of Chinese construction industry internationally. Therefore, it is very difficult for foreign people to obtain relevant information on the QMS of Chinese construction industry. In order to provide readers with a better understanding on the QMS of Chinese construction industry, in this paper we presents the factors that affect the QMS and analyze these factors by making a global review of construction quality performance from the view of the owners, the designers, the supervisors and the contractors.

2. Practices of typical Chinese construction

In China a large number of projects are still contribute to the government funds, most of the owners and the contractors are government owned enterprises [3]. Moreover most of the construction projects are contracted using the traditional approach (fig.1), and other approaches like design-build or turnkey contracts are seldom used. The efficiency and effectiveness of Chinese construction projects are still low [4].

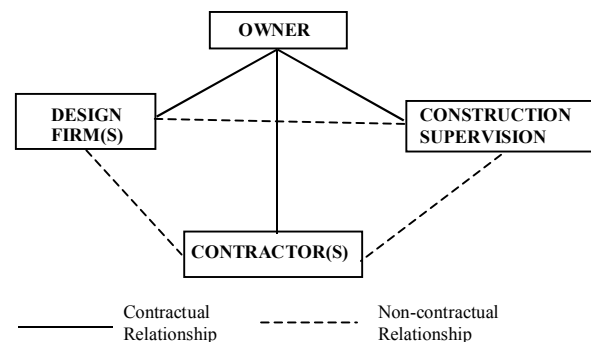


Fig.1 Forms of the traditional practice of Chinese construction project

Table 1

Factors affecting the quality management system of Chinese construction process

Factors affecting the quality management system of Chinese construction process		
Design phase	A-1	Lack of constructability in design documents
	A-2	Errors in design
	A-3	Lack of standard specification figures
	A-4	Un-share of design information
	A-5	Frequent design changes from owner
	A-6	Insufficient sense of responsibility of designers
	A-7	Shortage of supervisor's work
	A-8	Insufficient production-information
Construction phase	B-1	Frequent revision and change order by the owner
	B-2	Lack of cooperation from the owner
	B-3	Bad quality materials
	B-4	Delay in payment from owner
	B-5	Ineffective cooperation between contractors and designers
	B-6	Design changes
	B-7	Poor ability of supervisor
	B-8	Obscure function of supervision
	B-9	Poor construction plan of contractors
	B-10	Poor building technology of contractors
	B-11	Poor quality management systems
	B-12	Insufficient awareness of quality management in contractors
	B-13	Decrease in function of contractors
	B-14	Bad communication among contractors
	B-15	Bad communication among professionals concerned
	B-16	Ambiguous responsible scope of professional concerned
	B-17	Poor availability of equipment
	B-18	Bad quality of subcontract material

Owner

The practice of establishing construction projects in China involves the formation of a temporary Preparatory Office (PO), which represents the Ministry/Provincial/Municipal government in pursuing projects. As the government wants to restrict information related to the financial situation and the progress of projects, the officers of the Government normally form PO. These people are responsible for the management and coordination of the project from beginning to end.

Design firm

The Chinese design firm (DF) basically plays the role similar to the architect/engineer (A/E) in the Western construction industry. However, a design firm is only responsible for the preparation of preliminary and detailed designs. Its duty terminates when the design works complete [5]. The design system in the Construction industry consists of various types of design firms based on their specializations, such as petrochemical, transportation and building, etc. This is unlike the practice in the Western construction industry in that the A/E performs various kinds of designs.

In international practice, the role of the supervision has traditionally played by the A/E as the engineer. This is because they have daily knowledge of the project in detail. However, the Chinese design firms only carry out the design works and are

normally not responsible for supervision of the construction works.

Construction Supervision

The construction supervision (CS) is a legal requirement introduced in 1988 after the Provisional Construction Supervision Ordinance. The duties of CS are to supervise the works of a construction project as an independent third party. The aim is that the supervision should monitor various aspects of construction works, including the planning and control of project cost, timetable and quality [6]. Besides, the supervision responsibility will run through the project from beginning to end. Therefore, this hopefully complements the shortfall of the traditional Chinese construction practice, by bridging the gap between the design firms and the contractors.

Contractor

The Chinese contractor is the same as the contractor in the Western construction industry. The contractor is responsible for implementing the physical works of a construction project. The duty of the contractor includes the management of the construction site and its own resources, including the labor and construction plants. However, unlike the Western contractor, the contractor in China is not responsible for the procurement of materials, which is the duty of the PO for most of the projects. Moreover, the Chinese contractor usually does not carry out

detailed planning, such as method statement before the works carried out [7].

In addition, before the implementation of the Provisional Construction Supervision Ordinance in 1988, contractors were solely responsible for the construction quality under the supervision of PO. In the absence of an independent party to monitor the work, the quality of the works fluctuates.

3. Research Methods

3.1 Data Collection

The data for this research were collected using a questionnaire and supplementary interviews [8]. The investigation on the factors that affect the quality management system of construction process has attracted attention of many researchers. Based on the summary of the findings on this topic in literature [9] [10] [11], a questionnaire with 26 factors (table1) was devised. Owners' project managers (OP), design firms (DF), construction supervisions (CS) and main contractors (MC) were the main target respondents. By focusing on traditional procurement, ten completed projects were developed based on information obtained from the tender records of a major construction company in Beijing. Senior staff of owner organizations and construction firms was contacted, and through them key project participants of each projects were identified. Questionnaires were distributed to individual project participants and those who agreed to dispatch questionnaires to their project team members.

40 questionnaires in total were delivered; finally, 32 questionnaires were received (Table2).

Table 2
Rates of return

Part	Number of questionnaires mailed	Number of responses received	Rate of return %
OP	10	5	50
DF	10	8	80
CS	10	9	90
MC	10	10	100
Total	40	32	80

3.2 Measures

Respondents were requested to rate all the factors affected construction process quality management according to a five-point liker scale where 1 represented the lowest level of influence and 5 the highest. Respondents were also requested to provide information about quality management performance of the project in which they were involved.

4. Findings and Analysis

Table3, Table4 presents the ranking of the nominated factors based on the value of their means.

The following discussion will emphasize 8 factors (3 factors in design phase, 5 factors in construction phase) with the rank according to the mean value.

4.1 Factors affecting quality management system in the design phase

The ranking in Table 3 reveals that the ideas change with positions of each part. *Errors in design* were found to be the most important factor by the owners' project managers. Both the supervisions and the contractors regard *Insufficient production-information, Lack of constructability in design documents* as the first and second factor.

Insufficient production-information

According to the traditional approach, the demerit of this procurement is that the contractors can not participate in the planning and design works, which results in the loss of feedback on construction for the designers. Consequently, coordination problems between the design team and construction team will be increased dramatically. The competence will greatly impact the quality of design documents and services other than design.

Through the division of construction labor and the rapid change of construction technology, problems about the shortage of production-information and the lack for constructability in design documents is becoming more and more important.

Un-share in design information

Under the socialist system, the Chinese design firms were divided into the field of structural design and equipment design. In a project, special design teams are made up: basic design, mainframe construction design, drain design, and electric equipment design, etc [12]. Each team is responsible for the work of its own, but does not pay much attention to the entire design quality, much less the transmission of design information and communication between the teams [13]. Therefore, the mismatch between separate works is caused. A great deal of design changes are often urged in the construction stage. This factor is thought to be one of the main reasons to cause design errors.

Insufficient sense of responsibility of designers

As in other Chinese industrial enterprises, most of the design firms are state enterprises. These design firms do not have reasonable balance of national profit, corporate profit, and individual profit for a long term, and there is no clear rewards and punishments system [14]. There prevents employees from improving their sense of responsibility. In addition, as mentioned above, each design team assumes the responsibility of itself only. We think the

Table 3
Ranking of the factors affecting quality management system in the design phase

Party	Rank	Factor No.	Factors	Lowest ← Highest					Means
				1	2	3	4	5	
OP	1	A-2	Errors in design	0	0	2	1	2	4.0
	2	A-6	Insufficient sense of responsibility of designers	1	0	1	1	2	3.6
	3	A-8	Insufficient production-information	0	1	2	0	2	3.6
DF	1	A-4	Un-share of design information	0	0	2	2	4	4.3
	2	A-8	Insufficient production-information	0	1	3	2	2	3.6
	3	A-6	Insufficient sense of responsibility of designers	2	2	1	1	2	2.9
CS	1	A-8	Insufficient production-information	0	1	2	2	5	4.3
	2	A-1	Lack of constructability in design documents	0	1	2	2	4	4.0
	3	A-6	Insufficient sense of responsibility of designers	0	1	2	3	3	3.7
MC	1	A-8	Insufficient production-information	0	0	0	2	8	4.8
	2	A-1	Lack of constructability in design documents	0	0	1	2	7	4.6
	3	A-6	Insufficient sense of responsibility of designers	0	0	2	3	5	4.3

Table 4
Ranking of the factors affecting quality management system in the construction phase

Party	Rank	Factor No.	Factors	Lowest ← Highest					Means
				1	2	3	4	5	
OP	1	B-12	Insufficient awareness of quality management in contractors	0	0	0	1	4	4.8
	2	B-9	Poor construction plan of contractors	0	0	1	0	4	4.6
	3	B-6	Design changes	0	0	0	2	3	4.6
	4	B-5	Ineffective cooperation between contractors and designers	0	1	1	1	3	4.4
	5	B-14	Bad communication among contractors	0	0	1	0	3	4.0
DF	1	B-9	Poor construction plan of contractors	0	2	2	2	4	4.3
	2	B-12	Insufficient awareness of quality management in contractors	0	1	1	2	3	3.8
	3	B-11	Poor quality management systems	0	1	3	2	2	3.6
	4	B-14	Bad communication among contractors	0	2	3	2	2	3.6
	5	B-15	Bad communication among professionals concerned	0	0	2	1	3	3.6
CS	1	B-14	Bad communication among contractors	0	0	0	2	7	4.8
	2	B-9	Poor construction plan of contractors	0	0	1	1	7	4.7
	3	B-6	Design changes	0	0	2	1	6	4.4
	4	B-12	Insufficient awareness of quality management in contractors	0	1	1	1	6	4.3
	5	B-15	Bad communication among professionals concerned	0	0	2	2	4	4.0
MC	1	B-6	Design changes	0	0	0	2	8	4.8
	2	B-9	Poor construction plan of contractors	0	0	1	2	7	4.8
	3	B-12	Insufficient awareness of quality management in contractors	0	0	1	1	8	4.7
	4	B-5	Ineffective cooperation between contractors and designers	0	0	2	2	6	4.4
	5	B-8	Obscure function of supervision	0	0	2	3	5	4.3

quality consciousness of Chinese designer is lower than that of Western designers.

4.2 Factors affecting quality management system in the construction phase

Table 4 shows *Insufficient awareness of quality management in contractors*, *Poor construction plan of contractors*, *Bad communication between contractors and Design changes* are given to the most important factors respectively by OP,DF,CS and MC. Though it is presumable that each participate in project has the tendency to attribute the cause of the problems to other parties, the weakness of construction management can be said to be the main problem in construction phase. Excluding DF all the other parties regarded *lack of a contractor's construction plan* as the second factor that affects the quality management system in the construction phase.

Insufficient awareness of quality management in contractors

Apart from the reasons discussed above, there might be two special reasons to cause the Chinese contractor's poor quality consciousness.

- Under the socialist system, all building products are owned to state. The contractors cannot clearly recognize the correspondence between the quality and enterprise earnings, they cannot connect the confidence of quality management with a long-term profit of enterprise.
- Employer's incompetence is the other reason for the cause of low quality. In general, the technical competence of Chinese contractors at technician level is high, as they are normally highly educated and have sufficient technical knowledge in the trade. However, most of the people at worker level are unskilled and a lot of them are not all the year round construction

workers. As a result, the quality of works is often not guaranteed [15].

Poor construction plan of contractors

In China, construction process plan is not made at the site but in the technological section at the enterprise. Technological idea and construction measures are given priority in the content of construction plan; consequently, the plan lacks consideration for the design intention, change in the plan or coordination between the construction works [16]. Moreover, the working drawing that made by the designers is used directly to the site even though they stay in the expression of the design intention only. Therefore, it can be guessed that the level of construction plan quality based on such working drawings is not high.

Bad communication among contractors

The problem of *Bad communication among contractors* was thought to be caused by the insufficient plan management of main contractors and the lack of subcontractors' cooperative consciousness. Unlike the contractors in other countries, Chinese contractors are not required to coordinate with others [5]. This will limit their ability to take account of the needs and expectation of other contractors.

Design changes

Design changes were considered to be the most important factor by the contractors. It may result in changes in design and spending more time on rework. Consequently the contractors might exceed the timetable or budget to complete the project if additional time and cost are not allowed. In such case, the contractors cannot give warrantee of the construction quality.

In China, the problems of design changes were thought to be caused by the contractor's technology and the insufficient consideration for constructability of designers. In addition, as described in 4.1, the gap of information between design and construction, and poor quality of design documents are the other main reasons to cause design changes.

Poor quality management systems

TQC (Total Quality Control) and ISO (International Organization for Standardization) 9000 are used as the quality control system by the Chinese construction enterprises normally. Recently, like other sectors in the Chinese industry, the organization of construction enterprise is also reformed. Inspection supervisor or quality guidance from enterprise's headquarters has decreased than before [5]; the quality control enactments such as revision,

execution, supervision and inspection, etc. are all taken charge by the site. However, not all the sites have the ability to manage independently. Basic education of quality control, quality control activities and the feedback of quality information are not always ensured. Moreover, as mentioned above, it is difficult to set up quality management system in the site because of the bad consciousness of quality of the contractors.

The other factors

- *Ineffective cooperation between contractors and designers*

It is widely agreed in the construction process that the designers need to visit the sites and attend site meetings frequently to familiarize themselves with the progress and problems in construction. However, as described above, in China, the designers seldom get involved in during the construction phase. Normally they only go to the site when there is a big problem or need to attend the joint inspection [5]. This is quite different from the practice in UK, or US where the original designers are often employed as the owner's representatives to supervise the construction works. The ineffective cooperation between the Chinese contractors and the designers will greatly impact the quality management of the total construction process.

- *Obscure function of supervision*

Obscure function of supervision was considered as the fifth factor by contractors. The factor can be caught by the limit of CS' management and the problems of CS qualification system. Although CS is adopted to bridge the gap between design teams and construction teams, in fact the performance cannot be fine. Besides, the CS only take on the duty of construction site supervision, and seldom participate in the cost and progress management. This has restricted the professional development of CS [17]. As a result, this also restrained the improvement of construction quality management in China. This paper, however, will not discuss about CS further. Readers may refer to other sources for more detailed information [18].

5. Conclusions

The quality management problems in Chinese construction industry are both complex and deep rooted, influenced by many factors operating on procurement system, designers, contractors, supervision, and construction industry etc. From the above analysis, we have gained the following conclusions: the most common factors affecting the quality management of construction process have been identified. Specifically, *Un-share of design*

information, Insufficient production-information, Lack of constructability in design documents, contractor's Poor consciousness of quality, Lack of contractor's construction plan, Bad communication among contractors and Design changes are the important factors that affect the quality management system of construction process.

Based on the results of the surveys, some suggestions for better quality control are pointed out as follows:

- Make closer coordination between designers and contractors during the design phase. This will enhance the constructability of design; decreasing design change, introducing innovation and value engineering aspects in design. Construction companies are advised to adopt design-build, turnkey or other procurements in order to take more attention to quality management in the early stages of the design phase.
- At the corporate level, teamwork or partnership appears to be of importance to improve quality. Project participants should recognize that cooperation as well as technology represents the key elements of quality in whole project. To solve the problem of weak link among contractors, the main contractors should actively participate in the implementation of quality-enhancing measures and commitment. All the parties concerned with construction should get involved in the process of improving quality on a continuous basis.
- Construction plan was found to be the most important task (ranked second in the construction phase by OP, CS, and MC); especially if work is subcontracted to a variety of subcontractors. From the subcontractors' point of view, lack of information and overlapping activities, which are common on the site, may result in rework and low quality performance. Improved communication and shared information may increase the effectiveness of the plan made by the contractor. According to Stub [19], a distributed database for project control may improve the quality of construction plan.
- It is important to organize training courses for people at work level. Since most of the workers in the Chinese construction industry are undereducated, training for the workers by trade will enable them to have a thorough understanding for the quality requirements. Hence the quality of the construction project would also be improved.
- Despite the management and technology constraints, there are still many points to be improved within individual design firms and contractors. Efforts should be made to further enhance the designers' and the contractors' quality awareness and consciousness.

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