The quality supervision model construction of construction project in the whole life cycle

Qi Wei¹,¹, Lunan Sun¹,¹, Li Wei²,b and Qiannan Liu¹, c

¹Shan dong Academy of Building Research Co., Ltd, Ji Nan 250000, China
²Yantai Automobile Engineering Professional College, Yan Tai 264670, China

*Corresponding author e-mail: kudingchame@sina.com,
¹junedream1102@sina.com,zzz@zzz.com,
bhemuxi123@163.com,
c694018722@qq.com

Abstract. In order to find a solution to the shortcomings and problems in construction engineering supervision in China, the achievements of previous studies are summarized, and the construction engineering Life-Cycle is divided into pre-investment period, while-construction period, project operation period, and offers a theoretical basis for the quality supervision of construction project. In addition, by analysing the problems in current quality management with the principles of science norms vs standardized management, system management vs Life-Cycle, tradition inheritance vs reform and innovation, the basic framework of CELCQS model is constructed, and the duty subject of life-cycle quality supervision, the management subject of government supervision and the control subject of public supervision are pointed out. Among them, the duty subject includes the units of development, reconnaissance, design, construction, and project supervision; the subject of government supervision consists of the competent construction administration department and the national development and reform department and the construction drawing censorship; and the subject of social supervision refers to the project quality detection agency and the engineering cost consultation agency.

1. The connotation of life cycle quality supervision of construction project

1.1. The concept of construction engineering life cycle

The life cycle of a construction project refers to the whole process from the beginning to the end of the project, including project decision-making, preliminary preparation, construction implementation, operation and maintenance. There is no strict unified standard for the division of the whole life cycle of engineering projects. According to the relevant provisions of the construction procedure of engineering projects in China, the whole life cycle of construction projects can be divided into four stages, that is, the decision-making stage, the preliminary preparation stage, the implementation stage and the use and maintenance stage.
1.2. The quality supervision task of construction project life cycle

The main task of quality supervision in the whole life cycle of construction projects is implementing the concept of comprehensive supervision and the practice of uninterrupted quality chain within the whole life cycle of construction projects, so as to realize the quality supervision without gaps and gaps, and finally achieve the quality objectives of construction projects. This requires that each responsible subject should be responsible not only for its own quality supervision, but also for the quality behavior of its upstream and downstream related units and the quality of the delivered results, and examine the construction project quality from a systematic and overall perspective.

1.3. The quality supervision objectives of life cycle for construction projects

The goal of whole life cycle of construction project quality supervision from project decision-making to reasonable use fixed number of year all always perform quality supervision in the process, gradually from the current is given priority to with construction quality supervision into time management mainly, including investment decision stage, survey and design stage and construction drawing review stage, construction stage and using stage, regulatory agencies including the supervision unit, quality inspection institutions and so on the overall quality of supervision, construction and departments involved in all stages of the project quality comprehensive regulatory system, realize the whole construction process and a full range of quality control.

2. The related subject of life cycle quality supervision of construction projects

There are many subjects involved in the formation of construction project quality, and all of them bear certain responsibilities for the project quality at different stages. Drawing on the advanced experience of developed countries and regions, China has gradually established the “five rings” mode of project quality supervision, as shown in the figure 1.

The “five rings” model only gives the subject of quality supervision, without subdividing the category of quality responsibility undertaken by each supervision subject. At the same time, the model does not include the social supervision subject, which deviates from the requirements of the whole process and all-round construction project management. Based on the consideration of the whole life cycle of construction engineering, this paper constructs the “three-ring” mode of the whole life cycle quality supervision subject of construction engineering, as shown in figure 2. The “three-ring” model defines the relevant subjects of the life cycle quality of construction projects, as follows:
2.1. The responsible subject for the life cycle quality of construction projects

According to China's "regulations on construction project quality management", construction units, design units, supervision units, survey units, construction units are responsible for the quality of construction projects in accordance with the law, which constitute the five major responsible bodies for the quality of construction projects. The survey unit, design unit and construction unit are directly responsible for the survey quality, design quality and construction quality respectively. And the construction unit, the supervision unit is indirectly responsible for the quality of the construction project, which is referred to as the indirect subject in this paper. The indirect subject shall supervise the related construction activities of the related direct subject according to the construction engineering laws, regulations and engineering contracts. Among them, the construction unit mainly entrusts the supervision unit to carry out the supervision on the construction quality.

2.2. The government supervising subject of life cycle quality of construction project

At present, the government supervision subjects of construction project quality mainly include the government construction administrative departments and the construction project quality supervision agencies entrusted by the government. In addition, the construction drawing review system also belongs to the scope of government supervision and management, although there are academic views that it should belong to the subject of social supervision.

2.3. The social supervision subject of the life cycle quality of construction projects

In addition to the supervision units mentioned above, the social supervision and control subjects related to construction project quality also include engineering quality inspection institutions and engineering consulting institutions. Among them, the engineering quality inspection agency accepting the entrustment of the relevant units according to relevant state laws and regulations, technical specifications and the mandatory project construction standards, to enter the construction site construction materials, components of witness sampling inspection and sampling test project of structure safety, also the test data and test report is responsible for the authenticity and accuracy.
3. The Research on the basic framework of life cycle quality supervision model of construction engineering

3.1. The construction quality supervision legislation mechanism and the supervision organization system need to be further improved

The legislation mechanism of engineering quality supervision and the supervision institution system need to be further improved. The legislation in the field of construction engineering has ensured the engineering quality to a great extent through continuous reform, and has also greatly improved the role and efficiency of quality supervision. But in the construction engineering market does not regulate the line or in the form of the code to cover the illegal purpose of the behavior still exists. For example, Yin and Yang contracts, bidding in the field of cross-bidding, enclosing bidding, low bid and high price claims, project subcontracting and illegal subcontracting are directly or indirectly affect the quality of some bad behavior. In engineering construction, quality is often used to save construction cost, which not only causes the overall decline of engineering quality or affects the overall improvement of engineering quality, but also increases the use cost of the process from the perspective of the whole life cycle, resulting in the state of price difference. For this reason, the construction administrative department should take effective measures or issue specific local administrative rules and regulations to restrain the problems related to project quality in the areas under its jurisdiction.

3.2. The quality supervision department has a weak awareness of life cycle and lacks effective communication

As mentioned above, the whole life cycle of an engineering project is divided into four stages, namely the project establishment stage, the preliminary preparation stage, the project implementation stage and the operation and maintenance stage. At present, the quality supervision is mainly undertaken by the construction administration department, the supervision unit and the quality inspection institution, which is specifically engaged in the review and handling of the construction permit for planning and design review, the management of the bidding process, and the on-site management of construction quality. It can be found that the supervision and management of the construction administrative departments mainly focus on the preliminary preparation stage and the implementation stage, while the investment decision-making stage and the operation and maintenance stage still lack a complete set of quality supervision departments. In the preliminary preparation stage and the project implementation stage, even if the supervision work is concentrated on the construction administrative department, the internal business management of the construction administrative department also lacks effective communication. From a horizontal perspective, for example, the quality supervision department finds obvious engineering design defects in engineering practice. Since there is no effective communication and problem solving approach or channel between the engineering quality supervision agency and the drawing reviewing agency, the supervision of linkage dynamic control mechanism is imperative. From longitudinal perspective, the national construction administrative department and each construction administration department of the people's government at the provincial level, the quality of the construction administrative department and the supervising agencies, municipal quality supervision terminus and basic quality between regulators between the work of leadership and business also has the problem of inefficiency, sometimes the same regulated subjects in different areas and fulfill quality responsibility actually entirely different.

3.3. The quality information is not effectively shared throughout the project life cycle

In the process of construction project quality control, relevant information cannot be shared among multiple responsible subjects and project quality supervision agencies, and can’t achieve collaborative work among them, and can’t timely provide support for collaborative decision-making between responsible subjects of construction projects and competent administrative departments of construction. Lack of systematic understanding of the whole process of engineering quality formation, the monitoring of key chain nodes in the quality chain is not enough, more emphasis is placed on a kind of
quality control after the event, some of which belong to the "better late than never" type. However, from the perspective of life cycle quality supervision thought, combined with the irreversibility and complexity of the formation process of construction projects, the focus of quality supervision should be to identify quality hazard sources, that is, to implement pre-control and in-process control of project quality, and to fully share the discovered quality information among the supervision subjects.

![Figure 3. “Three Circles” pattern of construction projects life cycle’s supervision](image)

The implementation of whole-life quality supervision of construction projects is not only a change in the supervision content, but also a change in the supervision concept. It is necessary to reform the current supervision mode of construction projects, and form the coordination of supervision departments with their respective responsibilities, dynamic control mechanism and quality information sharing. According to the research, the supervision and management of the life cycle quality of construction engineering is to carry out the supervision and management of the quality of construction engineering in some stages and in the whole cycle according to the formation process and law of the quality of construction engineering. Among them, the construction units are mainly responsible for the quality of the project approval stage, and the supervision units and property management enterprises are encouraged to participate in the early quality management and Suggestions. The quality of the survey and design stage of the project is mainly the responsibility of the survey unit and the design unit, and the responsibility of supervision of the construction unit. The quality of the construction stage (including the completion stage) is mainly the responsibility of the construction unit and the supervision unit, the construction unit is responsible for supervision, by the project quality testing institutions to test the quality of the building block, material performance, etc.

3.4. The construction project life cycle quality supervision system

Based on the analysis of the basic framework and related subjects of life cycle quality supervision and management of construction projects, a life cycle quality supervision model of construction projects is constructed. This mode is mainly composed of two aspects: on the one hand, the government supervision and management system, mainly including quality supervision stations and construction drawing review agencies, which is the highest level of supervision and management, whose supervision and management covers the physical quality of construction projects and the quality
behavior of all participants. On the other hand, it is the social supervision and supervision system, which mainly includes the auxiliary supervision and control of the direct subject's quality behaviors and activities by indirect subjects such as engineering quality inspection institutions and supervision units and intermediary agencies. Among them, the social supervision and supervision system is restricted by the government supervision and management system. See the figure for the supervision model system of construction project life quality.

4. The quality supervision of construction project operation stage
In terms of the evaluation of construction project quality, there are many factors to be considered in the evaluation, and the evaluation indexes are divided into two levels. The five aspects of project entity quality, quality assurance data, project perceived quality, design quality and impact on the environment are the first-level evaluation indexes. There are several secondary indexes under each first-level evaluation index, such as foundation and foundation engineering, main body engineering, architectural decoration and decoration engineering, architectural roofing engineering and so on. In such a complex situation, if the enterprise's self-evaluation data is wrong or the evaluation method is improper, it is easy to cause the evaluation results distortion. The fuzzy comprehensive evaluation method quantifies the original qualitative factors and obtains the results through fuzzy calculation. The quantitative data can more comprehensively and objectively reflect the quality of construction projects, and the evaluation results are more scientific and accurate. The operation stage of construction project has the characteristics of long duration and many influencing factors, so the fuzzy comprehensive evaluation method is introduced into the quality evaluation and supervision of project operation stage, which is innovative and has research value.

5. Conclusion
For the construction engineering quality supervision in our country, the deficiencies and problems, on the basis of reviewing and summarizing predecessors' research results, on the basis of the construction project the concept of whole life cycle of construction project is put forward to the whole life cycle is divided into the early stage of the investment, investment, construction period and operation period of more than three times, and provides a theoretical basis for construction project quality supervision. By studying the current problems of quality supervision, on the basis of scientific and standardized and standardized management, system management and the whole life cycle, the principle of inheritance of tradition and innovation, to build the quality responsibility of construction engineering quality supervision in whole life cycle model of the basic framework, detailed analysis of the construction engineering quality supervision in whole life cycle management, the main responsibility of the government supervision and social supervision subject, established a construction engineering quality supervision in whole life cycle of government regulation system supplemented, social supervision system, clear the main responsibility related to "three-ring" regulation pattern, among them, the government supervision management main body includes: Construction of competent administrative departments and national development and reform departments and construction drawing review institutions; The main subjects of social supervision and control include: engineering quality testing institutions and engineering cost consulting institutions; The main body of responsibility includes: construction unit, investigation unit, design unit, construction unit, supervision unit. On this basis, combining with the construction engineering quality supervision in whole life cycle management system present situation, analyzed the existing construction license system, the construction drawing review system, government supervision system, project supervision system, engineering quality report accused complaint system and project completion inspection and acceptance for the record system and corresponding system, proved that the established compulsory insurance system and the necessity of the engineering quality security system.

References
[1] Jimmie Hinze, Gary Wilson. Moving Toward A Zero Injury Objective [J]. Journal of
[2] Project Management Institute Committee. A Guild to the project Management Body of Knowledge [J]. Project Management institute, 2000.

[3] Han Guo-bo, Gao Quan-chen, Ma Jing-hua. Study on Quality Risk Management of Construction Project Quality Control [C]. of 2006 International Conference on Construction & Real Estate Management. 2006, 10:889 ~ 892.

[4] John M. Nicholas. Project Management for business and Technology: Principles and Practice. 2nd ed. New York Prentice hall, 2001

[5] James R. Evans, William M. Lindsay. The Management and control Quality. 5nd ed. Cincinnati. OH [J]. South-Westem Publishing, 2002.