Construction Management Strategies Based on Quality Management System

Yangyang Zhou

Anhui Xingpeng Construction Engineering Co., Ltd., Anqing, Anhui, 246000, China

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Abstract: Against the backdrop of high-quality development in the construction industry, engineering quality issues have become the focus of social attention. Traditional construction management models struggle to meet the demands of complex projects. However, construction management measures under a quality management system can effectively enhance management standardization and systematicness. Therefore, the construction industry has begun to actively explore the integration path of quality management systems into construction management. This paper analyzes the importance and basic principles of construction management based on a quality management system and proposes scientific and reasonable management strategies, such as establishing a hierarchical quality responsibility system, implementing whole-process material quality control, using intelligent monitoring technology to improve management precision, strengthening dynamic control of construction processes, and building a continuous optimization mechanism, aiming to provide a reference for the high-quality development of construction projects.

1. Introduction

With the accelerating urbanization process, the construction industry has ushered in new development opportunities. High-rise building projects have emerged in large numbers, significantly improving people’s daily lives and production conditions. However, the expansion of construction scale and the increasing complexity of construction technology have posed severe challenges to construction management. The quality management system, with its advantages of scientificity and standardization, can point construction management in the right direction, adhering to the basic concepts of prevention first and continuous improvement. Deeply exploring construction management strategies under the quality management system has important practical significance.

2. Importance of Construction Management Based on Quality Management System

2.1 Ensuring Project Safety

The establishment of a quality management system in construction management can ensure safe construction. It is well known that quality management systems focus on the prevention ideology, and this requires careful planning prior to construction to anticipate potential safety hazards beforehand, develop corresponding preventive measures and emergency response plans so as to transform safety management from passive coping with accidents into active control so as to reduce the probability of construction safety accidents. Besides, the quality management system stresses on continuous optimization of construction management. At present, construction enterprises continuously optimize safety management systems and processes to form a closed-loop process of continuously optimized safety management based on extensive collection and analysis of safety data, which promotes the safe and stable development of construction enterprises [1].

2.2 Extending Project Service Life

By enabling systematic and standardized process control, the implementation of construction management under the quality management system increases lifespan of construction projects.

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Quality management focuses on the whole-life cycle management and promotes risk evaluation of key processes such as material selection and construction technology, which can strengthen the erosion-resisting performance with regard to environmental erosion at an early stage. Simultaneously, the qualification control of construction quality provides refined control of construction quality in advance and plays an important role by effectively reducing some typical quality defects occurring in construction and other issues such as reducing structural durability loss caused by quality problems as well as a reduction in project maintenance during project service period. Moreover, a closed loop of quality traceability is created in the quality management system and construction quality management model through retaining relevant records from materialmarch into the arena to completion acceptance, thus providing reliable data support for the renovation and maintenance of construction projects in later stage.

3. Basic Principles of Construction Management Based on Quality Management System

3.1 Prevention First

Construction management under the quality management system should adhere to the basic principle of prevention first, realizing theprepose of quality risk control and establishing an active risk resistance mechanism. This principle requires construction projects to establish a three-level prevention system from the planning stage. During the construction organization design phase, BIM technology should be used for construction simulation and collision detection to identify defects in construction drawings and process conflicts in advance and develop targeted solutions. At the technical disclosure stage, a visual mode of disclosure should be adopted, quality standards and requirements can be illustrated by means of 3D models and VR technology for use on site managers/operators, so that technical requirements dig into the level of implementation. An accompanying scientific and reasonable dual-control prevention mechanism should be established during construction in order to improve traditional construction quality inspection into process parameter monitoring [2]. In some construction projects, parameters during the step of concrete pouring temperature is collected and meanwhile steel structure welding current is used to collect information by using intelligent sensors; if exceeding a certain range, an automatic correction mechanism will be triggered in real-time into any possible defaults with a benchmark template that can be repeated for next constructions.

3.2 Full Participation

Construction management under the quality management system must adhere to full participation principle tightly, highlighting that all personnel at all levels of the project and throughout its whole process: from decision-makers to frontline operators should participate in quality management as owners, form a shared-quality co-responsibility mechanism.

During project initiation, Quality Standards and individual Accountability must be made explicit by all personnel involved. Management should build an open communication channel, regularly hold quality analysis meetings and technical disclosure meetings, encourage employees to put forward improvement suggestions, and let each operator master the operation specification and key points of quality. Complete involvement also requires the penetration of quality culture; construction enterprises can post quality slogans and continue to carry out quality month activities to create a good atmosphere for implementing total quality management.

Quality Objectives and Specifications are given: Middle managers and technical backbones should dig deep into the quality objectives and specifications and put them into operation instructions of executable operations, through disclosure to ensure accurate execution of process standards daily supervision.

Further, the entire framework for participation should apply to subcontractors and suppliers as well. By means of explicit agreements on quality requirements for input resources and joint management, the quality of the construction product is prepared from the source by ensuring good-quality input resources (input quality).

3.3 Quality Priority

Construction management based on the quality management system must take quality priority as the core principle, establishing a quality goal orientation from the project decision-making stage and placing quality control ahead of factors such as schedule and cost. In specific practice, a three-level quality control system should be built, and dual prevention should be implemented for high-risk projects such as deep foundation pits and high formwork, with BIM technology used to identify quality hazards in advance.

Meanwhile, this principle requires construction units to strictly implement the PDCA cycle (Plan-Do-Check-Act). Before project initiation, detailed quality planning should be conducted in accordance with QMS requirements, and full technical disclosure should be provided to all construction personnel to ensure they fully master process requirements and quality standards. On this basis, regular internal audits should be conducted to systematically analyze weak links in the quality management system and common defects in construction, and formulate and implement effective corrective and preventive measures.

4. Construction Management Strategies Based on Quality Management System

4.1 Establishing a Hierarchical Quality Responsibility System

Construction management under the quality management system should establish a hierarchical quality responsibility system, adopting a horizontal and vertical grid-based control strategy to achieve traceable, quantifiable, and assessable quality responsibilities. First, construction enterprises should divide three-level responsible entities. The strategic decision-making level should establish a Chief Quality Officer system, with the enterprise’s legal representative as the first person responsible for quality, formulating quality strategic policies and annual goals, and holding quarterly quality committee meetings. The process control level, with the project manager as the on-site chief qualityleading official, should establish a quality management team, actively implement the one-vote veto right for quality, and link quality assessment with the project bonus pool. The operation and execution level should establish mechanisms for pre-shift quality disclosure, in-shift process inspection, and post-shift finished product protection, and incorporate information on responsible persons for key processes into building components to achieve whole-life cycle quality traceability.

On this basis, construction management should be supported by clear responsibility investigation systems, assessment and incentive mechanisms, and smooth information feedback channels. Quality responsibilities should be linked to performance, salary, and excellence evaluation, and quality traceability systems should accurately associate problems with responsibility levels, forming a positive cycle where everyone is under pressure and everything has standards, and delivering high-quality construction products based on a solid quality responsibility system.

4.2 Implementing Whole-Process Material Quality Control

Construction management under the quality management system framework should build a whole-process material quality control system, conducting comprehensive evaluation and selecting high-quality suppliers from dimensions such as qualification review, production capacity, and historical performance [3]. Construction enterprises should formulate a source inspection mechanism, conduct on-site audits of key material production bases, verify raw material quality certificates, production process flows, and the effectiveness of testing equipment to ensure materials meet standards before leaving the factory. Materialmarch into the arena requires joint participation of the construction party, supervision party, and supplier in appearance acceptance and verification of quality certification documents. Third-party laboratories should be entrusted to conduct sampling re-inspection of key indicators such as cement strength and mechanical properties of steel bars, and materials can only be warehoused after passing the inspection. Qualified materials should be stored in designated areas, with appropriate storage and protection measures selected based on material characteristics. Construction enterprises should establish a material identification and traceability

system, clearly marking information such as material name, specification, andmarch into the arena time to ensure traceability of the source and usage location of each batch of materials.

In addition, quality activities in all links should form clear and complete quality records for archiving management. Construction enterprise managers should regularly analyze material quality data, use corrective and preventive measures in the quality management system to continuously optimize control strategies from management, technical, and process levels, and continuously improve the quality management level of construction materials.

4.3 Using Intelligent Monitoring Technology to Improve Management Precision

Construction management under the quality management system needs to achieve whole-life cycle quality control through in-depth integration of standardized processes and intelligent technologies. The construction industry should use intelligent sensors clusters of the leading IoT technology and lay stress-strain sensors, temperature and humidity sensors, and 3D displacement monitoring devices at critical nodes of building structures. The 5G network should reach the millisecond-level data transmission number, relying on such technologies as drone tilt photography and BIM model lightweight engine to build a three-dimensional monitoring network. Simultaneously, construction firms need to use past quality defect databases on which deep learning models were trained, and then deploy intelligent cameras at construction sites for online scanning of key procedures such as spacing between steel bars in the binding process and verticality of the formwork.

Moreover, construction management can further go into integrating intelligent monitoring with the PDCA cycle of QMS, optimizing construction and quality control plans according to data analysis results and elucidating more precise indicators for monitoring. A significant amount of manual inspection can be replaced by intelligent monitoring systems, which ensure uninterrupted and blind spot-free objective inspections and digital quality reports. The construction process must be recorded and archived automatically, which provides tamper-proof data evidence for quality traceability and accident analysis in order to promote the continuous improvement of the construction quality management system.

4.4 Strengthening Dynamic Control of Construction Processes

Dynamic control of construction management under the quality management system should focus on process control to achieve refined control of all elements and the entire cycle. Construction enterprises should subdivide construction processes into minimum management units such as sub-projects and inspection batches, formulate standardized operation instructions, and clarify quality standards, acceptance criteria, and responsible persons for each link. For example, in the concrete pouring process, key parameters such as slump test frequency and vibration time should be specified. Meanwhile, the establishment of a dynamic risk early warning mechanism should be based on historical data to build a quality risk database, using AI algorithms to analyze trends in construction parameter deviations. When indicators such as concrete strength and flatness deviate from control lines, early warnings should be automatically triggered and rectification work orders pushed [4].

Strengthen process verification and correction in construction management to establish a chain of responsibility for material quality tracking, adopt the one-item-one-code management model for key materials such as steel bars and cement, and utilize blockchain technology to build a data-sharing mechanism among suppliers, logistics, and construction parties that achieves full controllability of material quality. For critical processes related to structural safety and service functions, stricter dynamic supervision should be conducted. The personnel qualification, equipment status and operating environment must be checked before the construction the unqualified part shall implement a conditional acceptance and signature release system. It should even be implemented so-called process parameters during the whole-process parameter monitoring, namely construction parameters for continuous on-site all-day monitoring and permanent documentation to ensure that the mentioned parameters are always under control, as well as to ensure traceability of this subquality.

Furthermore, early warning lines shall be set for common quality defects and major control indicators in construction. In terms having advance risk prevention in practice: warnings signals is to be sent to managers, weak links identified at the system level and allocated appropriately living up to the strategic priorities of resource deployment by better management.

4.5 Building a Quality Data-Driven Continuous Optimization Mechanism

Construction management should be based on quality management system to establish a quality data-driven continuous optimization mechanism, insist on whole-life cycle quality control, implement dynamic collection-intelligent analysis-closed-loop application of quality data with the help of digital means. One is to construct an intelligent analysis closedloop of quality data for construction enterprises: treating quality defect data as the sample set, using machine learning algorithms to perform cluster analysis on historical quality defect data, identify high-frequency problem scenarios and correlation factors in the process of analyzing combinations or tasks and build a quality risk prediction model. It is based on this that construction enterprises should establish an analysis center to turn the unprocessed data into useful information, build a general project management information platform to automatically collect structured and unstructured data from multiple sources, use visualization dashboards to dynamically present key construction quality indicator trends, distributions and compliance status in graphics mode, so as to realize transparent management.

Further, construction management can connect quality data to performance evaluation to create an incentive structure that encourages all parties to improve their quality behaviours. To make systematic improvements and adapt the construction process and management flows more flexibly, you should regularly review the data and integrate identified improvement potential from this into continuous improvement plans.

5. Conclusion

To conclude, quality management system-based construction management strategies act as a stepping stone to project quality efficiency. The quality management system is used to implement on site can improve the construction quality significantly and avoid production safety accidents and reduce the risk of quality hazards. Therefore, the construction enterprises should establish hierarchical quality responsibility system, implement whole-process dynamic control material quality control, use intelligent monitoring technology to improve management precision and strengthen dynamic control of construction processes and build a quality data-driven continuous optimization mechanism so as to support the sustainable development of the construction industry.

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