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The Value of Construction Quality Management in Safety Risk Management

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Abstract: The construction industry is a pillar industry of the national economy. Its development quality and safety level are directly related to social public interests, personal life, and property safety, as well as the sustainable development of the industry. Focusing on the internal correlation between construction quality management and safety risk management, this paper analyzes the core value of quality management in safety risk management. Combined with the current development situation and practical pain points of the industry, it explores the specific application paths of integrating quality management into safety risk management. The research shows that systematic quality management is the foundation for building a solid safety risk defense line, which can realize advanced risk prediction, whole-process control, and source governance, and provide theoretical support and practical reference for the safe and high-quality development of the construction industry.

Keywords: Construction engineering; Quality management; Safety risk management; Risk prevention and control; Engineering construction

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1. Introduction

Construction projects are characterized by long construction cycles, multiple participating entities, complex operating environments, and diverse technical processes. Safety risks run through the entire life cycle from project initiation, design, construction, to completion and delivery. In recent years, the types of construction projects and safety accidents in China have continued to increase. New types of engineering, such as super high-rise buildings, deep foundation pits, prefabricated buildings, and large-span steel structures, have emerged continuously, making safety risks increasingly diversified and complex. Although the occurrence rate of safety accidents has decreased, major safety incidents still occur occasionally, causing serious casualties and economic losses.

As a core means to reduce the probability and loss of accidents, the effect of safety risk management is closely related to the level of quality management. Quality management is not only related to the physical

quality and service function of engineering projects, but also plays a key supporting role in the identification, assessment, control, and resolution of safety risks [1]. At present, some construction enterprises are faced with the disconnection between quality management and safety risk management. They value progress over quality, emphasize post-event remedy over pre-prevention, and rely on traditional experience rather than technical analysis, resulting in frequent potential safety hazards. Based on this, this paper deeply discusses the value and application paths of construction quality management in safety risk management, aiming to promote the coordinated development of quality and safety in the construction industry and lay a solid foundation for the healthy and stable development of the industry.

2. The value of construction quality management in safety risk management

2.1. Build a basic barrier for the source prevention and control of safety risks

The root causes of construction safety risks are often closely related to potential quality hazards. The core of quality management is to control the quality standards of all links from the source, so as to eliminate safety risks caused by quality problems fundamentally.

In the early stage of a project, quality management ensures that the design scheme complies with safety specifications and actual geological conditions by strictly reviewing the quality of survey and design documents, so as to avoid construction hidden dangers caused by design defects [2]. For example, in the design of a large-span steel structure convention center, if the wind load and temporary support stress state during construction are not fully considered in the design stage, local instability of the roof truss may occur during the assembly stage. With the intervention of quality management, the design calculation sheets and wind tunnel test data can be rechecked in a timely manner to find deviations in design load values, adjust the support layout scheme and hoisting sequence, so as to eliminate the collapse risk from the design source. The negligence of design quality will turn into major safety hazards during structural construction, which fully reflects the source control role of quality management.

In the construction stage, quality management requires construction personnel to operate in strict accordance with quality specifications and construction drawings, standardize the application standards of materials and equipment, and put an end to cutting corners and irregular operations [3]. Taking the core wall concrete construction of a super high-rise building as an example, due to the absence of material acceptance procedures, a batch of low-grade concrete was mistakenly used for the core wall. Quality management personnel discovered the problem in a timely manner through batch traceability and test block detection before pouring, avoiding potential safety hazards such as cracking and even the collapse of the core wall under wind load caused by insufficient concrete strength.

Quality management standardizes all quality links from the front end, moves the safety risk prevention threshold forward, achieves prevention before occurrence, and serves as the most fundamental and core guarantee for safety risk management.

2.2. Avoid safety risks caused by the schedule through quality inspection

In the process of project construction, quality, progress, and safety restrict and promote each other. At present, rushing the construction schedule has become a common phenomenon in the engineering industry, and the resulting hidden quality and safety hazards cannot be ignored. In this process, the investigation of potential quality hazards can often detect and avoid major hidden dangers in advance.

For instance, during the quality hazard investigation of a large bridge project, cracks were found on the newly cast box girder surface. Further analysis showed that the bridge girder erecting machine advanced too fast, and construction loads were applied before the concrete strength reached the standard, resulting in structural cracking. If allowed to develop further, the consequences would be unimaginable. Through this quality hazard investigation, the project attached importance to the progress control of key nodes, curbed the further development of risks in a timely manner, and avoided major safety accidents and property losses.

2.3. Improve the accuracy of safety risk identification and assessment

The primary step of safety risk management is to accurately identify various risk factors throughout the engineering life cycle and scientifically assess their probability and impact degree. Quality management provides systematic methods and data support for risk identification and assessment.

In construction engineering, quality inspection reports, hidden danger rectification records, construction logs, and other materials formed in the quality control process are direct bases reflecting the risk status of each link. By analyzing and sorting out these quality data, managers can accurately locate high-risk points and weak links [4]. For example, during the construction of a sea-crossing bridge, the quality management team can count the detection data of the reinforcement cover thickness of prefabricated box girder segments, find the over-limit deviation rate of the cover thickness of some segments, and evaluate long-term safety risks such as steel corrosion and reduced structural bearing capacity caused by such quality defects in combination with the chloride erosion risk in the marine environment. Thus, the formwork reinforcement process and spacer spacing can be adjusted in a timely manner to effectively control the over-limit rate, forming a closed loop from quality data to accurate safety risk assessment and effective control.

At the same time, tools such as the PDCA cycle and quality risk matrix in the quality management system can be combined with safety risk management methods to build a joint quality and safety risk assessment model and realize quantitative risk analysis [5]. Accurate risk identification and assessment are the premise of safety risk management. With rich quality data and professional control methods, quality management significantly improves the comprehensiveness and scientificity of risk identification and assessment, and prevents errors caused by cognitive deviation.

2.4. Strengthen the execution of safety risk whole-process control

The construction process is dynamically changing, and safety risks evolve with the change of working procedures and environmental conditions. Quality management itself is a continuous control activity running through the whole construction process, which can promote the implementation of safety risk control requirements in every procedure and every operation link.

Quality management establishes hierarchical quality inspection, on-site supervision, and procedure handover acceptance systems. The previous procedure can only start the next one after passing quality acceptance. This control mechanism naturally realizes the safety risk investigation of each operation and avoids the accumulation of unqualified procedures into hidden dangers [6]. For example, in the construction of a deep foundation pit support, after each layer of soil nailing anchorage operation, quality inspection must be carried out on anchor pulling force, soil nail spacing, and shotcrete thickness. The next layer of earthwork excavation can only be carried out after passing the inspection. This process control not only ensures the construction quality of the support structure, but also investigates the foundation collapse risk caused by

insufficient support strength in a timely manner, promoting the synchronous implementation of safety control with the construction progress [7].

At the same time, quality management can further clarify the quality control responsibilities of each post, force operators and managers to strictly abide by safety operation specifications, reduce safety risks caused by irregular operations, avoid the suspension of safety risk control responsibilities and formalistic control, and effectively improve the execution of process risk control.

2.5. Optimize the efficiency of safety risk emergency disposal

Safety risk prevention cannot completely eliminate sudden safety accidents, and efficient emergency disposal is the key to reducing losses. Quality management provides a complete plan, system, and resource guarantee for emergency disposal.

Quality management requires construction enterprises to formulate targeted emergency plans combined with engineering quality characteristics and risk conditions, and quality emergency plans can be directly transformed into the core content of safety emergency disposal plans [8]. For example, in the construction of subway shield tunnels passing through old building clusters, the quality management team can formulate special emergency plans for segment assembly quality, clarifying the emergency disposal process and material reserve for segment damage, dislocation over-limit, and water leakage.

For example, during shield tunneling, in case of sudden geological changes leading to local segment damage and excessive surface settlement, the project shall activate the quality emergency plan in a timely manner, and carry out surface grouting reinforcement and segment support in accordance with the grouting ratio, reinforcement scope, and personnel deployment process specified in the plan, so as to avoid building cracking and collapse accidents. At the same time, the emergency disposal experience accumulated in quality management can provide practical reference for safety accident disposal.

3. Application paths of construction quality management in safety risk management

3.1. Build an integrated control system integrating quality and safety

To realize the in-depth integration of quality management and safety risk management, it is necessary to break the barrier between them and build an integrated control system.

First, construction enterprises shall establish a unified organizational structure, set up a quality and safety management committee, coordinate quality and safety management work, clarify the quality and safety responsibilities of all departments and posts, and form a working pattern of full participation and joint management.

Second, formulate integrated control specifications, integrate safety risk prevention requirements into various quality management standards, and include safety risk prevention indicators in quality acceptance standards, construction specifications, and inspection procedures [9]. For example, in the construction of large stadium steel structure roofs, enterprises shall deeply integrate weld quality inspection with structural safety assessment. On the basis of conventional ultrasonic testing for all Class I welds, phased array ultrasonic and magnetic particle double inspection shall be carried out, and weld defect types shall be associated with structural stress analysis results, so as to establish a weld defect and structural safety risk grading evaluation system, making quality acceptance results directly serve structural safety risk assessment and control [10].

Finally, establish a collaborative assessment mechanism for quality and safety, incorporate the effect of safety risk management into the quality management assessment system, and include the rectification of quality hidden dangers into safety risk assessment, forcing all construction parties to implement quality safety responsibilities through assessment.

3.2. Empower quality and risk control with digital technology

With the accelerated digital transformation of the construction industry, digital means such as big data, Internet of Things, and BIM can realize the intelligent upgrading of engineering quality and safety management, and improve management efficiency and accuracy.

On the one hand, BIM is adopted to establish a 3D building information model, integrating information of design, construction, materials, and equipment, so as to realize visual control of engineering quality [11]. For example, in a super high-rise building, the construction party uses BIM to simulate the collision between steel bars and section steel in complex nodes. It is found that there are many position conflicts between steel bars and steel connection plates in the core area. If constructed according to the original plan, the steel bars cannot be fixed as required, affecting the seismic performance and overall safety of the building. After BIM collision detection and design optimization, the node form and steel layout are adjusted to avoid rework and eliminate potential safety hazards.

On the other hand, develop a digital quality and safety management system integrating quality inspection, hidden danger handling, risk early warning, and data analysis, realizing real-time information sharing and dynamic tracking [12]. During the catwalk erection of a river-crossing suspension bridge, Internet of Things sensors can be used to obtain the stress of load-bearing cables, anchorage displacement, and ambient wind speed. By comparing and analyzing the initial tension and cable bolt torque recorded during quality acceptance, the risk of cable force decline can be judged. Once a problem is found, an alarm will be issued immediately with corresponding tension suggestions to prevent catwalk collapse accidents [13].

3.3. Strengthen whole-life collaborative control of quality and risk

The whole life cycle of construction engineering includes preliminary decision-making, design, construction, acceptance and delivery, as well as operation and maintenance. Quality management and safety management interact and restrict each other throughout the whole process, requiring integrated whole-process management.

In the preliminary decision-making and design stage, quality management focuses on the quality of survey and design documents, organizing experts to evaluate the safety risks of the design scheme [14]. For example, in the design of high-pier and long-span continuous rigid frame bridges in mountainous expressways, quality management institutions shall first carefully review geological survey data. If problems are found in the bridge location, additional surveys and special seismic demonstrations shall be added to optimize the pier position and structural form, deepen pile foundation length, and install energy dissipation bearings to reduce safety risks.

During the construction period, focus on the quality and safety control of key parts and high-risk links, implement on-site supervision and special inspection systems, and strengthen the safety management of deep foundation pits, high formwork supports, large-area steel structure hoisting, high-pier pouring, and other high-risk projects [15]. For example, during the cable hoisting construction of large-span concrete-filled steel

tube arch bridges, the quality management team tracks the wear detection of steel cables, rebound detection of anchorage concrete, and flaw detection of buckle tower welds throughout the process, dynamically evaluates the safety state of the hoisting system through quality data, and ensures that the safety redundancy of the cable system meets the maximum lifting working condition.

In the stage of completion, delivery, operation, and maintenance, establish a regular quality and safety inspection system, regularly check the quality status of engineering facilities, timely discover and handle quality and hidden safety hazards in the operation process, and extend the service life of the project to reduce safety risks in the operation and maintenance stage.

4. Conclusion

Construction quality management and safety risk management are complementary and inseparable. Quality management is the foundation and core of safety risk management, while safety risk management is the goal and extension of quality management.

From the construction instability caused by deviation of design load value of large-span steel structures, to structural hidden dangers caused by insufficient concrete strength of super high-rise core walls, to collapse risks caused by defective high formwork erection, and seismic design changes caused by negligence in geological survey, every engineering case reveals the internal causal relationship between quality defects and safety accidents.

Further exploring the core value of quality management in source prevention, accurate assessment, whole-process control and emergency disposal, and adopting application paths such as building integrated control system, empowering with digital technology and implementing whole-life collaborative control can effectively solve the disconnection between quality and safety management, improve the overall efficiency of safety risk management, and promote the coordinated high-quality development of the construction industry, providing solid support for national economic development and social public safety.

Disclosure statement

The author declares no conflict of interest.

References

[1] Li Y, 2025, Research on the Application of Digital Technology in Construction Safety and Quality Management. Urban Development, 2025(18): 22–24.

[2] Zhao AY, 2025, Thoughts on Construction Schedule and Safety Quality Management. Theoretical Research in Urban Construction, 2025(15): 163–165.

[3] Liang J, 2025, Research on the Application of Risk Management in Construction Safety Production. Modern Occupational Safety, 2025(2): 53–55.

[4] Chen YQ, 2024, Architectural Construction Quality Safety Risk Management Platform Design, thesis, Guangxi University.

[5] Zhang SP, 2024, Application of Risk Management in Construction Engineering. China Construction, 2024(12): 19–21.

[6] Gao SH, 2024, Thoughts on Construction Progress and Safety Quality Management. Theoretical Research in Urban Construction, 2024(30): 58–60.

[7] Sun P, 2024, Application of Risk Thinking in Construction Quality Management. Engineering & Construction Design, 2024(18): 212–214.

[8] Zhang XS, 2024, Research on Risk Management in Construction Safety Production. China Building Decoration, 2024(11): 131–133.

[9] Chen L, 2024, Practice and Analysis of Construction Safety and Quality Management. Quality & Market, 2024(5): 39–41.

[10] Chen WX, 2023, Exploration on Construction Safety Quality Management. Real Estate World, 2023(20): 81–83.

[11] Wu G, 2023, Application of Risk Management in Construction Engineering. Modern Occupational Safety, 2023(4): 102–104.

[12] Zhang YM, 2023, Thoughts on Construction Progress and Safety Quality Management. Residence Industry, 2023(1): 158–160.

[13] Tang XH, 2022, Application of Total Quality Management in Construction Safety Risk Control. Residence, 2022(20): 121–124.

[14] Cao FD, 2019, Exploration on Construction Safety Quality Management. China Standardization, 2019(22): 172–173.

[15] Zhang Y, 2019, Discussion on Problems and Countermeasures in Construction Safety Quality Management. Building Materials & Decoration, 2019(26): 167–168.