Discussion on the Informatization Construction of Quality and Safety Supervision Management in Construction Projects

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Abstract: Based on the practical needs of quality and safety supervision management in construction engineering, and integrating three core aspects—responsibility implementation, physical inspection, and accident handling—this paper analyzes the key role of informatization construction in enhancing regulatory efficiency. By outlining four major pathways—establishing a unified regulatory data platform, developing intelligent monitoring systems for critical links, facilitating data interchange between regulators and enterprises, and establishing a credit information management module—the paper summarizes the implementation logic and operational focus of informatization construction. It elaborates on how information technology enables the digital and intelligent upgrade of the entire supervision process, providing practical references for addressing issues such as data fragmentation and delayed response in traditional supervision.

1. Introduction

With the expansion of construction project scales and increasing complexity, the traditional quality and safety supervision model, which relies heavily on manual inspections and paper records, is increasingly challenged by issues such as data fragmentation, insufficient risk prediction, and difficulties in responsibility tracing. Leveraging information technology to streamline the supervision chain and strengthen process control has become a key issue in enhancing the quality and safety standards of construction projects. This paper focuses on the core content of quality and safety supervision management in construction engineering, delving into specific paths for informatization construction. It aims to provide insights for building an efficient, precise, and closed-loop modern supervision system, promoting a shift in the supervision model from "post-incident handling" to "preventive measures and in-process control."

2. Content of Quality and Safety Supervision Management in Construction Engineering

2.1 Supervising the Implementation of Quality and Safety Responsibilities by All Project Parties

From the regulatory perspective, it is necessary to clarify the responsibility boundaries of entities such as the constructor, surveyor, designer, contractor, and supervisor. This involves signing responsibility commitment letters and establishing responsibility ledgers to decompose quality and safety indicators down to specific positions and personnel. Meanwhile, reliance on a supervision system is required to track the fulfillment of responsibilities in real-time. Dynamic checks should be conducted on key links such as the accuracy of geological data from survey units, the completeness of structural safety calculations by design units, the standardization of process acceptance by contractors, and the adequacy of supervision by monitoring units. Measures such as interviews, rectification orders within deadlines, and credit deductions should be imposed on entities failing to

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meet their responsibilities, ensuring all parties effectively fulfill their primary duties for quality and safety.

2.2 Inspecting Physical Engineering Quality and Construction Safety Protection Conditions

For physical quality inspection, techniques like the rebound hammer method and core drilling method should be used to check concrete strength. Rebar scanning equipment should verify the spacing of reinforcement bars and the thickness of the protective layer for concealed works. Sampling tests should be conducted on the compatibility of waterproof materials and the sealing of pipe connections to ensure physical quality meets design specifications and acceptance standards. Safety protection inspections should focus on monitoring data for deformations in deep foundation pit support structures, the spacing of uprights and the setting of ledger bars in high-formwork supports, the effectiveness of moment limiters and load limiters for lifting machinery, as well as details like the height of edge protection railings and the density of scaffold plank laying. Rectification notices should be issued for identified quality defects and safety hazards, requiring contractors to develop specific rectification plans and verify the results, thereby eliminating quality and safety risks.

2.3 Supervising the Investigation and Handling of Quality and Safety Accidents

Upon the occurrence of an accident, the supervision department must intervene immediately, overseeing the investigation team to operate according to the "Four No's Principle" (until the cause is identified; until responsible personnel are dealt with; until rectification measures are implemented; until relevant personnel have been educated) [1]. The process involves supervising the investigation team to retrieve original documents such as construction logs, supervision monthly reports, and test reports. The direct and indirect causes of the accident should be identified through site investigation, technical appraisal, and personnel inquiries, clarifying the responsible units and individuals. The development and implementation of the accident rectification plan must be tracked, assessing the feasibility and targeted nature of the measures. Supervision ensures the responsible unit completes technical rectification and management improvements. The accident investigation results and handling opinions should be made public to serve as a warning and educational lesson.

3. Pathways for Informatization Construction in Quality and Safety Supervision Management of Construction Engineering

3.1 Building a Unified Data Platform for Engineering Quality and Safety Supervision

At the top-level design stage, departments such as Housing and Urban-Rural Development and Emergency Management need to collaborate to define platform construction standards. Referring to the "Data Standard for Construction Engineering Quality and Safety Supervision Information," a data classification system should be established, categorizing data into 8 major categories and 32 sub-items, including basic project information, participating unit information, quality testing data, safety inspection records, and accident handling information, ensuring unified data caliber. In the data integration phase, existing databases like government service platforms and engineering approval systems need to be interfaced. Historical data migration should be completed using ETL (Extract-Transform-Load) tools, requiring over 95% automatic synchronization for basic project information. Qualification information of participating units must be verified in real-time against the National Enterprise Credit Information Publicity System to ensure the authority and completeness of data sources [2]. The functional development phase should focus on core regulatory needs, developing core modules such as project filing management, quality and safety inspections, hidden danger tracking and rectification, and data statistical analysis. The inspection module needs to support customizable inspection forms, on-site photo uploads, and rectification deadline setting. The statistical analysis module must have multi-dimensional data visualization capabilities, generating reports like regional quality and safety trend charts and participating unit credit rankings. After development, the platform should undergo a 3-month pilot test involving over 10 municipal supervision departments and more than 50 construction enterprises. At least 200 functional optimization suggestions should be collected. System vulnerabilities should be addressed based on test feedback, ultimately achieving operational standards of processing no less than 100,000 data entries daily and response times within 3 seconds after launch [3]. Post-launch, a professional maintenance team should be established, conducting quarterly data security audits and annual system upgrades to ensure long-term stable operation.

3.2 Developing Intelligent Monitoring Systems for Critical Engineering Links

During the requirements analysis and technology selection stage, high-risk critical links in construction, such as deep foundation pits, high-formwork supports, lifting machinery, and steel structure installation, need to be identified. Monitoring indicators for each link must be defined: deep foundation pits require monitoring support structure displacement, groundwater level, and surrounding settlement; high-formwork supports require monitoring upright axial force, ledger deflection, and frame tilt. Technology selection should adopt an "IoT + Edge Computing + Cloud Computing" architecture. Sensors should include displacement sensors with an accuracy of 0.1mm and pressure sensors with an error less than 1%. Edge computing gateways need to support 5G/4G dual-mode communication, ensuring data transmission latency is controlled within 500ms [4]. During system development and equipment deployment, hardware installation should follow a density standard of no less than 1 sensor per 500 ㎡. No fewer than 3 video surveillance devices should be deployed per critical link for round-the-clock monitoring without blind spots. Software development should include data acquisition, intelligent analysis, and early warning handling modules. The intelligent analysis module needs to embed machine learning-based risk prediction models, trained on over 5,000 sets of historical risk data, achieving an recognition accuracy rate of no less than 92% for risks like excessive displacement in deep foundation pits or instability of uprights in high-formwork. During system debugging and functional verification, 20 different types of ongoing projects should be selected for pilot application. The accuracy of sensor data acquisition and the response speed of warnings should be verified. The time from warning generation to pushing it to the supervisors' mobile terminals should not exceed 1 minute. The data interface capability between the system and the regulatory data platform should also be tested, ensuring monitoring data is automatically synchronized to the platform hourly, forming a complete closed loop of "device monitoring -> data analysis -> warning pushing> handling feedback" [5]. After the pilot, model algorithms should be optimized based on application effects, and the system's application scope should be expanded, ultimately achieving comprehensive intelligent monitoring coverage for all critical links of hazardous sub-projects exceeding a certain scale.

3.3 Promoting Data Interchange Between Regulatory Systems and Enterprise Information Systems

Data interchange standards and specifications must be formulated. Regulatory authorities should lead the compilation of the "Interface Standard for Data Interchange between Construction Engineering Supervision and Enterprises," clarifying requirements for data interaction format, protocol, frequency, etc. It should stipulate that construction enterprises upload data such as construction progress and quality acceptance records daily; supervision enterprises upload information like supervision logs and standing records weekly. The data format should uniformly adopt JSON, and the transmission protocol should use HTTPS encryption to ensure standardization and security of data transmission [6]. Interface development work should be carried out. Regulatory authorities need to reserve standardized data interfaces on the unified regulatory data platform, including data push interfaces, data pull interfaces, and data query interfaces. The data push interface should support enterprises actively uploading data at specified frequencies. The data pull interface should allow regulatory authorities to extract key data from enterprise systems after obtaining authorization. Enterprises need to modify their project management systems and quality and safety management systems, developing adaptation modules according to the interface standards. Large construction enterprises should complete system modifications within 3 months, while small and medium-sized enterprises can seek assistance from third-party technical service agencies, ensuring a 100% modification completion rate. Data interface testing should be implemented. Select 30 enterprises of different scales and types to conduct pilot data interface tests. Perform data transmission tests in batches, focusing on verifying the integrity, accuracy, and timeliness of data transmission. The consistency between data uploaded by enterprises and data received by regulatory authorities should reach over 98%, with data transmission delay not exceeding 30 minutes. A problem feedback mechanism should be established during the interface process to promptly coordinate and resolve issues such as interface adaptation abnormalities and data format errors, forming a "Data Interface Problem Handling Ledger" to record problem types, solutions, and outcomes [7]. A data security guarantee system must be established. Use data desensitization techniques to process sensitive enterprise information, partially masking fields such as financial data and employee ID numbers. Deploy security equipment like firewalls and intrusion detection systems. Regularly conduct data security vulnerability scans and perform data security emergency drills quarterly to ensure security during data transmission, storage, and usage, preventing risks like data leakage and tampering. Ultimately, achieve efficient two-way data interchange between regulatory systems and enterprise information systems, enhancing regulatory efficiency and enterprise management levels.

3.4 Establishing a Credit Information Management Module for Engineering Quality and Safety

During the credit indicator setting phase, a multi-dimensional credit evaluation indicator system must be established based on the reality of quality and safety supervision. Indicators should cover four first-level indicators—responsibility fulfillment, quality and safety inspection results, accident handling situation, and rectification implementation effectiveness—and 16 second-level indicators. The weight allocation could be: Responsibility fulfillment 30%, Quality and safety inspection results 25%, Accident handling 25%, Rectification effectiveness 20%. Specific scoring criteria should be set for each second-level indicator. For example, deduct 3 points for a construction enterprise failing to conduct self-inspection as required, deduct 15 points for a general quality or safety accident, and add 2 points for completing rectification on time and passing re-inspection, ensuring the evaluation indicators are quantifiable and operable [8]. In the credit information collection phase, information should be obtained through three methods: automatically capturing data like project filing, inspection records, and rectification status from the unified regulatory data platform (real-time collection); receiving credit information reported by industry associations, third-party testing agencies, etc. (summarized monthly); and accepting credit information from public complaints and reports (incorporated into credit files after verification), ensuring broad sources of reliable credit information. Collected credit information must undergo review, with a required pass rate of 100%. Information failing review should be returned for supplementation and improvement. During credit evaluation implementation, a weighted scoring method should be used to calculate the credit score of participating units, with a full score of 100. Credit levels can be divided into four grades based on the score: Excellent (90 points and above), Good (80-89 points), Qualified (60-79 points), and Unqualified (below 60 points) [9]. For dynamic updating of credit information, a real-time update mechanism should be established. Enterprise credit scores adjust in real-time with the generation of new credit information. Credit levels should be re-evaluated quarterly. A credit repair mechanism should be established. Enterprises with poor credit can apply for credit repair after completing rectification within a specified period and passing verification, with corresponding adjustments to their credit scores after repair. This ensures the dynamism and fairness of credit evaluation, guiding participating units to prioritize quality and safety management and enhancing the overall credit level of the industry.

4. Conclusion

The informatization construction for quality and safety supervision management in construction engineering must closely align with core regulatory needs, based on data integration, supported by intelligent technology, keyed by data interchange, and guaranteed by credit management. The unified regulatory data platform enables centralized management of regulatory data. The intelligent monitoring system for critical links enhances the timeliness and accuracy of risk identification. Data interchange between regulators and enterprises breaks down information barriers. The credit information management module strengthens the responsibility awareness of participating entities.

References

[1] Qu Boyuan. Current Situation and Future Development of Informatization Construction in Construction Engineering Quality and Safety Supervision Management[J]. Construction and Decoration, 2021(28):125-128.

[2] Dong Guangzhe. Current Situation and Development of Informatization Construction in Construction Engineering Quality and Safety Supervision Management[J]. Information Systems Engineering, 2021(7):123-125.

[3] Chen Xiaofeng. Research on Informatization Management of Construction Engineering Quality and Safety Supervision[J]. Science and Informatization, 2024(24):190-192.

[4] Feng Xiang, Sun Yirui. Informatization Management of Construction Engineering Quality and Safety Supervision[J]. Science and Informatization, 2025(8):4-6.

[5] Zhang Quanyong. Application and Practice of Information Technology in Quality and Safety Supervision Management of Transportation Engineering[J]. Science and Informatization, 2024(3):169-171.

[6] Xu Jianmin. Research on the Current Situation and Development Path of Informatization Construction in Construction Engineering Quality and Safety Supervision Management[J]. Computer Procurement, 2023(45):162-164.

[7] Sun Zhixin. Discussion on Informatization Construction of Construction Engineering Quality and Safety Supervision Management[J]. World Home, 2022(21):58-60.

[8] Ke Zhiting. Application of Informatization Mode in Quality and Safety Supervision of Water Construction Engineering[J]. Heilongjiang Hydraulic Science and Technology, 2022, 50(12):178-180,219.

[9] Meng Xiaoqing. Discussion on Informatization Construction of Construction Engineering Quality and Safety Supervision Management[J]. Encyclopedia Forum Electronic

Magazine,2021(13):2514.