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Research on the Improvement Strategy of Safety and Quality Management of Construction Enterprises

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Abstract

The technology in the research on the improvement strategy of safety and quality management of construction enterprises has effectively solved the problem of high cost and low efficiency through resistance degradation, while traditional manual solutions cannot effectively solve this problem. The successful development of the research on the improvement strategy of safety and quality management of construction enterprises has greatly improved the technology and management level of the construction industry, which provides a guarantee for the traditional weight safety management.

Keywords: *Smart Construction, Building Information Model, Internet of Things, Quality Traceability System;*

1. Introduction

The scale of construction projects is large, and it is difficult to grasp the coordination of various departments and organizations. Therefore, safety and quality management are correspondingly extremely difficult[1-3]. Traditional manual safety and quality management methods are difficult to completely solve, and they are extremely efficient and low-cost. The rapid development of the Internet, and the emergence of new construction technologies, have greatly improved the safety and quality management of construction enterprises[4-6]. This paper introduces new methods of safety and quality management of construction enterprises through this new technology, and makes contributions to the safety and quality management of traditional construction enterprises in my country.

2. Trend analysis of safety management and control work

The "13th Five-Year Plan for Work Safety" clearly stated that the current work safety work needs to be reformed and guided, driven by innovation, to accelerate the six types of innovation processes including theoretical innovation and technological innovation in production safety, and to establish an emergency response to the in-depth integration of information technology and safety production. On-site hazard identification, detection and assessment mechanisms, dynamic collection of emergency rescue information, and decision-making analysis mechanisms are required. At the same time, the formulation of planning goals requires that the total number of accidents be significantly reduced, and major accidents have been effectively contained.

Figure 1 shows the production safety accident data of housing and municipal engineering from 2004 to 2016. From the historical data shown in Figure 1, the total number of safety accidents and the number of casualties in my country's engineering construction field in the past ten years have been effectively controlled, and the existing safety The production management system has achieved remarkable results. However, in recent years, the marginal diminishing effect of the safety management system has gradually become prominent, and the data of safety accidents fluctuates to a certain extent, especially in 2016, there has been

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July - August 2020
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a large data rebound, and even a particularly serious safety accident.

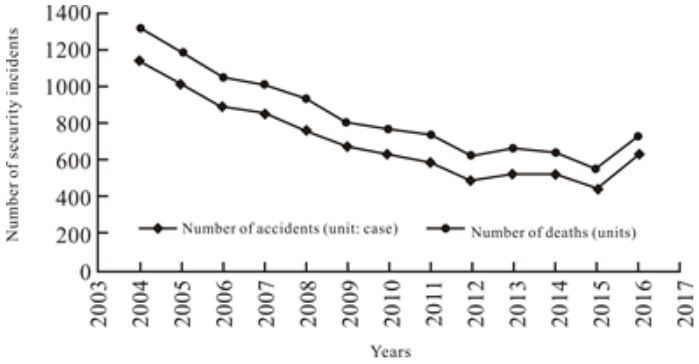

Figure 1. Data on production safety accidents of housing and municipal engineering from 2004 to 2016.

The safety and quality management model of construction enterprises simulates the impact of management on work progress and labor productivity. It uses the exponential mathematical relationship of the ratio of the number of safety and quality management of construction enterprises to the number of workers. If there is no management, it assumes that the safety and quality management of construction enterprises can be assumed in this way, using the following formula to calculate the "generation factor":

$$PF = 1 - \frac{0.5}{e^{R}} \quad (1)$$

Where PF = productivity factor

with

$$R = \frac{Number\ of\ foremen}{Number\ of\ operatives}$$

Then, the final duration of the activity can be calculated as the maximum duration based on enterprise safety and quality divided by the productivity factor indicated in Equation 2.

$$D = \frac{D_i(max)}{PF} \quad (2)$$

The planning goal of "significant reduction in the total number of accidents" contains three main points. One is to reduce the total amount, the other is to reduce the degree to a large extent, and the third is that this situation must be sustainable within a few years. There are several realizations of these three points. Realistic obstacles.

1) Continuing to strengthen the existing safety management system will consume doubled human, material and financial resources, and the efficiency and effectiveness of safety management will not improve much, affecting the realization of other goals and affecting the reasonable allocation of social resources.

2) The engineering construction field is highly mobile, safety awareness and technical level are uneven, construction procedures and environment are also undergoing major changes every day, and project safety assurance is difficult to maintain a stable normal state.

3) The programmatic problems of safety management work are prominent, the lack of a reasonable risk and cost sharing mechanism, and the fragility of the safety management system are prominent.

4) The fragmentation of safety management information is obvious, and the accuracy and efficiency of information sharing and use are low, which weakens the role of safety early warning and emergency response mechanisms.

It is necessary to actively explore the hidden regularities behind the safety accident data, adhere to the existing safety management system practices and consolidate the effectiveness of management and control, but also study the vulnerabilities of the existing safety management system. In the specific implementation, it is necessary to gradually eliminate the high-consumption and low-efficiency safety management response strategies, and promote the deep integration of information technology and safety production.

3. Key points of quality and safety management

1) On-site inspection information

Use the on-site management mobile terminal to carry out on-site inspections, problem rectification, and project acceptance, realize paperless office,

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July - August 2020
ISSN: 0193-4120 Page No. 6006 - 6013

achieve full-informatization of process management, and improve on-site management.

2) Quality and safety management based on BIM

The BIM model is the carrier of building information transmission. The quality and safety information of building components is linked to the BIM model to establish a digital archive of the entire process of on-site quality and safety management based on BIM.

3) Quality traceability of fabricated components

Use two-dimensional codes and RFID chips as tracking means to do a good job in the quality management and traceability of the assembled parts throughout the process.

4) Panoramic monitoring

Using oblique photography technology, using remote presentation methods such as PC and mobile, to achieve all-round and multi-view remote monitoring of the construction site.

4. Quality and safety management information implementation framework

The security management and control framework based on the perception of the Internet of Things uses perception technology and communication technology as the information input technology, and uses the security management and control information platform as the management and control interface to realize information perception, interaction, sharing and application, and serve more accurate and effective security management. . This paper proposes a construction safety management and control framework based on the perception of the Internet of Things as shown in Figure 2, emphasizing the establishment of a shared database, from which to obtain shared information from the enterprise itself, regulatory authorities, cooperative units, scientific research institutes and other places; in the safety monitoring information platform Adopting the design standards of visualization, dataization, and automation, timely obtain relevant information and serve the implementation of each functional module; in terms of function, in addition to adhering to the regular safety inspection module, the content design of the other 9 modules is also carried out to improve the initiative. The efficiency of protection, emergency warning, monitoring and testing, and education and training.

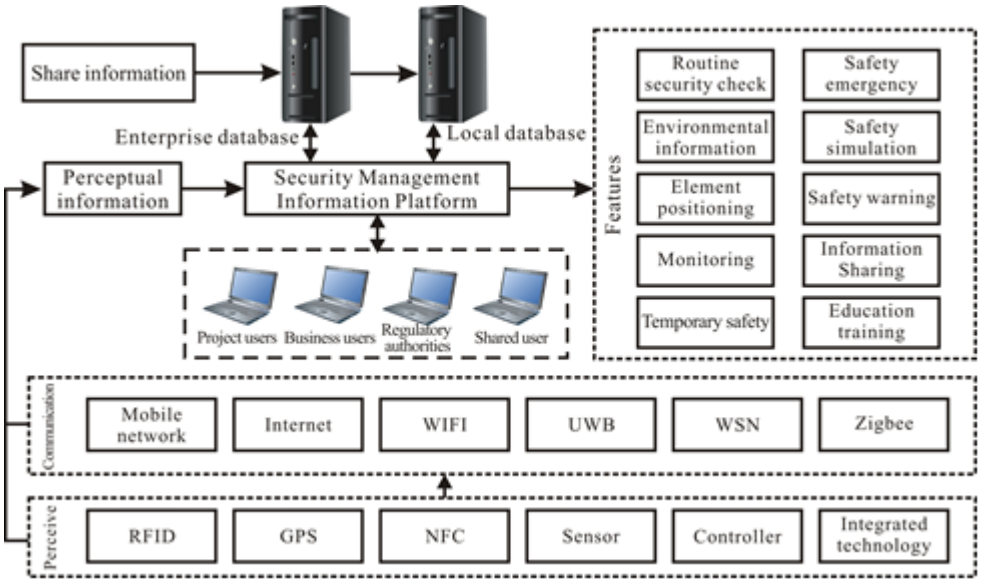

Figure 2. Construction safety control framework based on IoT perception.

1) Basic function modules. Environmental information, element positioning and monitoring and detection modules are basic functional modules. Acquire real-time environmental information during the construction process according to the needs of the project to form a comprehensive grasp of the

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July - August 2020
ISSN: 0193-4120 Page No. 6006 - 6013

construction environmental information. Provide support for safety protection, safety early warning, etc. The element positioning module will perceive the status and location of the human resources machine in real time, and realize functions such as personnel management, asset management, fatigue construction prevention, and trajectory tracking. The monitoring and monitoring module will integrate construction safety monitoring and detection information through video monitoring, elevator monitoring, precipitation monitoring, displacement monitoring, power monitoring, rainfall monitoring, etc., to reduce errors in human monitoring data.

2) Protection function module. Real-time safety, safety emergency, safety warning and safety simulation modules are protective function modules. Among them, the real-time security module uses ultrasonic ranging, infrared sensing and other technologies to prevent collisions between T2T and H2T and prevent falls from the edge of the tunnel through active warning, information prompt, and automatic shutdown. The safety emergency module implements emergency procedures, emergency responsibilities, etc., and associates them with element positioning modules to ensure timely detection, correct handling and system records in emergencies. The safety warning module will make safety judgments based on the information provided by the environmental information and other modules, and use the built-in warning indicators and warning methods to issue safety warning information. The safety simulation module lists safety hazard information according to project types and shared information, and simulates safety scenarios through methods such as routine safety hazard investigation, accident case analysis and reference, and on-site operation safety simulation to prevent safety hazards.

3) Auxiliary function module. Information sharing and education training modules are auxiliary function modules. The information sharing module has a close relationship with the basic functional modules. One is to share information on the natural conditions, construction conditions, and safety management of the project site; the other is to share and extract information from other companies, other projects, and other data sources to serve the local Safety management work. The education and training module is based on the safety knowledge base, accident case library, construction technology points, and uses real scene experience, operation simulation, virtual reality, etc. to carry out safety training, special training and job evaluation

5. Engineering application

5.1. Mobile inspection

The project uses the on-site management APP to conduct on-site quality and safety management, and implement daily inspections, problem rectification, rectification review, and project acceptance. Using the combination of mobile terminal and Internet of Things technology, real-time upload, local storage and interface sharing are used to realize mobile management of business work, real-time collection of construction site management data, intelligent identification and automated management of construction site control factors.

When the project management personnel conduct on-site inspections, they log in to the on-site management APP, find the problem, click the corresponding module, select the inspection site, and take photos to record the inspection. Among them, the inspection items that do not meet the standards should be rectified based on the seriousness of the danger, and the basic information of the rectification should be filled in to form a rectification notice, which will be pushed to the relevant on-site management personnel, and the on-site management APP will reply after the rectification is completed. Realize the efficient collaborative work mode of "discovering quality/safety issues → assigning rectification → making rectification → reviewing sales items". Set up information exchange channels and complete and efficient online work processes throughout all positions to realize paperless office.

The actual measured data is collected in real time through the mobile terminal, the data is entered in

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ISSN: 0193-4120 Page No. 6006 - 6013

time, to avoid secondary data processing, and the qualification rate is automatically analyzed according to the built-in measurement standards of the system, and the data is synchronized and summarized to the web management platform database in real time, hierarchical, divided into labor, The actual measurement results can be displayed visually by process and by post, which is convenient for enterprise management to understand the construction situation on site in time.

5.2. Web management platform

The project builds a web-side management platform, connects the various positions of on-site construction management horizontally, and vertically penetrates the information channels of on-site management personnel-project management-company leaders, and internally incorporates all parties involved in construction such as general contractors and subcontractors, and externally The construction party, the supervisory party, the government supervision department and other units have been docked to form a comprehensive and efficient and coordinated management model.

Through the web-side management platform, the quality and safety director formulates quality and safety management goals and on-site management plans, determines key parts according to project characteristics, and formulates weekly work arrangements for on-site management personnel to improve the pertinence and effectiveness of on-site management. Tracking the daily inspection documents and problem rectification through the collaborative platform to ensure the orderly progress of on-site management.

On-site management personnel use the mobile terminal of the mobile phone to carry out quality inspection, problem rectification and other work. The management process data is summarized in the background database, and various reports are obtained through analysis. Through reports, project managers can easily obtain information about the completion of work by related personnel, the distribution of quality problems, and the progress of various tasks. Realize online monitoring and tracking of quality management work, strengthen the pertinence of on-site management, and improve the level of on-site management.

5.3. BIM-based quality and safety management

Use mobile terminal inspection to collect quality and safety issues and rectification data, gradually establish a quality and safety issue database, and count the number of quality and safety issues, the number of rectification response questions, the number of issues to be reviewed, and the completion rate of rectification. The naming rules of the components in the project BIM model are the same as the naming rules of the daily inspection parts on the on-site management APP side, which can ensure that the quality and safety management forms in the database can be automatically associated through the BIM model parameters, and the quality and safety management data can be displayed on the BIM model. Quality and safety inspections and process inspections can be accurately positioned on-site with the help of BIM models

The project uses a large screen to display project management information, centrally integrates quality and safety management data, and visually displays the platform's statistical analysis results, mainly including the following.

1) On-site quality monitoring. The GIS icon in the BIM model shows the quality picture or problem at the corresponding location on the spot.

2) Statistics of quality problems. The overall display shows the number of quality inspections, the number of rectifications issued, the number of rectifications that have been made, and the completion rate of rectification.

3) Quality problem analysis. Count the quantity of quality problems by region (location), time, subcontractor, and responsible person.

4) Weekly/monthly reports on quality issues. Update the detailed quality descriptions weekly/monthly.

5.4. Quality traceability system

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The prefabricated building quality traceability system is based on the industrial chain of the entire process of prefabricated building production. It collects parts design, raw material storage inspection, production process inspection, parts outgoing inspection, transportation process, assembly process, supervision and acceptance process, and the whole life Periodic quality data, in accordance with current construction laws and regulations, realize the integration of information technology and current construction standards and norms. The parts adopt RFID technology (two-dimensional code identification, etc.) to realize the traceability of building quality. Realize the interconnection between things and people, things and things, as shown in Figure 3.

The RFID chip embedded in each part and the pasted two-dimensional code are bound with a unique numbered radio frequency chip to achieve single piece management. The RFID chip is used to realize the information perception of the parts and components from production to installation, and the RFID chip reader is used to collect key information and transfer it to the cloud database of the system in real time to realize the fast and seamless connection between information flow and physical logistics.

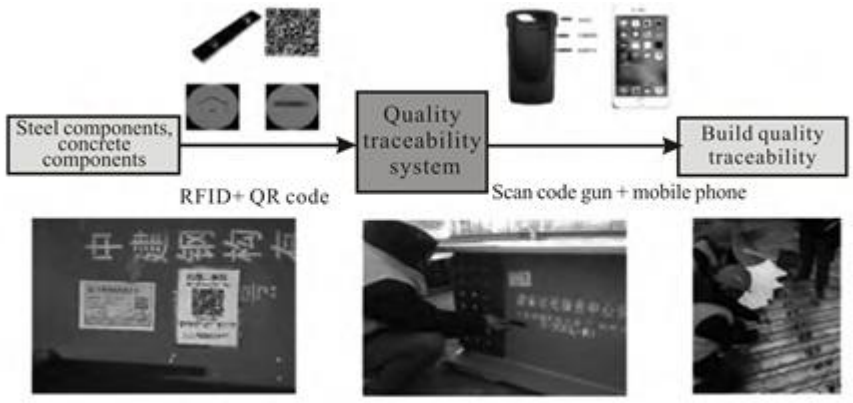

Figure 3. Quality traceability system.

The data collection and approval query of the quality traceability system are carried out using the PC terminal + APP terminal, which is convenient for users to view the quality information data of the key points in the production phase, construction phase, and operation and maintenance phase of the parts in real time, and realize the quality tracking of the entire life cycle of the prefabricated building And management.

5.5. Panoramic monitoring

The project builds a high-definition video monitoring system at the entrances and exits of the construction site, processing plants, project office areas, workers' dormitories, parking lots, fences, etc., and remotely monitor the detailed conditions of each area of the construction site at any time through mobile phones and computers, and track production progress , Check the working status of workers. Support real-time acquisition of high-definition digital video and pictures, real-time monitoring of the scene, early detection of safety hazards and timely handling, so as to maximize the safety of workers.

Using tilt photography technology, a camera is mounted on the UAV platform to collect live images from five different angles, including vertical and tilt, to obtain complete and accurate information on ground objects. By recording the GPS coordinates of each photo taken, the photos can achieve 30% sideways overlap and 66% heading overlap, which can be used to synthesize 3D aerial survey real scene models through real scene modeling software. Then

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put the video surveillance anchor point in the real scene model, and quickly view the surveillance picture by clicking the surveillance point in the real scene, and carry out remote omnidirectional and multi-view video surveillance of the construction site.

5.6. Smart fire protection

Intelligent smoke detectors are installed on the construction site to sense and generate smoke when a fire occurs, prompt sound and light alarms, and automatically push the alarm information to the management staff APP to improve the fire response ability, effectively prevent the expansion of the fire, and protect the construction personnel And site property safety.

5.7. Vehicle entry and exit management

The project carries out automatic license plate recognition and registration of vehicles entering the construction site, and records the time when vehicles enter and exit the site. Through the safety monitoring of vehicles, effectively regulate the entry and exit of vehicles on the construction site, prevent foreign vehicles from entering at will, ensure the safety and smooth implementation of the project, and protect the safety of vehicles and personnel.

5.8. Emotion recognition system

The project attempts to introduce the "safe production emotion recognition system", which actively recognizes the tiny amplitude and frequency of the facial muscles of the personnel, and through calculation and analysis, the potential emotional conclusions of the construction personnel can be drawn. The project will do a good job in safety training and psychological counseling for construction workers, and if necessary, dissuade workers from leaving to prevent production safety accidents.

5. Application effect of quality and safety management

Comprehensively comparing the research and application practices of the coal and construction industries in digital production decision-making and IoT perception technology, there are still many obstacles to the implementation of the construction safety control framework, which are mainly reflected in the development and application of the core platform, the cost sharing mechanism of the control system, and the material Scenario applicability adjustment of networked perception technology, etc. Therefore, the safety management theory and technological innovation of coal construction enterprises must be a process of advanced design, step-by-step implementation, key breakthroughs, and point-to-round.

In particular, it is important to point out that the safety management of coal construction enterprises should make full use of existing scientific and technological development achievements and innovate in safety concepts and usage modes, and apply BIM construction, wearable device research and development, virtual simulation technology, etc. to safety training, safety The whole process of confession and safety control. It is also necessary to comprehensively consider the safety management and control work, construction project management, and post-completion operation phases, and explore the connection between various safety measures, the pre-laying of sensing and communication networks, and the cost-sharing model of sustainable network environment construction to avoid duplication. Construction to improve the efficiency of capital use.

6. Conclusion

The Citizen Service Center project comprehensively utilizes BIM, Internet of Things, big data, artificial intelligence, mobile communications, cloud computing and other technologies to explore new measures for comprehensive, efficient and collaborative quality and safety management on the construction site under the smart construction mode. Through information technology, it realizes the efficient coordination and seamless connection of various inspection links and personnel of various positions in on-site quality and safety management;

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relying on the quality traceability system based on the Internet of things, realizes the whole process information collection and quality data traceability of assembled components; uses BIM Technically assists in the on-site inspection of the precise positioning of building components; adopts intelligent measures such as automatic vehicle identification to ensure the safety of daily personnel and vehicles of the project; improves the information and intelligent level of construction site quality and safety management, and promotes the sustainable development of the construction industry.

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