



Research on Application and Innovation in Civil Engineering Construction Management

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Abstract

Civil engineering construction management covers a number of management objectives such as time, cost, quality and carbon emissions, and is the key to determining the success of the projects. This paper starts from the basic connotation of construction management, analyzes the existing problems in the current construction management, and summarizes the existing methods and technologies on the emerging technologies, whole process monitoring, multi-party cooperation mechanism, standardized and refined management. Through in-depth discussion of the practical application of construction management methods, based on the perspectives of intelligence, low carbonization and information, it provides an effective path for the innovation and optimization of construction management methods, and provides theoretical support and practical reference for the green and sustainable development of civil construction industry.

Subject Areas

Civil Engineering

Keywords

Civil Engineering, Construction Management, Application, Innovation

1. Introduction

Civil engineering is the core field of national infrastructure construction, and its construction quality directly affects public safety, economic development and social welfare. However, with the improvement of the green transformation requirements of the construction industry and the increase of the complexity of the project, the traditional construction management concept and methods have been unable to meet the actual needs of modern construction projects, and ensure the

quality of civil engineering projects has become the focus of key research inside and outside the industry. Construction management should not only ensure the smooth progress of the project, but also take into account many factors such as time management, economic value, social responsibility and environmental benefits. Innovation and optimization of management methods and technologies are of great significance for improving the quality of construction projects, improving the utilization rate of construction resources, ensuring social harmony and stability, and sustainable development of the construction industry. This paper aims to analyze the current status of civil engineering construction management, explore the challenges of construction management methods and the direction of future innovation and improvement, in order to provide help for the stable development of the construction industry.

1. Concept and Significance

Construction management refers to the effective organization, coordination, control and supervision of the whole construction process through the use of scientific management methods and technical means in the process of project implementation, to ensure that the project is completed in accordance with the established objectives, and to ensure that each link in the construction process and the final construction results meet the requirements of safety, function, beauty, durability and environmental friendliness. The core content of construction management includes ensuring engineering safety and quality, directly related to the safety performance of buildings; improving project economic benefits and reducing quality defects can reduce maintenance costs and increase project return on investment; Enhanced environmental friendliness, high-quality construction can help reduce resource waste and environmental pollution, among other aspects. Of course, the factors that affect the quality of civil engineering construction management are also many, including personnel, technology, management, geographical environment and market environment, policies and regulations and other dimensions, the need for managers to work from multiple angles to maintain the efficiency of project management [1].

In the construction stage of civil engineering projects, the process operation is complicated, the cycle is long, the capital demand is large, and multiple management objectives are involved, which directly affects the overall benefit and sustainability of the whole project. Only by effectively implementing construction management can we ensure the overall quality of the project and complete it on time, thus ensuring the safety of people's lives and property [2]. Engineering accidents caused by extensive construction management will not only pose a threat to the life safety of the masses, cause significant property losses, but also bring serious negative effects to the society. For example, construction personnel lack a clear sense of construction quality management, resulting in the implementation of construction specifications is not in place [3]. In order to save construction costs and time, take some unreasonable and illegal operation means in the

construction stage, and even there may be shoddy construction materials, arbitrarily shorten the construction process time and other “work cheating” phenomenon. While these violations may reduce construction costs in the short term, they increase long-term risks and pose a significant threat to project quality and safety. When the building is put into use, there will be all kinds of potential quality problems, the results of which are unimaginable. Therefore, ensuring the quality of construction projects has become an urgent task in civil engineering project management.

2. Problem Analysis

In the actual construction process, due to the complex interweaving of various construction factors, there are still many problems in the management of civil engineering construction projects, which are analyzed from the aspects of imperfect management mechanisms, low degree of information, insufficient on-site supervision, and backward construction technologies.

2.1. Imperfect Management Mechanisms

Lack of effective management mechanisms, responsibility is not clearly defined. The construction process of civil engineering involves complex operation, close connection, and high management difficulty, and the construction management system established by relevant management departments and enterprises, in the process of top-down transmission, the effectiveness of the system will continue to weaken and become very vague. In the absence or imperfection of the management system, the definition of responsibilities is not clear, once there is a construction problem, it is often difficult to quickly locate the responsible person, which affects the timely solution of the problem. This unclear state of responsibility not only increases management costs, but also may pose a potential threat to project quality and safety [4]. For example, some projects fail to set clear goals according to the characteristics and needs of the project at the start-up stage, or the management goals are too vague and lack of operability, which will lead to unclear management direction in the project implementation process. Some projects have loopholes in the accountability system or ineffective implementation, and have not carried out reasonable and orderly responsibility allocation according to the actual situation, which will cause confusion in management work. In the face of problem situations, multi-party responsible persons do not make clear their own responsibilities or shirk their responsibilities, resulting in the failure to investigate the relevant responsible persons when construction problems occur, thus failing to form an effective deterrent and restraint effect. Therefore, improving the construction management system and ensuring that the system can be effectively implemented in combination with the actual project can play a positive role in the overall benefit of the project [5].

2.2. Low Degree of Informatization

In the past, manual paper records were less efficient and prone to errors. A large

amount of data and information generated during the construction process is transmitted in the form of paper or electronic forms, which easily leads to problems such as information loss, delay in transmission and misunderstanding, thus affecting the formulation and execution of the construction plan [6]. At the same time, the traditional manual experience judgment and decision are difficult to meet the high precision requirements in modern complex engineering. With the progress of science and technology, the informatization level of construction management is gradually increasing. Construction enterprises can monitor various indicators of construction sites in real time through information technology, formulate a more scientific and reasonable construction management plan, and lay a good foundation for subsequent decision-making work. However, in the actual construction operation, the information utilization rate needs to be improved, and it is difficult to ensure the synchronization and sharing of dynamic supervision information on the construction site, and it is impossible to find and correct construction problems in time [7].

2.3. Insufficient On-Site Supervision

On-site supervision work is very important, supervision and management are not standardized will seriously affect the construction quality, the construction quality poses a hidden danger. The regulatory measures adopted by civil engineering construction, the lack of substantive management means, although the development of the construction management system, but the professional quality of the relevant staff is low, the implementation of the intensity is not high, resulting in the management of civil construction is more formalized. In addition, the professional quality of the relevant staff is not high, lack of engineering practical experience, easy to ignore the importance of construction management. Construction supervision should carry out strict control in all aspects of the project, and management measures should run through all construction links of the project implementation, but some projects have problems such as lack of management measures or poor implementation. For example, the quality inspection in the construction process is not strict, and the quality record is not perfect, which will lead to the omission or cover up of quality problems, so that the overall project has serious quality problems, and greatly increase the risk of repair.

2.4. Backward Construction Technologies

Some construction units have low acceptance of the new technology, and the technology application is not in place. The use of advanced construction technology and equipment can improve the speed and quality of construction and reduce the waste of resources and labor costs [8]. However, due to the lack of in-depth understanding of the potential advantages of advanced technology, some construction units, due to cost control considerations, the introduction of new technology requires supporting equipment and technical support, will increase short-term investment, fail to realize its long-term value to improve construction efficiency and

quality, downplay its long-term benefits in improving construction accuracy, shortening the construction period and reducing rework costs. At the same time, the technology reserve and personnel training system is not perfect, resulting in the practical application of new technologies is inefficient and can not give full play to its advantages.

3. Application of Specific Methods

3.1. Intelligent Management of Emerging Technologies

Emerging technologies provide new opportunities for construction management. Through the introduction of building information modeling (BIM), Internet of Things (IoT) and other scientific and technological means, the digitization and intelligent construction management of the whole construction process are realized. For example, the use of BIM technology to compare with the design drawings to find the quality problems existing in the construction process in time to ensure that the construction quality meets the design requirements [9]. Using the capabilities of BIM's cloud platform, managers can conduct dynamic simulation exercises throughout the construction process and gain a clearer understanding of their own workflow and professional cross-cutting issues. This early risk identification and understanding of the key and difficult points of work not only improves the efficiency of communication and coordination in construction, but also enhances the overall management results [10]. Construction units can also monitor key processes and mechanical equipment on the construction site through the IoT technology to improve construction quality and reduce the failure rate of equipment. Emerging technologies have good development prospects in the field of construction management, but the implementation of technologies will bring high capital, human resources and other resources investment, resulting in small and medium-sized construction enterprises in the promotion and application process facing greater pressure.

3.2. Whole Process Monitoring

The whole process monitoring not only requires all-round control of the construction process, but also includes the inspection of the site environment, safety facilities and other aspects, which can timely detect potential management problems, so as to avoid small problems from evolving into major accidents [11]. Construction management is the result of the construction subject's coordinated management of multiple objectives under the premise of safe operation. Through the control of construction objectives and the seamless connection of each construction link, a complete management closed loop is formed to improve the overall quality and reliability of the project. During the construction preparation stage, visualization and simulation analysis of construction plans are conducted, along with the accurate completion of drawing reviews and material acceptance. In the construction phase, process inspections and safety checks are implemented to dynamically control the construction progress, while a data monitoring system is

used to collect real-time construction data. At the completion phase, a scientific and rigorous acceptance process is adopted to further ensure the quality of the final project delivery.

3.3. Multi-Party Cooperation Mechanism

Design units, construction units, supervision units and owners are deeply involved. Through the establishment of a division of responsibilities system, clear responsibilities of all parties, the use of efficient project management communication platform, to achieve real-time information sharing and rapid feedback of problems. In addition, the application of intelligent task allocation and progress tracking tools can dynamically adjust the resource allocation of all parties, enhance the efficiency and accuracy of collaborative work, and provide strong support for the continuous improvement of construction management quality. However, in the process of multi-party collaboration, all parties will face organizational culture differences, technical difficulties in information sharing, conflict of interest and responsibility shifting, cross-field cooperation and coordination and other obstacles. Therefore, the relevant parties need to fully communicate, clarify their respective roles and responsibilities, strengthen technical training and support, overcome these difficulties, and ultimately achieve efficient, precise and collaborative project management.

3.4. Standardized and Refined Management

Standardized and refined management are the key measures to improve construction quality. Through the formulation of unified construction specifications and operation manuals, combined with intelligent algorithms to carry out multi-objective optimization of the construction process, it can ensure the consistency of construction standards and the efficiency of implementation schemes, and provide intuitive operation guidance for construction personnel. At the same time, pay attention to the construction personnel professional quality and technical level of training and improvement [12]. The use of online training platform to carry out professional training, improve the skill level of construction personnel, enhance their understanding of standardized operation and execution ability, not only enhance the overall ability of the construction team, but also lay the foundation for the implementation of standardized management. In addition, in the process of implementing standardized and refined management, it is necessary to consider the feasibility of technology implementation, the adequacy of personnel training, the difference in management cognition, and the reasonable allocation of capital and human resources.

4. Innovation and Optimization Directions

In order to meet the needs of the sustainable development of the construction industry, the future construction management should pay more attention to the application of intelligent and automated technologies, and promote the digital

transformation of the whole construction process, so as to improve the construction efficiency and quality. In addition, strengthening the concept of green construction and sustainable development, and integrating environmental protection technology and green building materials into the entire construction process will also be an important direction of future development. At the same time, the establishment of a unified national construction management platform and the improvement of the standardization system will help improve the overall efficiency of management and the execution of the industry. Through these innovations and optimizations, civil engineering construction management will provide solid support for the sustainable development of the construction industry and contribute to creating a safer, more efficient and environmentally friendly built environment.

4.1. Promoting the Application of Intelligent and Automated Technologies

Increasing investment in scientific research and promoting the application of intelligent and automated technologies in construction sites is an important way to realize intelligent construction management. For example, construction robots can perform high-precision, high-repeatability and high-risk tasks, such as concrete placement, welding, painting and other processes, which significantly improve construction efficiency and safety while reducing human error. In addition, combined with data analysis and machine learning technology, intelligent analysis of real-time video surveillance on the construction site can quickly identify potential construction conflicts and problems, and provide optimization recommendations to improve management accuracy and response speed.

Although there is great potential to promote the application of intelligent and automated technologies, there may be some difficulties in the future development process. For example, the high cost and complexity of construction equipment and technology may be difficult for small and medium-sized enterprises to bear, and the construction site data collection and processing infrastructure is not yet complete, which will limit the application effect of technology. The existing staff training system and skill reserve may be insufficient, resulting in poor adaptability of new technologies, and it is difficult for multi-departments to realize the effective connection between intelligent technologies and traditional processes. The government's support for the application of new technologies is insufficient and the relevant regulations lag behind, and the promotion of intelligent and automated construction technology requires the government to provide support in terms of policies, funds and standards, but in many regions, the policy support and application of such technology is still at an early stage, requiring further policy guidance and legal protection.

4.2. Strengthen Green Construction and Sustainable Development Concept

Promoting the high-quality development of green construction, implementing

fine management, optimizing the construction process, and ensuring the quality and efficiency of construction projects are the keys for construction enterprises to gain competitive advantages in the marketplace [13]. Integrate the concept of green building, improve the utilization of resources and reduce the impact on the environment by optimizing the construction process and construction organization plan. The use of prefabrication, dust-free construction, garbage recycling and other technologies can effectively reduce dust, noise and carbon emissions, and reduce interference to the surrounding environment. Prioritize the use of renewable, low-energy, low-pollution materials to reduce the carbon footprint and improve the environmental performance of the project. Through the comprehensive monitoring of construction environmental indicators, and the introduction of third-party assessment agencies to ensure that the construction quality and environmental objectives are coordinated.

Although the promotion of green construction and sustainable development concept is of great significance to improve the environmental protection level of the construction industry, it also faces some challenges in the practice process. First of all, the cost of updating technology and equipment is high, especially when promoting advanced technologies such as assembly-type construction and dust-free construction, the initial investment is large, and some construction units may have concerns about the adoption of these new technologies due to cost pressure. Secondly, the supply of environmentally friendly materials may also become a constraint, especially in some areas, the supply of renewable, low-pollution building materials is limited, and the market price of these materials is high, increasing the cost of construction. Thirdly, the environmental awareness and technical level of construction personnel are uneven. Although some projects can improve workers' understanding of green construction through training, there are still some construction personnel who lack active cooperation with environmental protection measures, which may affect the implementation of environmental protection measures in the construction process. Finally, the imperfect supervision and evaluation system will also affect the realization of green construction goals. Some projects lack a perfect supervision mechanism, and the actual effect of green construction is difficult to quantify, resulting in the goal cannot be effectively achieved.

4.3. Establish a Unified National Construction Management Platform

Through national policy support, promote the establishment of a nationwide construction management information platform to improve the overall level of the industry. To realize the whole life cycle traceability of construction problems, when construction problems occur in the project, the source of the problem can be quickly traced, the responsible body can be clearly defined, and improvement suggestions can be provided to reduce disputes and resource waste caused by information asymmetry. Store and analyze key data such as engineering drawings,

construction plans, material inspection reports and quality inspection records to ensure transparency and standardization of the entire construction process. At the same time, through the establishment of data interface and industry information system interconnection, to provide real-time and comprehensive data information for project management, supervision departments and owners.

The construction of a national unified construction management information platform has significant long-term benefits, but in the implementation process, the technical, management and policy difficulties can not be ignored. To ensure the smooth implementation of the platform, the joint efforts of the government, enterprises and various stakeholders are needed to solve a series of issues such as cross-departmental coordination, data compatibility, security protection, standardization implementation, and personnel training. Through perfect policy support, effective management measures and continuous technological innovation, we can gradually overcome these challenges and promote the construction management into a new era.

5. Conclusion

The civil engineering construction management is crucial for ensuring project safety, economic efficiency, and sustainable development. In recent years, continuous optimization of construction management methods has not only facilitated the smooth implementation of projects but also significantly enhanced the comprehensive value. However, as the construction industry transitions toward intelligence, sustainability, and green development, higher demands are being placed on construction management, necessitating further improvements to existing methods. Implementing scientifically sound management measures, promoting the application of intelligent and automated technologies, strengthening green construction and sustainable development concept, and establishing a unified national construction management platform will better meet the industry's development needs and create a better living and working environment.

Conflicts of Interest

The author declares no conflicts of interest.

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