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Innovation Model of Civil Construction Engineering Management Based on Construction Concept

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Abstract: Civil engineering is a complex and huge system engineering, which requires collaborative cooperation involving multiple fields and specialties. The traditional civil engineering management model has some difficulties and challenges in project schedule control, quality management and cost control. In order to improve the management effect and project performance of civil construction engineering, it is necessary to introduce an innovative management model, that is, an innovative model based on construction concepts. The analysis of the innovative model of civil construction engineering management based on the construction concept in this paper aims to optimize resource scheduling, improve the accuracy and implementability of construction plans by introducing advanced technologies and methods, thereby improving project management efficiency, enhancing project quality control, reducing costs and risks, and facilitate information sharing and collaboration. According to the experimental results, it can be known that the performance of the innovative model of civil construction engineering management based on the construction concept is also very good, and the effects in project schedule control, quality management effect, and cost control are all good. The innovative model based on the construction concept has promoted the transformation and progress of the management concept of civil construction engineering, and stimulated the innovation vitality of the industry. This not only helps to improve the competitiveness of the industry, but also provides a practical basis and reference experience for technical research and development in related fields.

1. Introduction

The traditional civil engineering management model is often unable to achieve accurate control of project schedule, continuous improvement of quality and effective control of cost when faced with complex projects. This is due to the lack of an effective information transmission mechanism in the traditional model, resulting in poor coordination among all parties involved in the project, inefficient use of resources, and failure to detect and correct quality problems in a timely manner. With the continuous development of information technology and the wide application of intelligent equipment, such as BIM technology, Internet of Things technology and big data analysis, etc., it provides new possibilities and opportunities for civil engineering management. These technologies

and concepts can realize real-time monitoring and precise control of project progress, quality and cost, thereby improving management efficiency and precision. The innovative model based on the construction concept adopts BIM (Building Information Modeling) technology and real-time monitoring methods, which can more accurately understand the progress of the project, and adjust and coordinate the progress of various tasks in a timely manner. By optimizing resource utilization and scheduling, it can better control the project schedule, improve construction efficiency and project delivery speed.

Scholars from various countries have begun to pay attention to the innovative model of civil construction engineering management based on construction concepts, and have carried out some research and application. These studies mainly focus on the application of BIM technology, the construction of digital quality management system, the application of intelligent equipment and cost control technology. In recent years, with the vigorous development of the construction industry, as a relatively important part of the construction industry, civil engineering has also developed rapidly. In civil engineering construction, engineering construction and cost management issues have a direct impact on the quality of the project, which may endanger personal safety and property safety, and is not conducive to the development of construction enterprises. Based on this, Meng Shumei deeply discussed the problems of civil engineering management and cost control and the corresponding countermeasures for reference [1]. The construction industry is a pillar industry of China's national economy, which is closely related to people's lives to a large extent. Therefore, it is imperative to strengthen the management of civil construction projects and comprehensively improve the overall quality of construction projects. Accordingly, Gao Shuo mainly analyzed the risk management in civil construction engineering in detail, and proposed some effective control strategies [2]. The scale and quantity of projects in China's modern civil engineering industry are gradually increasing. Especially in recent years, due to the steady growth of the national economy and the improvement of people's living standards, the construction industry has also achieved unprecedented development and achieved outstanding achievements. Construction management plays a vital role in the development of construction projects. What Xu Jiao explored is how to manage scientifically and effectively in the face of complex construction projects, because it is related to the development and benefits of construction enterprises [3]. The construction link of civil engineering buildings is an important part of the construction process, which affects the quality of the overall project engineering. The implementation of all-round construction management for civil engineering is convenient to enhance the overall economic and social benefits of construction enterprises and ensure the quality and safety of project engineering. However, in the actual construction environment, there are a large number of safety hazards and problems in the construction of civil engineering, which affect the quality and safety of construction projects. Li Haiwei proposed corresponding governance measures to ensure the quality of civil engineering construction and promote the orderly development of the civil engineering industry [4]. But none of them have analyzed the principles based on the construction concept.

The analysis of the innovative model of civil construction engineering management based on the construction concept aims to optimize resource scheduling, improve the accuracy and enforceability of construction plans, improve project management efficiency, strengthen engineering quality control, reduce costs and risks, and promote information sharing and collaboration. The practical significance of this innovative model lies in improving project efficiency, ensuring project quality, reducing costs and risks, and promoting industry development.

2. Construction of Innovative Model of Civil Construction Engineering Management Based on Construction Concept

The construction of an innovative model of civil construction engineering management based on construction concepts is of great significance for improving project efficiency, quality control, cost management, and risk control [5-6]. It can not only improve the management level of a single project, but also play a positive role in promoting the development of the entire industry. The specific construction process of the innovation model of civil construction engineering management based on the construction concept is shown in Figure 1.

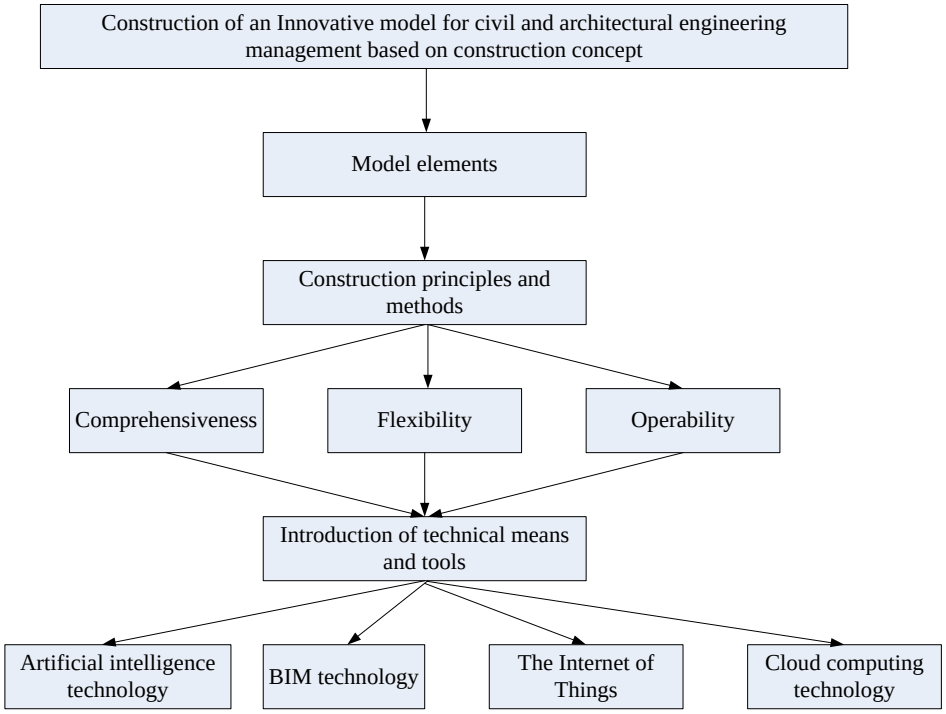


Figure 1: Construction process of innovative model of civil construction engineering management based on construction concept

2.1 Model Components

In the innovation model of civil construction engineering management based on construction concept, the elements of the model are crucial [7-8]. These elements form the basis of the entire model and play a key role in achieving successful project management and innovation.

The first element of the model is the construction concept. Construction concept refers to a way of thinking, management method or working concept adopted in the implementation of civil engineering projects. These concepts can include refined management, whole process control, information support, etc. The selection and application of construction concepts have an important impact on the management effect and innovation ability of the project.

The second element of the model is civil construction project management [9-10]. Civil engineering management refers to the process of planning, organizing, directing, controlling and evaluating civil engineering projects [11-12]. In the model, civil construction engineering management needs to be guided by the construction concept, and integrate various management activities to ensure that the project is completed efficiently and with high quality according to the established goals [13-14].

The third element of the model is innovation. Innovation plays an important role in civil construction engineering management [15-16]. The model needs to contain innovative thinking and methods, and encourage team members to propose new ideas, technologies and solutions to promote the continuous development and improvement of the project.

The fourth element of the model is the operating mechanism and evaluation method of the model. An effective model needs to have a clear operating mechanism and evaluation method, so as to monitor and evaluate the management effect of the project, and make adjustments and improvements in time.

The elements of the innovation model of civil construction engineering management based on construction concept include construction concept, civil construction engineering management, innovation, and the operating mechanism and evaluation method of the model [17-18]. These elements interact and support each other to form a model that can promote project innovation and successful management.

2.2 Principles and Methods of Constructing Innovative Models of Civil Construction Engineering Management Based on Construction Concepts

In the process of building an innovative model of civil construction engineering management based on construction concepts, it is very important to choose the appropriate construction principles [19-20]. The basis for selection of the principles of comprehensiveness, flexibility and operability will be explained and analyzed below.

Comprehensiveness: The principle of comprehensiveness means that multiple factors and elements are considered in the design and construction of the model. In terms of civil engineering management, the principle of comprehensiveness requires the integration of various management links, management elements and related information for consideration and overall processing. In this way, the fragmentation among various management links can be avoided, and the synergistic effect of management can be improved.

Flexibility: The principle of flexibility requires the model to have the ability to adapt to different situations and changing requirements. In civil construction project management, the characteristics and requirements of projects may change over time, so the model needs to be flexible and able to be adjusted and optimized according to actual conditions. For example, in terms of change management, the model should be able to flexibly adapt to project changes and manage them effectively.

Operability: The principle of operability emphasizes the practicality and feasibility of the model. In the management of civil construction projects, the model must be able to be applied practically and provide practical operation guidance for managers. During the design and construction of the model, attention should be paid to operability, so that managers can easily understand and use the model, so as to achieve effective management decisions.

The relationship between construction principles and model functional requirements: the selection of appropriate construction principles needs to be combined with the functional requirements of the model. Before building a model, it is necessary to clarify the expected function and application scenarios of the model. For example, if the goal of the model is to optimize resource scheduling, then the principle of flexibility will be more important; if the goal of the model is to improve construction efficiency, then the principle of comprehensiveness will be more critical. Therefore, choosing an appropriate construction principle needs to be closely related to the functional requirements of the model.

2.3 Introduction of Technical Means and Tools

Application of BIM technology in innovative models based on construction concepts: BIM technology is an integrated digital modeling method that can create, manage and communicate project information at all stages of the building life cycle. In the innovative model based on the construction concept, the introduction of BIM technology can realize the integration and sharing of building information, enhance the effect of communication and collaboration, and improve the efficiency and quality of the construction process.

Among them, the development level is:

$$\mathrm{LOD} = \mathrm{A} - (\mathrm{B} + \mathrm{C}) \tag{1}$$

Among them, A represents the calculation accuracy of the geometric quantity of the component, B represents the information richness of the model, and C represents the detailed description of the structure and assembly information of the component.

The BIM collaborative design formula is:

$$\mathrm{D} = \mathrm{N}(\mathrm{Q}/\mathrm{S})_2 \tag{2}$$

Among them, D represents the design efficiency, N represents the design team size, Q represents the design quality, and S represents the design time.

The quantitative evaluation formula of BIM is:

$$\mathrm{IE} = (\mathrm{BE}/\mathrm{LE}) * 100\% \tag{3}$$

Among them, IE represents the efficiency of information integration, BE represents the workload consumed by BIM system modeling and information management, and LE represents the workload of modeling and information management using traditional methods.

Application of Internet of Things technology in innovative models based on construction concepts: Internet of Things technology can realize the interconnection among multiple resources such as equipment and materials. In the innovative model based on the construction concept, the introduction of the Internet of Things technology can realize the collection and monitoring of various real-time data during the construction process, realize the automation and optimization of resource scheduling, and improve construction efficiency and safety.

Application of artificial intelligence technology in innovative models based on construction concepts: artificial intelligence technology can realize intelligent processing of decision-making and prediction in the construction process by learning and analyzing large amounts of data. In the innovative model based on construction concept, the introduction of artificial intelligence technology can realize the optimization of construction plan and the intelligence of resource scheduling, and improve the construction efficiency and the accuracy of project management.

Application of cloud computing technology in innovative models based on construction concepts: cloud computing technology can provide real-time data storage and processing capabilities, and support multi-user collaborative work. In the innovative model based on the construction concept, the introduction of cloud computing technology can realize the sharing and collaborative processing of model data, and enhance the flexibility and operability of project management.

3. Performance Testing of Innovative Models Based on Construction Concepts

3.1 Comparison of Project Progress Control

The purpose of the experiment: Comparing the project schedule control effect of the traditional model and the innovative model based on the construction concept in different time periods.

The experimental steps are as follows:

The first is to divide a group of engineering projects into two groups: a traditional model group and an innovative model group based on construction concepts.

The second is to ensure that the initial progress of the two groups is the same before the experiment starts, that is, each initial progress is 0.

The third is to use the traditional project schedule control methods adopted by the traditional model group, such as schedule plans based on Gantt charts and network diagrams.

Fourth, using the BIM technology-based schedule control method adopted by the innovative model group based on construction concepts to optimize resource utilization and schedule by monitoring and coordinating the progress of different types of work and equipment during the construction process in real time.

Based on the actual progress data provided, recording the actual progress of the two groups for each time period. The experimental results are shown in Figure 2.

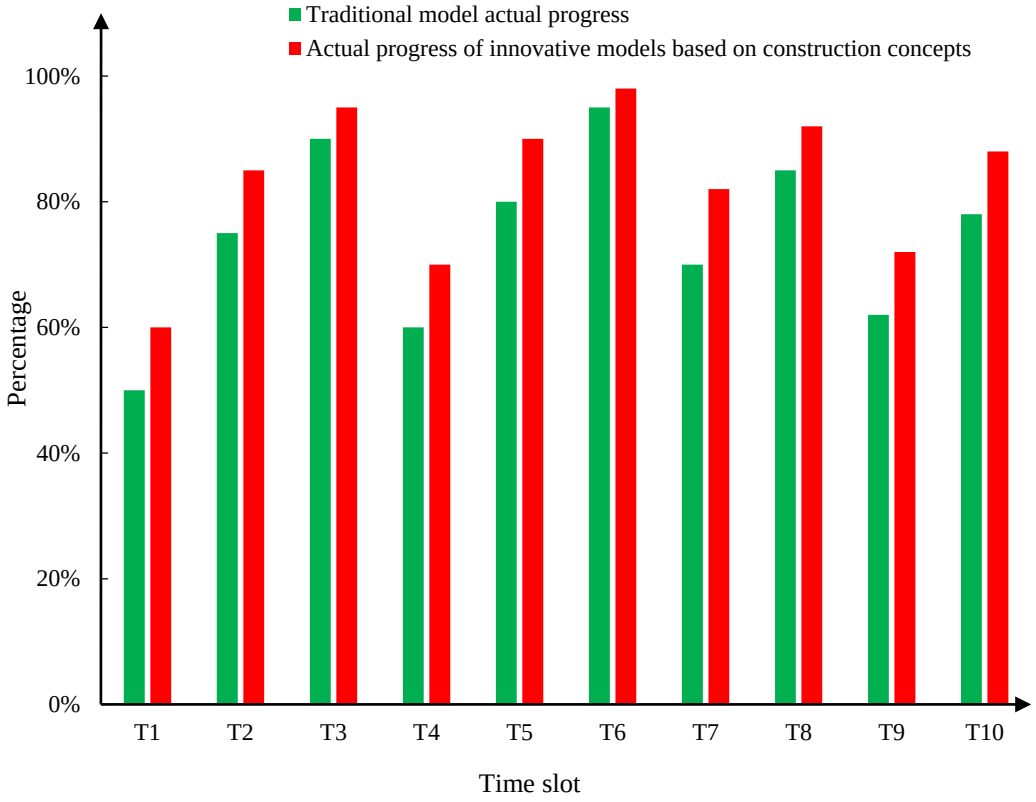
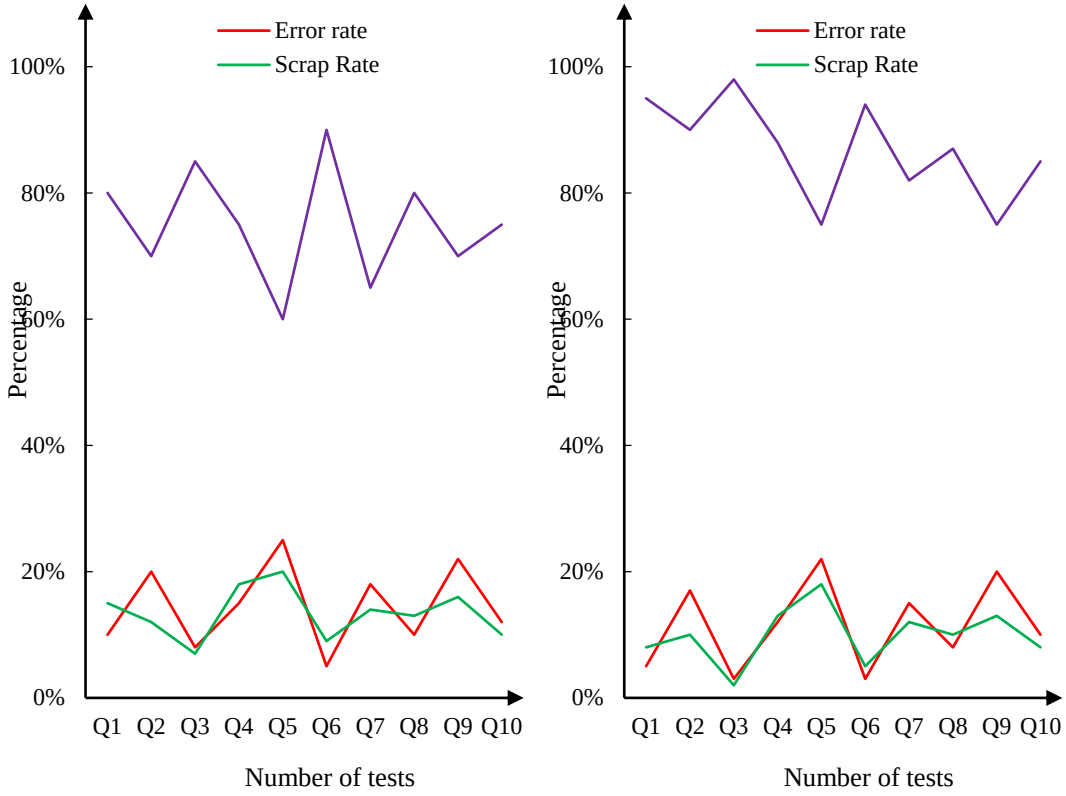


Figure 2: The effect of project schedule control under the two models

As shown in Figure 2, it can be seen that in each time period, the innovative model based on the construction concept has achieved better progress performance than the traditional model. On average, the progress of the innovation model is about 10% higher than that of the traditional model. Among them, the gap is the largest in the T7 time period, the project progress of the innovative model based on the construction concept is 82%, while the project progress of the traditional model is 70%. This may be because the innovative model based on the construction concept uses BIM technology to monitor and coordinate various tasks in the construction process in real time, which can better optimize resource utilization and schedule, and improve the control effect of project progress.

3.2 Comparison of Quality Management Effects

This paper randomly selects some construction projects as experimental objects and divides them into experimental group and control group. The experimental group uses an innovative model based on construction concepts for quality management. The control group used traditional models for quality management. Collect relevant data on each project, including error rates, scrap rates, and compliance rates. The experimental results are shown in Figure 3.



(a) Traditional model (b) Innovation model

Figure 3: The effect of quality management under the two models

As shown in Figure 3, Figure 3(a) is the quality management effect under the traditional model, and Figure 3(b) is the quality management effect under the innovative model based on the construction concept. It can be seen from Figure 3 that compared with the traditional model, the innovation model performs better in reducing the error rate, reducing the scrap rate, and improving the compliance rate, and has a higher quality management effect than the traditional model. This further demonstrates the value and advantages of using digital quality management systems, sensors and data analytics for real-time monitoring and automatic correction of issues.

3.3 Cost Control Comparison

This paper first determines the cost indicators of the two models: the actual cost, randomly selects some projects to use the traditional model, and the other part uses the innovative model. Recording actual cost data for each item. The experimental results are shown in Figure 4.

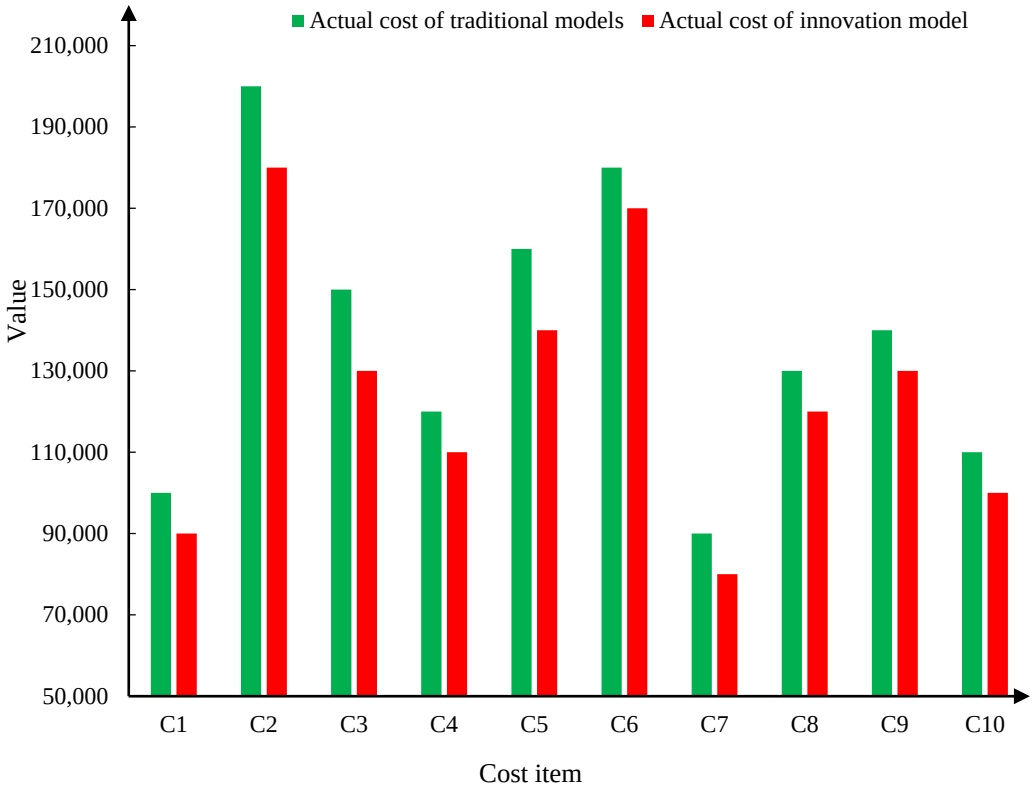


Figure 4: Cost control effects under the two models

As shown in Figure 4, the actual cost of the innovative model is lower than the average actual cost of the traditional model, and the innovative model can save a large part of the cost compared with the traditional model. When carrying out task C2, the actual cost of the traditional model is as high as 200,000, while the actual cost of the innovative model is completely lower than the actual cost of the traditional model of 20,000. It can be seen that the cost control effect under the innovative model of the construction concept is better.

4. Conclusion

According to the analysis of the experimental results in this paper, it can be known that the innovative model based on the construction concept has better results in project schedule control, quality management and cost control than the traditional model. In terms of project schedule control, the innovation model has a higher schedule performance than the traditional model, and the average schedule is about 10% higher than the traditional model. In terms of quality management, compared with the traditional model, the innovation model can reduce the error rate and scrap rate better, and improve the compliance rate. In terms of cost control, the innovation model has a better cost control effect than the traditional model, and the average actual cost is lower. The innovative model based on the construction concept is superior to the traditional model in terms of project schedule control, quality management and cost control, and can improve the efficiency and effectiveness of construction projects.

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