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Application of BIM Technology in Informatized Construction Management of Municipal Engineering

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Abstract: Municipal engineering is complex and involves large-scale construction. With the improvement of modern construction levels, traditional construction models and methods for municipal engineering are relatively lagging behind, and problems such as information silos and potential safety hazards during the construction process remain to be solved. How to meet the high-standard requirements of municipal engineering and improve the construction quality and efficiency is a key issue that needs to be overcome at present. BIM technology is a three-dimensional (3D) model information technology that can integrate and share relevant engineering information to reasonably control project costs, improve construction progress management, and quality control. Based on this, this article briefly summarizes the application advantages of BIM technology, the main problems existing in current municipal engineering construction management, and analyzes the specific applications of BIM technology in informatized construction, hoping to promote the development of urban infrastructure construction towards intelligence and refinement.

Keywords: BIM technology; Municipal engineering; Informatization; Construction management

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1. Introduction

Against the background of the transformation of municipal projects, municipal engineering adheres to the concepts of green environmental protection and high-quality projects, and introduces BIM technology for project construction management. BIM technology can effectively improve the efficiency of construction progress management and cost control, realize information sharing and collaborative work, and provide safety guarantees for construction projects, bringing a revolutionary change to project engineering management. Relevant municipal project managers should deepen their research on BIM technology to effectively solve various problems in municipal engineering construction and improve the construction level and quality of municipal engineering.

2. Application value of BIM technology in municipal engineering construction management

2.1. Improving the accuracy and visualization of construction engineering design

The emergence of BIM technology enables designers to create 3D models, presenting various components of municipal engineering, such as roads, bridges, drainage pipes, and underground pipelines, in an intuitive 3D form. This 3D model can not only display the appearance of the project but also integrate rich engineering information, such as the dimensions, materials, and performance parameters of components, helping designers conduct comprehensive analysis and optimization [1]. During the design process, the collision-detection function of BIM technology can automatically check for design conflicts between different specialties. For example, in the design of municipal utility tunnels, collision detection can be used to find out whether there are intersections or collisions between different pipelines, such as water supply and drainage pipes, power cables, and communication optical cables. By identifying and solving problems in advance, design changes and rework during the construction process can be avoided, thereby improving the accuracy and reliability of the design.

2.2. Optimizing construction plans and improving construction efficiency

By combining the construction schedule plan with the BIM 3D model to form a 4D construction simulation, construction workers can intuitively see the time sequence and spatial changes of the entire construction process and clearly understand the work content and construction sequence of each construction stage [2]. Taking municipal road construction as an example, BIM 4D simulation can be used to display the sequence and time arrangement of various construction links such as road base laying, surface course pouring, and installation of ancillary facilities. Potential problems in the construction process can be identified in advance. In response to these problems, construction workers can adjust the construction plan in a timely manner, reasonably arrange the construction sequence, and optimize the construction site layout to ensure the smooth progress of the construction process. At the same time, BIM technology can also allocate and optimize construction resources reasonably. By inputting information about various construction resources, such as labor, materials, and equipment, into the model and combining it with the construction schedule plan, the demand for resources can be analyzed in real-time, and preparations for resource allocation can be made in advance to avoid resource waste and shortages.

2.3. Strengthening communication in project construction and improving the coordination of construction projects

Municipal engineering construction involves multiple specialties and participants, such as design units, construction units, supervision units, and property owners. Communication and coordination among all parties are crucial. With the help of BIM technology, information sharing among project parties can be achieved, providing a real-time communication and collaboration environment for all parties [3]. For example, during the construction process, the design unit can upload the latest design plans and modification opinions to the platform in a timely manner, and construction workers can start construction according to the new design requirements immediately. At the same time, the construction unit can also provide feedback on the problems found and suggestions to the design unit and other relevant parties through the platform, and all parties can negotiate and solve them together. In addition, the visualization function of the BIM model enables more intuitive communication among all parties, allowing them to express their views more accurately, improving communication efficiency and the accuracy of decision-making.

2.4. Improving the ability to control construction quality

Construction quality is the lifeline of municipal engineering. With the help of the BIM model, construction workers can monitor construction quality in real-time and adjust deviations during the construction process in a timely manner, effectively ensuring project quality. For example, in road construction, construction workers can use professional measuring equipment to monitor the construction site in real-time according to the quality standards, such as road surface slope and flatness set in the BIM model, and compare the monitoring data with the standard data in the model. Once a deviation between the actual construction data and the standard data is found, construction workers can take immediate measures for rectification to ensure that the construction quality is always under control [4]. At the same time, during the construction process, quality inspection data, construction records, and other information can be associated with the BIM model to form a complete quality information file, providing a basis for subsequent project acceptance or solving quality problems during the use process.

3. Characteristics and main problems of current municipal engineering construction management

3.1. Disconnection between the construction process and plan

Municipal engineering usually involves large-scale construction, involving numerous participating units and a wide range. This complexity greatly increases the number of uncertain factors during the construction process [5]. In some project practices, the actual construction process may deviate from the initial construction design plan, which will slow down the construction progress of the municipal project. At the same time, it will also restrict and negatively affect the maintenance of on-site project management levels and the improvement of resource allocation efficiency.

3.2. Great difficulty in engineering quality control

Ensuring engineering quality is the core factor affecting the construction level of municipal engineering and a major problem that project managers need to solve urgently. In many municipal projects, the construction period is tight and the tasks are arduous, leaving project managers and construction workers with insufficient time for adjustment and optimization. As a result, it is difficult to achieve an efficient balance among the construction progress, construction quality, and cost investment, hindering the construction process of municipal engineering projects [6].

3.3. Many restrictive factors in the urban environment

Against the background of urbanization construction, the diverse needs of the urban internal environment pose certain challenges to municipal engineering construction. For example, urban old-road renovation projects can affect the daily travel of urban residents, forcing construction parties to frequently adjust the construction plan, which in turn affects the project construction period and quality [7]. During the construction of drainage and greening projects and other municipal projects, it may have an impact on the urban environment. These influencing factors not only increase the difficulty and cost of construction management but also prolong the construction period.

4. Applications of BIM technology in the informatized construction of municipal engineering

4.1. Progress management

The core of project progress management is to develop an appropriate construction plan based on the established project progress plan. During the project implementation, comprehensive and full-process supervision of the actual project completion status is carried out, and the actual progress is compared in detail with the pre-planned progress [8]. The four-dimensional construction progress model, constructed based on BIM technology, combines the time dimension with the 3D BIM model, bringing a new perspective and method to municipal engineering progress management. Before the project starts, by importing the detailed construction progress plan into the BIM model, each construction task is associated with the corresponding 3D model component, forming a dynamic and visual construction progress simulation. For example, in municipal bridge construction, the BIM 4D model can clearly display the time sequence and progress arrangement of each construction link, such as pier pouring, bridge erection, and deck paving, allowing construction workers to visually observe the dynamic changes of the entire construction process [9]. During the construction process, with the help of relevant BIM software and technical platforms, the construction progress can be monitored in real-time. If the actual progress of a construction task lags behind the planned progress, the system will automatically issue an early warning and visually display the deviation through charts, color-coding, etc. At the same time, using the dynamic adjustment function of the BIM model, construction managers can optimize and adjust the construction progress plan according to the actual situation [10].

4.2. Quality control

"Quality First for Century-Long Projects" has always been the fundamental and unshakable goal of municipal engineering project quality. Therefore, in the entire process of municipal engineering construction, emphasis should be placed on pre-construction quality control and in-process supervision. The core concept of prevention-first should be firmly established, and the intensity of quality control should be effectively strengthened [11].

BIM technology plays an important role in municipal engineering quality control. During the construction process, by associating quality data with the BIM model, integrated management of quality information can be achieved. For example, in a road construction project, quality inspection data such as road surface compaction and flatness are input into the BIM model and associated with the corresponding road model components. Construction workers and quality managers can view the quality data of each part at any time through the BIM platform, intuitively understanding the project quality status. Moreover, the visualization feature of BIM technology makes quality inspection more convenient. Through the 3D model, inspectors can clearly see every detail of the project, making it easier to identify potential quality problems and effectively avoid various mistakes caused by subjective factors of personnel during the construction process [12]. In addition, when quality problems are found, BIM technology can also achieve rapid traceability of the problems. By checking the BIM model information associated with the quality problems, including construction time, construction workers, and materials used, the cause of the problems and the responsible person can be accurately identified, providing a basis for formulating targeted solutions [13].

4.3. Assisting in topographic survey work

Municipal engineering is usually related to the construction of roads, bridges, and other projects in various regions. Whether building roads in cities or uninhabited areas, topographic surveys are required in advance. Engineering surveys, especially preliminary surveys, are key tasks in municipal engineering. Traditional survey work requires manual sampling and mapping. However, in the face of complex terrain, the actions of surveyors are restricted, and even the life safety of surveyors may be threatened. Even in flat areas, since surveyors need to hold equipment by hand, it will affect the accuracy of the collected data. These adverse factors have a negative impact on survey work. BIM technology can use drones to obtain images and radar to obtain positioning during the survey stage to collect more accurate data. Subsequently, the data collected by the drones is imported into BIM software to construct a real-scene 3D model, improving work efficiency and accuracy and reducing the risks of manual sampling. On this basis, the surface model formed based on the survey can help construction units design the optimal plan and facilitate the calculation of site engineering quantities.

4.4. Cost control

The BIM model integrates rich engineering information and can accurately calculate the engineering quantities of various materials and components in municipal engineering, enabling effective control of project costs. For example, in a municipal road project, the BIM model can accurately calculate the quantities of materials such as sand, gravel, cement, and asphalt required for the road base and surface course, as well as the number of various drainage pipes, inspection wells, and other components, providing a reliable data basis for cost accounting. Through BIM technology, resources such as labor, materials, and equipment can also be reasonably allocated and optimized according to the construction schedule plan and engineering quantity information. Specifically, before construction, by inputting relevant information about resources, such as the skill levels of personnel, material supply situations, and equipment performance parameters, into the BIM model and combining it with the construction schedule arrangement, the system can simulate the construction process under different resource allocation schemes, analyze the utilization efficiency of resources and cost consumption, and thus select the optimal resource allocation scheme [14]. In addition, BIM technology is integrated into the entire life cycle of the project. It can carry out simulation modeling for each construction stage of the project. Through precise calculations of the model, the progress details of each construction stage, as well as the specific situations in terms of labor allocation, capital investment, and mechanical equipment use, can be accurately deduced. Based on these data, the cost composition required for each stage is further analyzed in depth, so as to accurately obtain the total construction cost of the project. Then, this total cost is rigorously compared with the actual value of the project, and the parts with differences are carefully sorted out and analyzed in depth, so as to control construction costs, reasonably optimize resource allocation, and improve the economic benefits of the project [15].

5. Conclusion

BIM technology has become a key force in promoting the transformation of informatized construction management. With its advantages of visualization, simulation, and collaboration, BIM technology can effectively solve many problems in municipal engineering construction, further improving project quality, shortening the construction period, and reducing costs. Although BIM technology faces problems such as costs, talent shortages, and poor software compatibility during the application and promotion process, with continuous industry research in practice, these difficulties will eventually be overcome, providing impetus for the high-quality development of urban construction.

Disclosure statement

The authors declare no conflict of interest.

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