

The Application of BIM Technology in Project Management of Construction Engineering from 3D to 6D

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ABSTRACT

With the rapid development of information digitization and globalization, BIM technology emerges at the historic moment. Its visualization, dynamic, coordination, simulation and optimization characteristics have exerted a huge impact on traditional construction project management and brought a revolutionary breakthrough. With the increase of digital dimension in BIM technology, project management of construction engineering also extends to many directions. This paper expounds the changes brought by BIM technology to management from 3D to 6D, demonstrates the integrated application value of BIM technology and construction project management, and realizes the full life cycle informationized delicacy management of construction project design, construction, operation and maintenance.

Keywords: *BIM technology, Construction project management.*

1. INTRODUCTION

The functions of modern construction engineering projects are becoming more complex, the construction volume is becoming larger, and the requirements on construction technology are becoming more elaborate, which brings a variety of difficult challenges to the management of construction engineering projects.

BIM is short for Building Information Modeling. The development of this technology today is not a direct literal understanding of the building information model, its connotation has been greatly expanded. From the initial BIM-3D model management, development to BIM-4D schedule management, BIM-5D cost management and then to BIM-6D operation and maintenance management, BIM technology has covered the whole life cycle of construction projects. Therefore, BIM technology has become a management system and a management concept for engineering projects.

2. BIM-3D MODEL MANAGEMENT

Traditional construction model mainly uses CAD technology to realize 2D information model construction, which is not intuitive and difficult to coordinate and communicate. On this basis, adding the vertical coordinate becomes the 3D model, which is the

representation of the object in the 3D space. BIM-3D model management has the following advantages.

2.1. Construction Design Optimization

Modern construction engineering projects have novel and complex construction structure, high technological content and great difficulty in construction. BIM technology can supplement and strengthen the engineering design content which is not easy to be expressed in the traditional plane construction drawings. Due to the intuitionistic nature of the model, it can better express the curved surface and special-shaped structure, which enables each participant of the project to have a more intuitive and accurate grasp of the project content and design details. Through the collision test, we can find out where there are conflicts in the components or the system, and effectively avoid the rework and waste in the construction operation process. Through the analysis of net height and net width, the measured model value is compared with the specification limit to determine whether to adjust.

2.2. Site Analysis and Layout

The traditional construction site analysis can only give qualitative results but lacks accuracy. The current

BIM technology can simulate the construction site through data acquisition through the positioning system, thus providing reliable data for the planning and design of the construction site. In addition, professional 3D software can be used to simulate the installation of temporary facilities such as tower cranes, roads, external frames and processing plants, so as to achieve scientific and reasonable layout and improve construction efficiency and safety.

2.3. Easy Design Change

In the actual construction process, local changes in construction design often occur. This also tends to "affect the whole body", resulting in the redesign and planning of many graphic drawings, increasing the workload, but also a lot of time wasted. 3D models can solve this problem well. First of all, in 3D software, such changes are easy to implement and can be completed in a short time. Secondly, due to its visual characteristics, it can intuitively show the visual differences and the increase and decrease of the amount of work before and after the change. This allows participants in a project to reach agreement quickly, reducing negotiation time and waste of resources.

2.4. Disclosure of Visualization Techniques

Traditional construction technology disclosure, mainly in the form of paper text records, there are higher requirements on the quality of skilled workers, understanding of the design intention of the deviation and other problems. The application of BIM technology can effectively solve this problem, with various forms of visual disclosure, such as the graphical static display, the roaming dynamic display, and the virtual construction-type animation display, etc., which can help the construction personnel to better analyse the key points of construction technology and control the key points of construction safety management. The combination of centralized disclosure and regular pre-class education can better improve the disclosure effect.

2.5. Coordination between Systems

A building project involves complex systems such as water supply and drainage, electrical lighting, lightning protection and grounding, heating, ventilation, monitoring, etc. Because the space is limited, to the limited space to be able to let each system to give full play to the function, and at the same time to meet the need of beauty, this system's installation and construction put forward a very high requirement. Through BIM-3D model management, the scientific and reasonable arrangement of equipment and pipelines of each system can be realized to avoid crossing each other. Considering the future operation and maintenance and secondary construction, enough space is reserved in the

model design. Finally achieve the coordination of equipment and pipelines of each system, improve the accuracy of construction and installation.

2.6. Calculate the Project Quantity Accurately

In traditional construction projects, the calculation of the project quantity is a complex process, which often takes several weeks for the relevant staff to complete. BIM-3D model is a 1:1 simulation of the physical building. After adopting technologies such as mutual deduction of the physical construction, relevant quantities can be directly extracted from the 3D model, which can be completed within a few hours, greatly shortening the working time, improving the working efficiency and the accuracy.

3. BIM-4D SCHEDULE MANAGEMENT

Time dimension is added on the basis of 3D model to form 4D model, which is the mutual combination of "space" and "time". The logic expression of traditional construction schedule plan is not intuitive, and it is abstract and difficult to directly find problems in the formulation of optimization plan. It is not convenient to analyse the influencing factors compared with the actual schedule. BIM-4D can effectively manage the construction schedule, which is reflected in the following two aspects.

3.1. Pre-start Progress Simulation

Traditional construction schedule management is mostly planned and designed through Gantt chart, network chart, critical path, etc. It can be handled if the scale of the project is relatively small, but it is difficult to meet the requirements for large-scale construction projects. BIM-4D schedule management has achieved the progress of the effect of visual management, first clear the project management progress target, secondly by contains the geometric information of 3D model is developed based on the correlate documented schedule plans in order to form the 4D model, and then formulate construction process, to carry on the delicacy construction simulation, to verify the rationality of the schedule optimization of construction progress plan, to form the optimal project schedule.

3.2. Comparison of Progress in Construction

BIM-4D can be used to present the construction process of a building project by comparing the actual situation on the construction site. By observing the construction of the project, progress deviations that may or have occurred in the construction process can be found. If they are inconsistent with the target, the system will automatically prompt the management personnel. In BIM-4D, the method of different colour areas is adopted to determine the degree of progress

deviation. Managers can intuitively understand the actual progress of the project based on the colour situation, so as to obtain the results according to the model and adjust measures reasonably, thus ensuring the consistency between the construction progress and the planned progress and reducing the consumption of resources. The real-time model or the actual situation of the site can be compared with the progress model to complete the management. Nowadays, the BIM technology commonly used in project schedule management is mainly 3D laser scanning technology, which derives the model data under the BIM scenario. Also, panoramic images can be derived to compare with BIM-4D implementation by virtue of panoramic camera scanning technology.

4. BIM-5D COST MANAGEMENT

BIM-5D refers to the 3D model + time + cost model, that is, according to the plan, the equipment, materials, labor force and other input plans are prepared, and the associated list forms a 5D model that increases the cost dimension. Its biggest advantage lies in the accurate calculation of project cost while directly extracting project quantity data, which greatly reduces the workload of traditional cost personnel. In this way, management personnel can use BIM-5D to define the cost of construction projects, and then control the cost with targeted measures to complete the cost management of construction projects with high efficiency, high quality and high accuracy.

4.1. Improve the Accuracy of Cost Prediction

In the bidding of construction projects, the tenderer will forecast the budget expenditure of the whole project according to regulations. This need a very high accuracy requirement for the drawings and lists provided by the tenderer, and also need a very high requirement for the technical level and professional quality of the budget personnel. The database using BIM technology can quickly and accurately provide relevant data and information at each stage of construction, which greatly improves the accuracy of the results of cost prediction in the early stage of construction projects.

4.2. Effective Cost Control

In the traditional construction engineering design, it is common to purchase materials more or less, which results in the increase of cost or the delay of construction schedule. Using BIM technology can accurately collect the data of each stage of construction and calculate the quantity of materials to be prepared for each link, and improve the utilization rate of materials according to the actual situation, so as to reduce the procurement cost and project cost. In addition, during the construction of a building project, engineering changes are often a problem, which has a great impact

on the cost control of the entire project. The application of BIM technology ensures that problems occurring in construction can be found in time and a series of responses can be made quickly, and the modified scheme can be accurately integrated, which will greatly reduce the cost increase caused by engineering changes.

4.3. Reduce Time and Labor Costs

In the construction process of a construction project, management personnel can set reasonable cost parameters in the BIM database for data analysis according to the actual construction progress and various requirements during construction. Because BIM database can be dynamically managed, managers can update and modify the database at any time during construction, which reduces the time cost and human cost of management.

5. BIM-6D OPERATION AND MAINTENANCE MANAGEMENT

After the construction project is completed, the relevant units need to carry on the maintenance management to it. In this stage, BIM technology can be used to manage and supervise the use time, use situation and performance change of the construction project, and timely supplement and update the collected data, so as to provide reference for the management and maintenance of the building. In other words, on the basis of BIM-5D, the detailed information such as location, function, loss status, energy consumption, manufacturer and contact information of building facilities and equipment is added, and the fixed-point record is generated uniformly for BIM-6D for operation and maintenance management.

5.1. Improve Operation and Maintenance Management Efficiency

In the traditional operation and maintenance process, due to the asymmetry of information between the operation and the construction party as well as the limitation of the preservation method of construction project information, problems such as the inability to grasp the location of equipment, depletion rate and loss of maintenance records often occur. Through the use of BIM technology, the detailed attributes of each link of the building can be completely recorded and handed over to the operator by the construction side completely to facilitate the operation and maintenance management of the operator. Through the effective application of BIM model, the operation and maintenance side stores the maintenance records of the equipment and facilities in the project in a timely manner, and marks the maintenance status with different colours, so as to have a real-time feedback and strong pertinence, and greatly

improve the management efficiency of the operation and maintenance side.

5.2. Anticipate Problems and Solve Them Quickly

In the operation and maintenance stage, real-time monitoring and maintenance are carried out for all equipment and facilities of the construction, and comprehensive data information is provided for all equipment and facilities, which can be used to find out the failure points and causes of the construction in a timely manner, so that the maintenance department can quickly locate and specifically remove the faults. For the equipment that will reach the service life, it can evaluate and repair in advance or contact the manufacturer for replacement according to the color mark and system alarm prompt, so as to ensure the safe and stable operation of the equipment. For the facilities needing reinforcement, BIM technology can be used to simulate the reinforcement process, so as to formulate reasonable and effective reinforcement plans and improve the service life of the construction.

5.3. Realize Intelligent Energy Management

Improving the efficient use of energy is an important content to improve the use function and efficiency of constructions. BIM-6D can conveniently monitor and manage the use of energy in the construction, add sensing function to the energy use record, realize the collection and processing of energy information and automatic statistical analysis of energy consumption in the management system, and warn the abnormal use. By collecting and processing data from temperature sensors and human perception sensors that are widely deployed in constructions, equipment such as central air conditioners and lights can intelligently decide where to cool, heat or light, reducing energy waste.

6. CONCLUSION

BIM-3D model management, BIM-4D progress management, BIM-5D cost management, BIM-6D operation and maintenance management also play roles in BIM quality management, BIM safety management, etc. The application of BIM technology in construction project management is, in essence, the efficient integration, sharing and exchange of various information and data in construction project management, giving full play to the value of information and data. The development of BIM technology is in the ascendant, and its integration with GIS, VR, cloud computing and Internet of Things is also advancing with The Times. Although currently faced with such practical problems as slow promotion and application, insufficient software development and insufficient technical personnel, the revolutionary

impact of BIM technology on construction project management is beyond doubt and will surely flourish.

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