Research on the Method of Engineering Project Schedule Control Based on BIM Technology

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Abstract. The construction industry is developing rapidly, the scale of construction projects is larger and more complex, and the construction period is constantly getting longer, which puts forward higher requirements for the management level of construction projects. The schedule control of construction projects is one of the three major goals of construction project control. Traditional schedule control methods cannot match the needs of modern management. Based on this, this article applies BIM technology to the progress control of construction projects, and studies the progress control method of construction projects based on BIM technology. The article discusses the basic characteristics of BIM technology, analyzes the application of BIM technology in construction project schedule control from the aspects of applicability and feasibility, and studies specific control methods. The article discusses in detail the framework model of schedule control and the preparation of schedule plan, and provides a reference for construction project schedule management personnel.

1. Introduction
The requirements for project quality, benefit and management level have been continuously improved. Therefore, the key issue in the construction field is to improve the level of project management and improve project benefits [1].

In a modern project management system, schedule management is a vital work content in project management, which directly affects the social and economic benefits of engineering projects. Traditional schedule management is based on the two-dimensional drawing method, and there are practical problems such as the intuitionistic image of the network plan, obvious schedule planning errors, and unsmooth information transmission, which ultimately results in delays in construction schedules, waste of resources, and cost overruns [2]. At present, delays in the progress of construction projects in our country occur from time to time, and it is difficult to take into account the multi-party coordination of progress, cost and quality only using traditional schedule control methods. The large-scale and complicated trend of construction projects puts forward new requirements for schedule control methods.

Building Information Modeling (hereinafter referred to as BIM) technology emerged as a new information technology, which brings great value to the promotion of engineering project life-cycle management [3]. BIM is a management method that can be visualized and simulated. The emergence of this technology provides a component-based and visualized dynamic control method for construction project schedule control [4]. My country’s application of technology in construction project schedule control is still in its infancy [5]. Therefore, it is necessary to conduct a detailed study on how to apply technology to project schedule control, through visualization and dynamic interactive
methods, combined with two-dimensional coordinates. The three-dimensional space and progress information realize the four-dimensional progress control of the construction project.

2. BIM technology and project schedule control

2.1. BIM technical characteristics
BIM technology draws on the product model definition (PDM) of the manufacturing industry. It is an information model that includes product composition, function, and behavior data, and can describe a product throughout its life cycle. BIM realizes digital information expression for buildings. This resource library can be shared to provide a basis for decision-making throughout the project life cycle. Project participants can extract, modify, and update information at all stages to achieve project collaboration [6].

BIM technology is an engineering database technology based on three-dimensional surface application objects and has the following characteristics:

- By constructing a three-dimensional model, BIM displays the detailed geometric information and functional attributes of the building and components in a three-dimensional manner, and achieves a good simulation effect, so that the participants of the construction project can visually understand the project situation [7].
- BIM technology can detect collision problems between different professional components and construction equipment of construction projects, find design defects and related conflicts, and facilitate engineers to adjust quickly and accurately, and reduce the coordination of actual construction. The use of BIM technology can strengthen the coordination and mutual assistance between various units of construction engineering.
- BIM technology can perform multi-stage simulation through 3D models. In the bidding and construction phase, increase the dimension of schedule and cost information, realize 5D simulation, control the construction schedule and cost in real time, and optimize the construction plan [8].
- The BIM model is a huge database. The BIM can be used to classify and accurately locate complex information, modify and provide building change information.
- BIM can output building plans, structural construction drawings and other drawings. The use of BIM technology can simulate and visualize construction projects, generate comprehensive pipeline diagrams after collision elimination, collision inspection reports, etc., generate roaming videos, and display the internal and external components of the building.
- BIM technology adopts IFC (International Foundation Classes) data standard format.

2.2. Project progress control
Project progress control is an activity to supervise and control the implementation process of engineering projects. Progress control is a cyclic PDCA process: Plan-execute (Do)-check (Check)-action (Action). Effective control of the implementation process of a construction project, so that it can successfully meet the contractual targets of construction period, quality and cost, is the central task of project control. With the increasing complexity of construction projects, the difficulty of management also increases [9].

The inability to effectively control the project schedule is largely due to the inability to obtain information smoothly. The emergence of BIM technology can largely solve this difficulty. Therefore, the integration of BIM technology with traditional project management methods and traditional project management software can effectively solve the difficulty of information acquisition.

The information in the BIM model covers all stages of the project's full life cycle, including not only the three-dimensional geometric information of the building, but also the information required for management activities such as progress, cost, and resources [10]. The application of BIM technology in construction project schedule control covers the whole process of the project.
In the construction phase, a common BIM construction management platform should be built, and the situation of the construction site should be tracked and recorded by combining advanced technologies such as RFID, laser scanning, and cameras with manual collection, and BIM information should be updated in time. Managers of all parties can negotiate and cooperate in the BIM management platform, and the modification of the plan will also be updated in the platform to provide a basis for future progress evaluation and achieve dynamic progress control. The project schedule control method based on BIM technology is shown in Figure 1.

![Figure 1. Project schedule control method based on BIM technology](image)

### 3. Construction Project Schedule Control Model Based on BIM Technology

#### 3.1. Overall framework based on BIM technology

The functional requirement analysis of the model is a guiding and directional problem of model design. Combined with the characteristics of BIM technology, the construction project schedule control model based on BIM technology needs to satisfy statistical analysis, project implementation process simulation, and dynamic information release. Multi-user and multi-role functional requirements for applications.

To realize the function of the model and to effectively complete the construction of the model, several key issues need to be solved [11]. In the selection of data analysis methods, after completing the real-time update of information, statistical analysis of the project data is required. In terms of data sharing and interaction, data standardization is the key to solving problems. A unified data model standard is needed to ensure that data can be effectively shared and transmitted in different software and platforms. The model should adopt the widely accepted IFC standard to provide guarantee for information sharing and interaction. In terms of real-time information updates, it is crucial to build a common collaborative management platform and obtain information in a timely and effective manner. By building a cloud BIM platform to provide a common working space for managers in different regions, the transmission and sharing of information can be guaranteed. The overall framework of the BIM technology-based construction project schedule control model is shown in Figure 2.

![Figure 2. Overall framework based on BIM technology](image)

#### 3.2. BIM-based schedule planning

The preparation of the construction schedule needs to clarify the start and end time of each process and the logical relationship between the processes. The BIM technology-based schedule planning is established on the basis of the three-dimensional model, and the model is used to assist the WBS work decomposition process, so that the process and the model components form an association relationship. Apply BIM technology to each preparation link, and realize the visual expression of the progress in the progress management software. Figure 3 shows the preparation process of the 3D model construction schedule based on BIM technology.

![Figure 3. Preparation process of the 3D model construction schedule based on BIM technology](image)
3.3. Information Model Based on BIM Technology

Associating the BIM three-dimensional model with the schedule information can form a 4D information model based on the BIM model, WBS work decomposition as the core, and schedule as the extension to realize the visual expression of the construction process. Modeling based on the schedule management platform needs to take into account the four elements of organization, process, information and system and the relationship between them. The building system is an integrated system of various computer software that connects the entire project to create and use information. Only when the four are considered comprehensively can a good system architecture be constructed. Based on the schedule management platform, the three-dimensional model and schedule dimension information are concentrated into a central model. Therefore, a software platform system is required to be compatible and integrated with multiple building management software to support the management of different elements.
Integrate WBS, schedule information, component's three-dimensional information and resource information, and its integration is based on the format standard. According to the component's work package label, the data is correlated to form a schedule space control model based on. The hierarchical structure of construction project schedule management based on BIM technology is shown in Figure 4.

The application layer is based on the final function realization layer in the schedule management system, which can realize the user's function of managing the entire schedule through the interface based on the data processing at the platform layer. The platform layer is the link between the model layer and the application layer. The platform layer mainly includes a multi-dimensional visualization platform, a construction schedule preparation platform, and a resource management platform. Each platform cooperates with each other for data sharing, and finally provides a basis for the realization of the application layer's functions. The model layer is the core of the entire system. It can integrate the scattered information in the data layer according to functional requirements. When the information in the data layer changes, the information in the model layer can also change according to the algorithm. The data layer contains all schedule control information based on technology.

Figure 4. Hierarchical structure of construction project schedule management based on BIM technology

3.4. 5D model based on BIM technology

The designer completes the construction of the BIM three-dimensional model, and the BIM software can automatically count the engineering quantity and component characteristic information through the building model. By linking the building components with the WBS work package, the 3D information is associated with the progress information to form a BIM 4D model, and then the cost information including materials, labor, and mechanical equipment costs are associated with it to form a 5D model based on BIM technology as shown in Figure 5.

During the implementation of the project, the manager should select appropriate monitoring points to monitor the project regularly based on the actual situation of the project. The progress and cost deviations are calculated by comparing the three. Measure the progress and cost performance of the project.

4. Conclusion

The construction schedule control of construction projects based on BIM technology is still in the initial stage of development, and a relatively mature theoretical system has not been formed, and there
are only a handful of domestic application research and engineering practices. The combination of BIM technology and traditional construction schedule control methods is to increase the BIM-related application process without changing the original schedule control process, so that the various tasks of schedule control can be carried out effectively. The combination of BIM technology and PDCA cycle principle can realize the advanced control and closed-loop feedback control of the construction schedule. By simulating the construction progress of the construction project, it is possible to understand the project progress in real time and realize dynamic progress monitoring. The schedule control of construction projects is a very complicated issue. Due to the limited time, this research only puts forward the overall framework of model application in theory. There are still many defects and shortcomings in practical application, and there are many aspects that need further research.

![Figure 5. 5D model of construction project schedule control based on BIM technology](image)

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