



Study on the Application of Digital Design and Management Based on Bim Platform on Public Buildings Chengdu Medical Trade Building as an Example

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Abstract. As the country continues to attach importance to the construction industry, China's construction industry has also ushered in unprecedented opportunities and challenges. Architectural design is the most important link in the construction process of building projects, and the traditional design methods are still lacking in enhancing efficiency and optimizing design. BIM technology, as a new design method, provides new ideas to solve the above problems. BIM technology has the following advantages: (1) through the automated analysis of building models, it can effectively improve the design efficiency and design quality; (2) BIM technology can share the information of models to a high degree, and discover the existing problems and contradictions by means of simulation and collision detection, effectively avoiding the design error rate; (3) with simulation and collaboration as the main means, it can improve the construction engineering project management efficiency and reduce the waste of resources. In this paper, based on the above research results, we will start the research on the application of digital design and management based on BIM platform in public buildings, and explore how to realize the digital design and management process through BIM platform and the application scheme of different types of public buildings.

Keywords: BIM; Public Buildings; Digital Design and Management

1 Introduction

In recent years, China's economy has developed rapidly, and the construction industry has also made great progress with the development of the national economy. With the accelerated urbanization and urbanization construction process, the domestic construction market is facing unprecedented opportunities and challenges. Our government encourages competition among enterprises and has started to promote BIM technology in the construction industry, which mainly uses three-dimensional spatial graphic data as the carrier of project information and can be applied in the whole life cycle of construction to realize the organic combination of design, construction and operation in construction projects. The use of BIM technology in architectural design is a systematic

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project, which requires the integration and sharing of various types of information and the use of information models for expression. By establishing BIM model through BIM software, it can make each profession work together and effectively reduce unnecessary contradictions and problems generated during the whole construction process of the project.[1-3]

1.1 Architectural Design Process

Architectural design is the preliminary part of building product design and construction throughout the project cycle, covering the planning, schematic design, construction drawing design and construction phases. It is an indispensable part of the whole process, from the creation and integration of architectural models to the evaluation at the later stage. At present, the traditional engineering design methods mainly include: expressions based on 2D drawings, such as floor plans, elevations, sections, etc.; expressions supplemented by 2D drawings, such as plan dimensions, elevation dimensions, etc.; and expressions based on 2D drawings, such as sketches of plan dimensions (or construction details). When using traditional methods for architectural design, the shape of the building needs to be modeled and parameterized, but this information is imperfect[4]. With the introduction of BIM technology into the field of architecture, the integration and visual representation of various information models becomes possible. Traditional architectural design methods have obvious advantages compared with BIM technology.

1.2 BIM Model Construction



Fig. 1. Chengdu Medical Trade Centre Model

The 3D model built using BIM software is a design based on the actual physical space. By constructing a 3D model, the appearance of the building can be visualized and the design model can be analyzed to control the building cost, construction schedule and

building cost. The use of BIM technology for 3D modeling of actual buildings can effectively save a lot of labor, material and time costs, improve efficiency, and ensure the quality of construction. In this paper, through the use of Revit software to build a three-dimensional model, a project I led in 2020 Chengdu Medical Trade Building as an example, Figure 1 shows the BIM model established for the Medical Trade Building. Different modeling schemes are adopted according to different building types during modeling. The plan elevation, which has less impact on the modeling time, is chosen as the modeling basis. The model can be used to visualize the building shape, internal layout and building area.[1, 5]

2 Current Status of Domestic and International Research

Foreign research on digital design of buildings started earlier, and developed countries have accumulated many years and rich experience in digital information construction. The United States has been more mature in the application of digital information technology, among which the application of BIM, BIM + GIS and other technologies are the most prominent. Civil 3D modeling software is one of the most widely used software in the United States[6-8]. The American Institute of Engineers (IEEE) has developed the BuildingInformationModeling (BIM) standard, which aims to achieve the sharing and interaction of information in all aspects of buildings, so that designers and architects can Civil 3D modeling software has many advantages when applied to the construction field: (1) efficient modeling, which can reduce the time and workload of traditional 2D design methods by more than 50%; (2) 3D modeling software can realize structural analysis, collision detection, virtual construction simulation and other work in the whole construction project; (3) 3D model has the characteristics of large amount of information and high accuracy. China has conducted in-depth research on digital design in recent years, and put forward the idea and proposal of BIM+ GIS application in the construction field. But at present, BIM technology is still in the primary stage, and there is still a certain distance from maturity. At this stage, there are some BIM talents in China who are involved in the field of digital design, but most of them focus on engineering applications, and the research work carried out by some universities and research institutions is also in the initial stage.

2.1 The Development History of Foreign BIM Technology

The U.S. BIM standard started in the 1980s, based on the Building Information Modeling (BIM) proposed by the American Society of Civil Engineers (ASCE), and established the "American Institute of Architects/American Society of Civil Engineers BIM Working Group" in 1993 shortly thereafter. Working Group", also known as the BIM Working Group, was established in 1993. In the following years, architects and engineers joined, but no unified standard has been formed. With the rapid development of computer technology and the increasing demand for design, the construction industry gradually realized the need for new technologies to improve the design process and increase efficiency. In this context, the Japanese Civil Engineering Association (JAIA)

proposed the Building Information Modeling (BIM) standard in 1995[9-11]. Since then, this standard has been recognized and applied worldwide. Due to the influence of cost factors and the constraints of laws and regulations, China started late in the application of BIM technology. At present, China does not have a complete set of scientific and reasonable standards to guide the interaction and sharing of information, communication and collaboration of all parties involved in the entire engineering construction process. At the same time, China's BIM-related laws and regulations are also relatively late, which cannot ensure that the development and application of BIM technology in China is regulated and protected. In view of this, China must accelerate the development of BIM standards that are suitable for China's national conditions and can effectively promote the transformation and upgrading of China's construction industry, and also give full play to the role of the government to coordinate the data transmission and information exchange among all relevant stakeholders.

2.2 Case Study of Foreign BIM Application

In foreign countries, the application of BIM technology is very common, such as the United Kingdom, Germany, Singapore and other countries have introduced corresponding BIM policies or standards, and the application of BIM technology is promoted. Among these countries, the UK is taken as an example for detailed analysis. Since the promulgation of the first "Construction Industry Regulations" in 1980, the UK has been attaching great importance to the development of information technology in building design and management. The regulations stipulate that "any new or expanded building must be installed with a software system that integrates design and engineering information", which is what we call the Building Information Model (Buildinfo Model). The regulations require the unified management of engineering information, construction materials and construction methods to achieve "data sharing and collaborative work". The regulations also require the establishment of a three-dimensional model for building performance analysis in large projects. In 1992, Japan promulgated the "construction software industry policy", the Japanese construction industry began to gradually shift from the traditional two-dimensional design to three-dimensional design. Based on the three-dimensional model data information technology construction began to be attached to and in Japan to promote the application. The UK has formulated a series of policies at the government level to promote the development of BIM technology. For example, the British Parliament passed the "Building Engineering Information Model Act" (BuildinfoDataofArchitecture) bill in 2014, which requires building contractors to create a BIM model for calculating project fees and costs. In addition, the UK government has also adopted various documents to guide the application of BIM technology across the industry, including detailed guidance on BIM technology in documents such as the Building Information Modeling Implementation Guide published in 2010; the Digital Engineering and Construction Roadmap published in 2012, which clearly sets out a "sustainable vision for the adoption of BIM technology "; in 2013, the "Digital Engineering and Construction Roadmap" was released to emphasize the necessity and importance of BIM application promotion in design, construction, operation and

maintenance; in 2015, the UK government released the "National Information and Digital Engineering Roadmap" in which the application of information technology to various industries to enhance the level of information technology was clearly proposed, including the transportation industry, health care, the public services and other fields.

2.3 Status of Domestic Development

At this stage, China is in the initial stage of BIM technology application, although a few universities and research institutions have carried out research on the application of BIM technology in the field of construction, but the majority of domestic universities and research institutions are still in the stage of learning from foreign advanced experience. For example, Shanghai Jiaotong University has started the research on the application of BIM technology in architectural design since the 1990s, and its article "Construction Project Information Management System Based on BIM Technology" was selected as one of the "100 Excellent Doctoral Theses in China" in 2015. However, unfortunately, this article only stays at the level of theoretical research, and does not provide an in-depth and systematic analysis and discussion of architectural BIM technology. For example, Mr. Huanming Du, a professor of Hong Kong Department of Urban Planning, has published an article on "Developing a Platform for Large Public Building Projects Based on GIS Technology".[10, 12, 13]

3 Digital Design Methods and Tools

Digital design based on BIM platform can use BIM software to create models quickly and accurately in design, optimize design by integrating data between different software, and use model and database information for simulation and analysis, which greatly improves design efficiency in terms of simulation and calculation. Since different types of public buildings have different needs for digital design, there are some differences in digital design methods and tools. According to the digital methods and tools used, the digital design methods can be divided into two categories: the first category is to use computers for intelligent calculation; the second category is to use professional software for algorithmic modeling, and then the computer automatically completes the model generation. The digital methods used in this paper are mainly based on digital design solutions developed on the BIM platform that are suitable for different types of construction projects.

3.1 The Realization of Intelligent Calculation under BIM Platform

Intelligent calculation refers to the use of BIM platform for digital design of the project, which can automatically complete collision checking, seismic analysis and other work. For example, for the project of Chengdu Medical Trade Building, a public building with a large area, the minimum net height of the interior can be automatically determined by intelligent calculation (Figure 2); for a public building with a large volume, the key

nodes in the structural design can be automatically determined by intelligent calculation. The public buildings that need to use intelligent calculation in this project include large public buildings such as medical trade buildings, libraries and exhibition halls. With the intelligent calculation function, relevant data can be obtained directly from the database and then analyzed automatically according to the design specifications, reducing the errors that may be caused by manual operation. In the intelligent analysis, the complex problems will also be broken down into smaller and independent problems for calculation. Therefore, it is necessary to determine different intelligent analysis software and related algorithms according to different types of buildings when using intelligent calculation functions.



Fig. 2. Basement E&M Collision BIM Model Optimisation Comparison

3.2 Automatic computer Generation of Digital Models

The digital method used in this paper is algorithmic modeling using software. By using building professional software to model the interior, exterior and electromechanical equipment in public buildings in a unified manner, and then generating a design solution that meets the actual situation by using the calculation function of the software, this method is more flexible and efficient than the traditional design method. Building professional software is developed based on CAD platform, such as AutoCAD, Bentley CAD and Autodesk MapInfo, etc. These software are used to organize, generate, annotate and edit and process the 3D models. The generated digital model is saved to the local database, and finally the information transfer and exchange function between the model and database is used to transfer the design plan to the BIM model on the BIM platform. When exporting the model, you can also modify the model in terms of material, color and grid division, and generate complete construction drawings.[14-16]

4 Design Process and Management Methods

As an important place for people to work and live, public buildings should be designed to meet the requirements of the general public for their functionality and comfort, and at the same time, they should be coordinated with the surrounding environment and

other buildings to ensure a good indoor space environment and visual effect. Therefore, the quality of architectural space should be improved through reasonable design in the design process. The digital design process based on BIM platform is shown in Figure 1. Using BIM technology can transform complex engineering into simple structure, and at the same time can connect building monoliths with each other. Through BIM model, different functional buildings can be analyzed in an integrated manner to improve design efficiency. According to different functional requirements, different models can be established and coordinated with each other, such as simulation analysis and collision detection, to determine the best solution; through the spatial layout simulation to determine the functional partition and control the spatial flow; in the construction process, the design can be adjusted according to the actual situation in time to meet the construction needs. Digital management for public buildings mainly includes the following aspects: (1) Strict control of the entire structure when modeling the building in 3D, including plan layout, node structure, etc.; (2) Use of BIM technology for spatial analysis and component reinforcement to optimize the spatial layout and plan layout of different functional areas; (3) Different types and sizes of components can be used according to actual needs when arranging components. (3) Different types and specifications of components can be used according to the actual needs when arranging components, so that they meet the corresponding requirements; (4) BIM technology is used to combine design elements such as building surroundings, surrounding facilities and building internal space with the building model to form a complete digital system. According to the different building types, the corresponding digital models are established and the collaborative simulation analysis is realized. Then all the model information is associated into one BIM model, thus forming a unified and complete digital system. When a problem occurs somewhere, it can be reflected to the relevant staff in time. At the same time, BIM model can accurately reflect the actual situation on site and the drawings when there is an error can also be timely feedback to the construction staff to reduce the rework phenomenon.[17-19]

4.1 Design Effect Analysis

BIM technology can improve design efficiency and standardize construction management, and has the following roles in specific projects: (1) BIM model can understand building information that cannot be realized on design drawings, such as load, material information and building deformation. In addition, the BIM model can also be used for cost estimation and construction simulation to reduce errors and rework in the construction process. (2) In the modeling process, the coordination among various professions can be effectively controlled, and the design drawings can provide accurate data information and operation platform for each profession, and the BIM model can also be used to make three-dimensional labeling of various equipment and pipelines to make them meet the design requirements. (3) BIM technology can be used to arrange the equipment and pipelines required by each profession reasonably to avoid design omissions or repeated arrangements; at the same time, it can also compare the comprehensive results of pipelines with the actual situation and adjust and optimize the relevant content. (4)

The model established by BIM technology can effectively express the intention of architectural design and various construction requirements; using the BIM platform, various construction materials, equipment and other parameters can be measured and accounted for, and construction specifications or procedures can be prepared according to relevant standards to guide the construction of each profession. (5) When establishing the model, problems can be found and solved at any time; when simulating construction, construction methods can be adjusted according to the actual situation, reasonable construction plans can be formulated and basic data can be provided for construction drawings. (6) By simulating and analyzing the design scheme, the parameters of materials and equipment used can be accounted for, and the most reasonable design scheme can be selected. At the same time, the construction drawings can be compared with the actual situation to determine whether there are omissions in the design; the 3D model can also be used to verify the corresponding norms and standards to improve the quality and efficiency of the design.[20-22]

4.2 Collaborative Work

Collaborative work is a very important part of the design process, and this is also true for public buildings. Collaborative work means close collaboration between various units in the construction industry to achieve the final design purpose through information sharing, timely communication and coordination of problems. The use of BIM technology can realize the collaborative work between various disciplines such as architecture and structure, building and decoration, etc., and can reintegrate the disciplines according to the actual needs of the design process, so as to complete a complete digital design system. (1) BIM model is the foundation of the whole digital system. By analyzing and processing the built BIM model, we can get the position relationship between each component, so that we can analyze whether there are collision or interference problems between components and solve them accordingly; (2) Using BIM technology, we can realize the collaborative work of each profession in the same software. Since the model contains all the data information required by each profession, it is possible to share the data information to improve the design efficiency; (3) BIM technology can be used to realize collaborative work in the same software. Since different software systems of different professions use different platforms, the collaboration can be realized by transferring information between different software. Through this software, the data information required by different software can be passed to each other and updated; (4) BIM technology can also realize cross-design and multi-disciplinary collaborative design among different professions. Since BIM model has strong adaptability, it can integrate many different types and specifications of components to form a building model. Based on this model, it is not only possible to optimize the design of its internal structure, but also to design and analyze various professions in the same platform, thus making the overall design more reasonable.[23-25]

4.3 BIM+5G Technology

5G network has the characteristics of low latency and large bandwidth, and its application in digital management can help designers convert drawings into digital information and build digital models, which is convenient for designers to view and modify in real time during the design process and reduce the chance of errors. At the same time, it can also provide feedback to the relevant personnel in the form of graphics and other forms of problems in the digital management process so that they can deal with them in a timely manner. In addition, the emergence of 5G technology can also improve design efficiency and reduce costs. Figure 2 shows that BIM+5G technology can realize real-time, fast and accurate conversion of design results into data information, storage and management, and real-time transmission to the cloud server through the network for viewing and modifying functions, reducing the errors brought by human transmission. During the construction process, various data information can be linked and summarized and analyzed in time to grasp the progress of each link. Moreover, 5G technology can be used to add construction simulation content and construction progress simulation content to the BIM model to ensure the smooth implementation of the project. When problems arise, pictures and text information can be uploaded to the cloud server in time and remote guidance and solutions can be realized through 5G technology to achieve efficient communication and instant information exchange. In addition, 5G technology can also be used to achieve real-time monitoring and remote management of the project. By establishing BIM+5G model, the project can be monitored visually and the parameters can be analyzed to understand the specific situation and adjust the solution in time. The above-mentioned functions can reduce costs and improve work efficiency, thus improving the quality and effectiveness of project construction. The BIM model can also be imported into the VR glasses to better observe the construction site and the distribution of space on each floor to ensure its design effect.[23, 26, 27]

5 Typical Cases

In this paper, a typical case of Chengdu Medical Trade Building is selected for study, and the whole project of "Chengdu Medical Trade Building" is undertaken in Dafeng Street, Xindu at the end of 2020. The construction of Chengdu Medical Trade Building consists of two office buildings and commercial podium. The total building height is 89 meters (20 floors, 84.05 meters) and 73.8 meters (16 floors, 69.05 meters) respectively, and the commercial below is 3 floors and 17.3 meters. Xindu District will further plan and construct the "Medical Trade Industry (line) Park" with high standard in accordance with the development strategy of "one core, one park and many points into a circle" of medical trade industry, and accelerate the construction of the medical trade industry (line) ecosphere with east and west in series. The project belongs to the strategic emerging industry that China has been developing vigorously in recent years, and is a public building project with unique concept in China. Its functions are positioned as a technology experience center, a smart city showcase and a tourist destination, etc.

5.1 Architectural Design

According to the planning requirements of Medical Trade Building Industrial Park Park, the project is divided into two functional areas: one is the R&D industrial area, and the other is the pharmaceutical trade commercial supporting service area. The design divides it into two components. The R&D industrial zone mainly includes office area, R&D area and conference exchange area, which are mainly high-rise; the pharmaceutical trade commercial supporting service zone mainly includes large shared exchange space, commercial trade exchange area and other areas, which are mainly multi-story and large space Mall. The digital design based on BIM platform can help designers improve efficiency, realize accurate analysis and calculation and collision check, enhance effective control of the project site, and save human resources while ensuring project quality. The site is precisely divided in the project planning; BIM technology is used to establish the site model associated with the design model and optimize the project site layout and traffic flow through digital modeling; BIM technology is used to complete the 3D roaming of each single building and public supporting facilities to visually display the dynamic information of the building; BIM technology is used to analyze and design. As shown in Figure 3:



Fig. 3. BIM model construction

5.2 Construction Process

The biggest difficulty of the project lies in the structure, and the overall design is complicated as the professions involved include architecture, structure and electromechanics. In the whole project, the most important three blocks are tunnel, rail transit and building. The tunnel part adopts the U-shaped steel beam combination support technology, which makes the whole steel structure with good seismic performance. The rail transit part is a super-large span and super-long distance urban metro hub project. Due to the adoption of a large number of new technologies and techniques, the Medical Trade Building is one of the Daxing places carrying medical trade commerce activities in the western region. The project has two major architectural difficulties: firstly, it

needs to accurately coordinate the different electromechanical equipment and process paths for trade medical and R&D needs; secondly, it needs to accurately calculate the material usage and the actual demand on site, and compare and adjust with the actual situation on site. These two major difficulties can be simulated and verified by BIM technology, and then the most reasonable design and construction plan can be obtained.

5.3 Summary

The rapid development of the construction industry has brought higher requirements for design and management, and BIM technology is playing an increasingly important role in design and management. From the current development trend, BIM technology in design and management should focus on the following aspects: 1) By establishing standard models and digital 3D models, it provides the possibility of information integration and transmission; 2) By coding building information, it can uniquely identify various equipment and facilities, making resource sharing possible; 3) Through data integration and transmission functions, it can improve the design 4) through modeling and analysis technology, efficient, reliable and visualized management of the whole life cycle of the building can be realized; 5) through the introduction of advanced technologies such as BIM technology, Internet of Things technology and virtual reality, the construction of a smart city can be realized.

6 Conclusion

BIM technology can bring great economic and social value to the construction industry. At present, BIM technology has been widely used in the field of engineering construction and has become a major tool for design, construction, operation and maintenance. (2) For public buildings, BIM technology can not only improve the efficiency of its building space utilization and reduce project costs, but also save a large amount of human resources and improve its overall service level. (3) At present, China is vigorously promoting the deep application of big data technology and information technology in the construction industry. Integrating new technologies such as big data and cloud computing into traditional industries can help enterprises solve practical problems faster and better and improve work efficiency. We hope that the research on the application of digital design and management based on BIM platform on public buildings can provide some reference for other industries.

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