*i*Journals: International Journal of Software & Hardware Research in Engineering (IJSHRE)
ISSN-2347-4890
Volume 10 Issue 9 September 2022

Application and exploration of BIM in assisting the whole process of hospital project informatization

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ABSTRACT

In recent years, BIM Technology has set off a digital wave in the construction industry. After more than ten years of rapid development, the technology has been proved to play an important role in improving the informatization management level of construction enterprises and promoting the digital upgrading of engineering projects. This paper discusses the application of BIM Technology in the whole life cycle of project design, construction and operation and maintenance under the construction environment of a hospital complex building project in Fuzhou City with small site, combined with the characteristics and construction difficulties of the project, Provide data support for the project, realize effective decision-making and fine management, so as to reduce design changes, shorten construction period, control cost and improve quality.

Keywords: BIM; information software; visualization; assembly type.

1. INTRODUCTION

With the comprehensive development of the national "13th five year plan" medical reform, the construction of hospital engineering has made great progress in recent years. However, hospital buildings are always regarded as the difficulty of project management in the construction industry because of their strong professionalism, involving many specialties, complex functions, complex construction and operation. With the development and application of BIM Technology in China, it has gradually become an important means of hospital construction management. Compared with the multi-directional and deep-seated applications in the world, the BIM application in hospital construction projects in China is still at a lower level than the preconstruction drawing verification based on collision detection of components and pipelines and preliminary simulation of construction, and its real application value in the whole life cycle has not been brought into play. This paper takes a hospital complex building project in Fuzhou City as an example. Under the construction environment with a small site, combined with the characteristics and construction difficulties of the project, the multi-directional application and exploration of BIM Technology in the whole life cycle of project design, construction and operation and maintenance are carried out. In order to achieve effective decision-making and fine management, so as to reduce design changes, shorten the construction period, control costs and improve quality.

2. ENGINEERING BACKGROUND

2.1 Project overview

The project is located in the South Second Ring Road of Fuzhou City. The total building area of the project is 39885.80m2, including 29513.54m2 above ground and 10372.26 m2 underground. The new outpatient complex building has eight floors above ground and one floor underground. The maximum height of the structural finish is 34.95m, and the maximum height of the parapet top is 38.95m. It is a steel structure fabricated building. The new high-voltage distribution room has two floors above the ground, with a building height of 10m (including 0.3m indoor and outdoor height difference). It is a frame structure building. The new sewage treatment station has one floor above ground and one floor underground. The building height is 3.7m (including 0.3m indoor and outdoor). It is a frame structure building. The project adopts EPC management mode, and is listed as a key project of Fujian Province in 2019. It is also listed as the first intelligent hospital in Fuzhou that needs to combine BIM Technology for later operation and maintenance management.

The ± 0.00 of the project is equivalent to the elevation of the Yellow Sea of 3.74M, the relative elevation of the site leveling is 0.00m, the relative elevation of the bottom of the basement floor cushion is -7.20 / - 9.20m, and the excavation depth of the foundation pit is 7.20 ~ 9.20m.

Fig 1: Project effect

2.2 Project features and difficulties

The project is a people's livelihood project with medical treatment, scientific research and first aid as the main body, with the purpose of serving the society. The process from design to construction is heavy, the drawings are changed frequently, and the electromechanical pipelines are complex. Therefore, BIM Technology was adopted at the early stage of the project, mainly to solve the comprehensive layout of electromechanical pipelines, system verification and dynamic management of the whole process of BIM. Different countermeasures were developed for the key and difficult points of the project, and the construction tasks were completed efficiently in combination with BIM Technology.

The main key and difficult points of the project are as follows:

(1) This project is a key government project with high social attention;

(2) High quality requirements for fine decoration, many subdivisional and sub divisional works, complex construction technology and delicate components of fine decoration projects, coupled with the professional level of the owner or the general contractor, often can not intuitively understand the design intent and effect, which brings many inconveniences to later management;

(3) Mechanical and electrical pipelines are complex. Compared with other public buildings, medical buildings add professional systems such as medical gas, which makes it difficult to arrange comprehensively. Therefore, it is inevitable to carry out cross operations of various disciplines, which makes it difficult to coordinate on site;

(4) The project is a medical and people's livelihood project with many design changes. The detailed design scheme should be revised and improved in time to avoid rework on site;

(5) The project adopts the EPC management mode, which makes management and coordination difficult. The owner requires that the later operation and maintenance management be combined with BIM Technology.

3. BIM APPLICATION ENVIRONMENT AND ORGANIZATION

3.1 Implementation plan planning

(1) Before the implementation of the project, formulate a complete set of BIM collaborative work docking processes and work standards, such as unified modeling standards, project template documents, document system establishment, etc. at the same time, formulate the task allocation scheme

of implementers, BIM work schedule and model delivery standards;

(2) In view of the special medical system of the project, the system simulation check of the hospital is focused on to check whether the design scheme meets the requirements of medical norms.

(3) The general contractor of the project takes the lead in carrying out the detailed design. The BIM team of the project creates a detailed design model according to the detailed design scheme of the designer, and submits it to the owner, the designer and the builder for review and confirmation. The technical director of the project shall make technical disclosure to the construction team, and compare the actual construction situation on site with the model to ensure that the model is consistent with the site.

(4) In combination with BIM management platform software, the construction process progress is dynamically simulated, and the quantities of components, equipment and materials are counted and checked during the process, so as to control the project cost, progress, quality and safe construction in real time.

3.2 Composition of implementation team

The BIM implementation of the project adopts the multi-level integrated three-level management operation mode of the head office's technical center, BIM studio and BIM application team of the project department. All team members have intermediate or senior professional titles and have obtained BIM skill level certificates, which provides a strong guarantee for the promotion and application of BIM.

The project absorbs excellent BIM talents from various disciplines, establishes a BIM application team of the project department, and links with the company's technical center and BIM studio to ensure the implementation of BIM for the project. It makes horizontal comparison, vertical understanding, summary and analysis of key information such as project progress, cost, quality, safety and new technology.

3.3 Main application measures

Create and integrate BIM models of various disciplines, integrate collaborative management of architecture, structure and electromechanical disciplines in the construction process, and organize engineers of various disciplines in the BIM implementation team to work together under the leadership of the technology center of the group company to scientifically, reasonably and orderly carry out various applications of Bim in the project.

3.4 Project software and hardware configuration

In combination with the application objectives and implementation scope of the project, the project mainly uses the following software: Autodesk Revit 2018 for architectural and structural professional modeling, Guanglianda magicad for electromechanical professional modeling, NavisWorks manage 2018 for visual disclosure and roaming display, and Guanglianda BIM 5D for dynamic management.

The main hardware configuration is: CPU: Intel Core i7-8700k; Memory: Kingston DDR4 2400mhz (32GB); Graphics card: NVIDIA geforce GTX 1070 (8GB); Alien laptop; IPad, etc.

4. WHOLE PROCESS INFORMATIZATION APPLICATION

4.1 Full professional model creation

The main purpose of the project is to guide the site construction with BIM Technology, and a refined model has been established for architecture, structure, water supply and drainage, electrical, HVAC, fire protection, medical gas and other disciplines. The model accuracy of architecture and structure discipline reaches lod300, as shown in Fig. 2, and that of electromechanical discipline reaches lod400, as shown in Fig. 3. At the same time, the model should take into account the needs of drawing guidance and construction, and the equipment in the model should be modified and upgraded accordingly.

Fig 2: Civil Engineering Model of the project

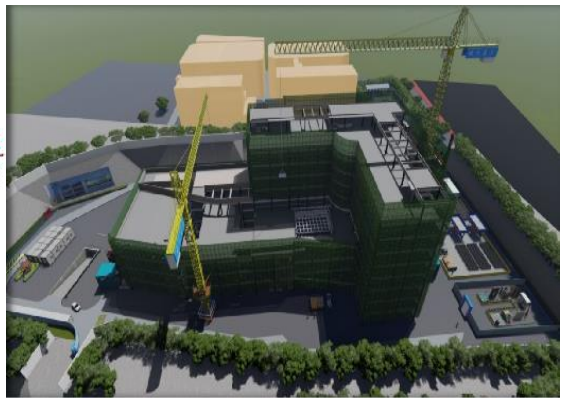

Fig 3: project electromechanical model

4.2

4.2.1 Joint review of auxiliary drawings

The BIM model building process of each discipline is equivalent to the all-round verification process of design drawings. The project evaluates the quality of design drawings based on the BIM model. For errors, omissions, collisions and deficiencies in drawings, 68 civil engineering professional problems and 33 electromechanical professional problems have been submitted. They are proposed before the joint review of drawings, and then the design changes or construction optimization items are confirmed at the same time, as shown in Figure 4.

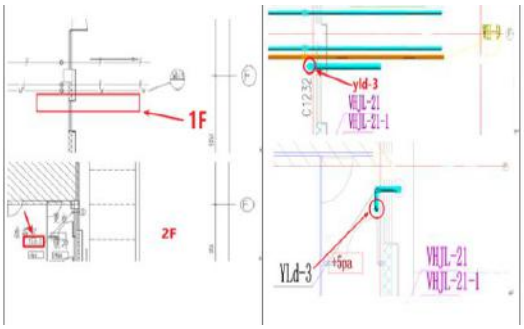

Fig 4: collision problem detection

4.2.2 Reasonable site layout

BIM is used to create a visual construction plane model at each stage, including the main entrance and exit of the construction site, temporary construction roads, material storage yards, turnover sites, large machinery occupancy, etc., to help the project make reasonable site planning at each stage in the early stage, greatly improve the efficiency of management, simulate the layout of the site under various working conditions, and avoid construction blocking caused by project impact in the construction site, as shown in Figure 5.

Fig 5: Site layout model

4.2.3 Comparison and selection of refined decoration schemes

Establish the refined decoration BIM model, and intuitively experience the refined decoration effect and space layout through generating two-dimensional codes and roaming; Conveniently modify the decoration style, quickly view the overall visual effect, facilitate the comparison and selection of fine decoration schemes, and improve the accuracy of decision-making.

4.3 Special application of electromechanical discipline

4.3.1 Comprehensive optimization of pipeline

According to the electromechanical model, the layout of equipment pipelines in the waste space of the building structure is optimized to improve the space utilization rate of equipment pipelines, reduce the space cost and improve the space quality after the completion of the project, aiming at the dense places of pipelines such as walkways on each floor; The integrated management optimization scheme is proposed. After discussion and confirmation by the design unit and the construction unit, the integrated management optimization of the overall electromechanical model is carried out, as shown in Fig. 6.

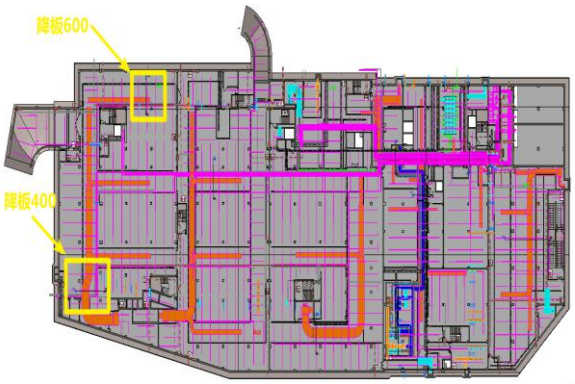

Fig 6: Optimization model of basement pipeline

4.3.2 Clear height analysis and roaming

Integrate the built BIM models of various disciplines to export lightweight fuzor documents, review whether the net height of each space meets the requirements of the specifications and the owner's needs, form a net height analysis diagram, optimize the layout of equipment pipelines in the waste space of the building structure, improve the space utilization rate of equipment pipelines, reduce the space cost, and improve the space quality after the project is completed, as shown in Figure 7.

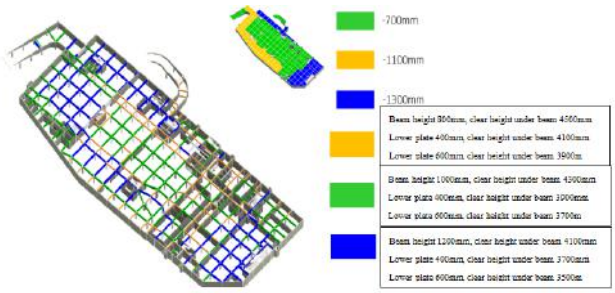

Fig 7: Analysis Model of Clear Height of Basement

4.3.3 Mechanical and electrical support and hanger optimization layout and force analysis

After the confirmation of the mechatronic arrangement, the support and hanger of the model is arranged. In order to reduce waste, facilitate construction and improve the appearance of pipeline, Bim mechanical and electrical personnel will be close to the pipeline, after adjustment to adopt a comprehensive support hanger way, the rest are seismic support and hanger and a separate support and hanger. On the basis of optimal arrangement of model pipe ensemble, MagicCAD software is used to arrange pipe support and hanger. The spacing of support and hanger is strictly in accordance with the design and specification requirements. At the same time, carrying on the bearing calculation to the support hanger, checking whether the type selection of the support hanger can meet the load requirement.

4.4 medical applications

4.4.1 Indoor and outdoor daylight analysis

(1) outdoor daylight shadow analysis: using daylight and shadow simulation, by calculating the sky radiation part to determine the effect of daylight hours on the hospital, the Shadow is visualized and the design scheme is validated, as shown in Figure 8.

(2) indoor sunlight analysis: using BIM technology to validate the feasibility of ward daylighting design, which can ensure good sunlight without causing indoor glare, and considering that the hospital is a big consumer of electricity, under the condition of ensuring the light comfort of the patients, the artificial lighting in the room can be reduced, the energy consumption can be reduced, and the operation and maintenance cost of the hospital can be reduced.

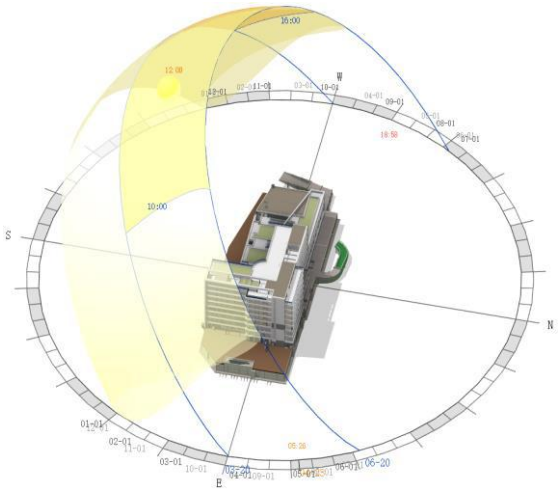

Fig 8: Outdoor Sunshine Analysis

4.4.2 Simulation of pedestrian evacuation

The BIM technology is used to verify the evacuation staircase, evacuation path and fire compartment. At the same time, the BIM model of the medical technology building is simulated dynamically according to the human behavior

mode to provide necessary security for patients and medical workers, as shown in Figure 9.

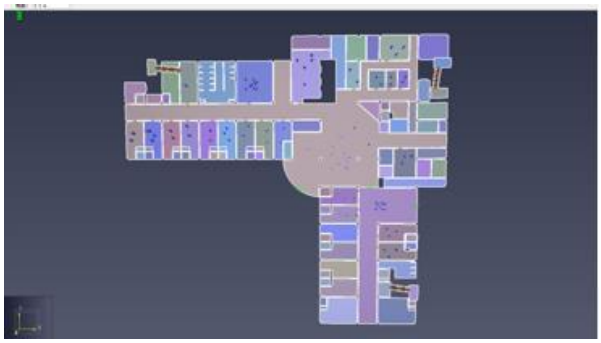

Fig 9: Simulation of Personnel Evacuation

4.4. 3 Deliberation of 3D visual ward layout scheme

In order to create a comfortable medical environment for patients, BIM technicians deliberated on the 3D plan of the ward decoration layout when the refined decoration plan was not completely determined, and assisted the refined decoration specialty to determine the final plan, as shown in Figure 10.

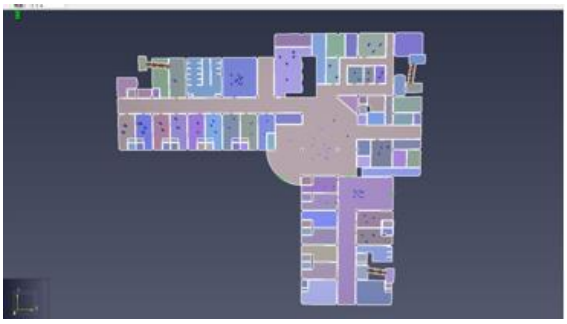

Fig 10: Visual Ward Layout

5. SUMMARY AND OUTLOOK

Compared with the traditional rough project management method, this project adopts a number of information management measures based on BIM technology to effectively improve project cost control, quality and safety management, progress management, material traceability management, etc. At the same time, in view of the particularity of complex layout of mechanical and electrical pipelines, equipment and medical gas pipelines in hospital projects, BIM technology is used to optimize the layout of mechanical and electrical pipelines, carry out standardized deepening design of equipment pipelines and traceable management of the whole process of factory processing and prefabrication, which greatly reduces waste and rework in the project. In combination with the BIM5D whole process information collaborative management platform, the project construction schedule can be reasonably arranged, the cross operation of various disciplines can be scientifically carried out, and the model based on the construction process is inversely optimized, which is convenient for the later operation and maintenance management.

The project adheres to the concept of "ingenuity in manufacturing and practical implementation of BIM", reduces the waste of resources, promotes the application of BIM technology in the construction industry, and creates a green and information-based construction site under the condition of multiple participation and mutual benefit. The project has trained many professional BIM management talents through the implementation and application of BIM technology, laying a solid foundation for the comprehensive development of BIM. BIM is a new revolutionary breakthrough for the construction industry. In the process of using BIM for construction, the project has made preliminary exploration and achieved some benefits, but there are still many deficiencies and defects. As the general contractor of the project, there is an insurmountable gap between BIM and professional subcontracting. In the future BIM promotion work, the project can adhere to the principle of maximizing benefits and achieve the following:(1) BIM application talents are the key pilots to promote the continuous development of this technology. We should continue to promote the BIM training for all staff and strengthen the training of BIM application talents for the project.(2) Strengthen the in-depth application of emerging software such as BIM5D, and deeply explore the whole life cycle management of BIM5D technology based on engineering projects.(3) Strengthen the exchange of experience in various BIM technologies, and conduct in-depth research on BIM application technologies to promote the informatization of all staff project management.

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