Application of BIM Technology in Engineering Project Management of Beijing Tiantan Hospital (Postprint)

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Date: 2017-10-20T00:00:00+00:00

Abstract

The Tiantan Hospital project, undertaken by China Construction First Group Corporation as the general contractor, is currently the largest hospital project under construction in Beijing in terms of scale. From the project' s inception, emphasis was placed on advancing the application of Building Information Modeling (BIM) technology throughout the engineering process. Beyond providing fundamental construction technical guidance, BIM technology was further integrated into project management practices, thereby establishing a foundation for the smooth implementation of the Tiantan Hospital project. This paper focuses specifically on introducing the application of BIM technology within this project.

Full Text

Preamble

Volume 8, Issue 2, April 2016

Application of BIM Technology in the Management of Beijing Tian Tan Hospital Project

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Abstract: The Tian Tan Hospital project, constructed by China Construction First Building (Group) Co., Ltd. as the general contractor, is currently the largest hospital under construction in Beijing in terms of volume. From the outset, the project has prioritized the application of BIM technology, extending its use beyond basic construction technical guidance into project management, thereby laying a solid foundation for the smooth execution of the Tian Tan

Hospital project. This paper focuses on introducing the application of BIM technology in this project.

Keywords: BIM system software/hardware configuration and organizational planning; BIM technology; project management; application

Classification Code: TU17
Document Code: A
Article ID: 1674-7461(2016)02-0038-06
DOI: 10.16670/j.cnki-cn11-5823/tu.2016.02.06

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1 Project Overview

The Beijing Tian Tan Hospital relocation project is located at the northeast corner of Huaxiang Bridge in Fengtai District, Beijing, with a total construction area of 267,931 m^2 and a site area of 272.6 acres. The main structural systems include concrete frame-shear wall and steel structure (for the outpatient building), with three underground floors and five to eleven above-ground floors. The project comprises 11 individual buildings integrating outpatient services, emergency care, inpatient wards, and research facilities. The total construction period is 915 days, commencing on May 1, 2014, with a planned completion date of October 30, 2016. The exterior design features a unique neuron-inspired 图腾 concept for the specialized outpatient building, creating a spacious, transparent, and aesthetically pleasing main entrance hall [Figure 1: see original paper].

Given the project' s massive scale, complex structural forms, numerous medical mechanical and electrical systems, and frequent interdisciplinary coordination, it presents significant challenges in construction organization, resource allocation, and general contracting coordination. To address these challenges, the project established a 20-member BIM team to conduct BIM organizational planning, aiming to leverage BIM technology for both construction guidance and project management.

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2 BIM System Software/Hardware Configuration and Organizational Planning

2.1 Deployment of Software and Hardware

After evaluating various BIM software and hardware options, the Tian Tan Hospital project department selected Autodesk's Revit and Navisworks software, Trimble' s Tekla software, and Glodon' s GCL, GGJ, BIM drawing review, BIM browser, and BIM solution systems. For hardware, the department set up a server as the database terminal, equipped high-performance computers (i7 processor, 32 GB RAM, 2 TB hard drive), and installed 100 Mbps dedicated fiber optic infrastructure to ensure smooth operation of the project BIM system.

2.2 Establishment of BIM Team

China Construction First Building Group attaches great importance to BIM talent development. During the project preparation phase, the organization conducted multiple BIM training sessions for technical personnel. Through combined theoretical and practical cultivation, the Tian Tan Hospital project department established a young and dynamic BIM team with dedicated full-time BIM specialists. The team evolved from novices to an elite group [Figure 2: see original paper].

2.3 Development of Unified BIM Standards

Before commencing BIM work, project personnel collaborated with Glodon' s consulting team to develop the "BIM Implementation Guidelines," "BIM System Technical Standards," and "BIM Work Standards" (including the "Overall Implementation Plan," "Specialized Application Standards," "Work Specifications," "Modeling Standards," and "Delivery and Acceptance Standards"). These standards provided favorable assurance for the smooth implementation of subsequent BIM work.

2.4 Establishment of Project Templates and Family Libraries

Before formal modeling, each discipline established corresponding template files [Figure 3: see original paper], and created over 500 professional family files for civil engineering, mechanical/electrical systems, and medical equipment based on project requirements and family library management rules. These files formed valuable reusable resources for similar future projects.

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3 Application of BIM in Construction Technology

3.1 Clash Detection and Pipeline Optimization

Adhering to the concept of modeling while applying, the Tian Tan Hospital project synchronized deep design work with continuous model updates. Clash detection identified at least 360 major clashes in the basement, 210 in the main building, and 58 drawing issues. Subsequent pipeline optimization considered not only the model itself but also on-site installation sequences, maintenance spaces, and support/hanger installation, achieving zero collisions after adjustment [Figure 4: see original paper]. This work directly reduced numerous rework instances for the project department, saving over one million yuan in costs.

3.2 Visualized Technical Disclosure and On-site Verification

The Tian Tan Hospital project department held weekly deep design meetings for various disciplines, where the two-dimensional, intuitive, and three-dimensional

models effectively facilitated communication on detailed locations, saving approximately 10% of communication time. The project also combined BIM models with on-site installation conditions to conduct comparisons and verifications of key locations, ensuring construction teams executed work according to drawings with guaranteed quality [Figure 5: see original paper].

3.3 BIM-based 3D Site Layout

With 10 building structures under simultaneous construction, rational dynamic site layout presented a major challenge. BIM technicians virtually constructed all on-site objects, optimizing layout plans through walkthroughs and simulated installation/dismantling time to ensure unobstructed transportation routes, facilitate construction personnel management, and effectively avoid secondary handling and accidents [Figure 6: see original paper].

3.4 Mechanical and Electrical System Verification

Building upon conventional BIM applications, the Tian Tan Hospital project conducted deeper-level applications such as mechanical and electrical system verification. The team selected air and water systems in the basement, sample rooms, and equipment rooms from the BIM model for detailed verification, calculating system pressure, pressure drop values, and valve opening degrees to provide accurate guidance for on-site commissioning personnel and establish basic data for future operation and maintenance warnings and maintenance [Figure 7: see original paper].

3.5 Formwork Safety Verification and Prefabricated Component Processing

With 11 buildings in the project, the volume of temporary works was substantial. The project department used Glodon' s formwork products to conduct safety verification of external scaffolding, ensuring safe construction. The calculated formwork quantities also provided valuable guidance for subsequent material procurement. The effective application of prefabricated component processing technology was crucial for ensuring and advancing the project schedule. The Tian Tan project team broke down and quantified water pipes, air ducts, and cable trays according to modular requirements, enabling factory-based prefabrication.

3.6 Precise Brick Layout for Interior Finishing

The project department utilized Glodon software' s one-click brick layout function in the BIM model' s secondary structures. By simply selecting wall surfaces for brick arrangement and inputting corresponding parameters, the system automatically generated brick layout plans for construction guidance, improving work efficiency by more than five times [Figure 8: see original paper].

4 Application of BIM in Project Management

4.1 Model-Construction Data Integration

Project personnel used the BIM platform to integrate models created with Revit, Tekla, GGJ, and other BIM tools, along with data from Project, Word, Excel, and other office software. They linked schedule, drawing, quality/safety, and cost data to the models, forming the Tian Tan Hospital project' s BIM data center and collaborative application platform. This integration supported multi-department, multi-position collaborative applications and provided a foundation for refined project management.

4.2 BIM-based Schedule Management

Addressing schedule management challenges, project personnel imported and linked schedules with models. The system displayed three-dimensional dynamic progress simulations based on actual site conditions, enabling extraction of work quantities for any time point or period to effectively guide owner quantity reporting and subcontractor verification. Ten quantity reports have been completed to date, with schedule data basically meeting owner requirements. The BIM management system set 13 milestone events and over 20 warning messages, identifying four instances of unmet milestone nodes and triggering five types of warning messages that were simultaneously sent to relevant personnel to help management optimize schedules and ensure timely completion. Additionally, the BIM management system assigned supporting works linked to the schedule plan to corresponding departments based on their responsibilities, and department heads further assigned tasks to specific implementers, achieving accountability and creating an executable schedule plan [Figure 9: see original paper].

4.3 BIM-based Drawing Management

The Tian Tan Hospital project linked drawings with corresponding models, enabling quick queries of detailed drawing information for specified components across all disciplines, including different drawing versions, modification sheets, design change negotiation documents, and Q&A files. For 1,204 project drawing changes, the drawing module dynamically tracked corresponding application statuses. Using the advanced drawing search function, users could quickly locate relevant drawings and information from massive databases—tasks that previously required 2-3 people and one hour can now be completed in seconds by simply entering search conditions, making it several times faster than traditional methods [Figure 10: see original paper].

4.4 BIM-based Commercial Management

The Tian Tan Hospital BIM model enabled automatic quantity calculation and multi-dimensional quantity summarization. The project department linked the BIM model with general and subcontractor contract unit price information, allowing examination of specific components' quantities and corresponding contract unit prices and total prices. For general contractors, effective integration of BIM and commercial management represents the most important aspect of BIM value realization, particularly with the rapid development of one-click BIM quantity calculation and BIM-based general/subcontractor management models that further promote BIM application in commercial management.

First, model usability was verified through a progressive checking approach: local areas first, then single-level horizontal components, followed by multi-level vertical components, with identified issues corrected promptly. Second, quantity accuracy was verified by comparing Revit models with commercial GCL models, revealing precision errors of less than 1%, confirming model correctness. For owner quantity reporting and subcontractor verification, the project department selected model scopes based on schedule plans, automatically calculating quantities and reporting amounts to facilitate owner payment applications and subcontractor payment approvals, improving efficiency by more than double compared to previous methods. For cost management, the project department used the BIM management system for automatic cost accounting, achieving three-way comparison of budget, income, and expenses. Management could view cost comparison and trend analyses through line charts, enabling timely decision adjustments and control direction to realize intuitive, real-time, and refined cost management [Figure 11: see original paper].

4.5 BIM-based Quality and Safety Management

The project department recorded 28 quality issues and 200 safety issues through mobile on-site collection or PC input, with personnel and time assigned for effective monitoring according to established standards. Data accumulation and analysis identified frequent quality and safety problem locations, helping management prevent issues in advance, deploy focused inspection priorities during the process, and optimize resource allocation [Figure 12: see original paper].

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5 Application of BIM in Project Operation and Maintenance Phase

5.1 Integration of BIM and IoT for Operations Management

The BIM model contains fundamental data and information on component locations, dimensions, installation times, and manufacturers for structural elements, concealed works, mechanical/electrical pipelines, and valve groups. This information facilitates operations management during project delivery and use,

improving work efficiency and accuracy while reducing time, material waste, and failure losses when malfunctions or issues occur. Key applications include: (1) Equipment remote control: Independent operating devices can be integrated onto a unified platform for management and control through RFID and other technologies, enabling both status monitoring and remote control. (2) Internal space facility visualization: BIM establishes a visual 3D model from which all data and information can be retrieved. (3) Spatial positioning of lighting, fire protection, and other systems and equipment: Providing spatial location information transforms traditional numbering or text representation into intuitive 3D graphical positions for easier location identification. (4) Operations and maintenance data accumulation and analysis: Accumulated O&M data holds significant management value, enabling problem and hidden danger analysis through data, as well as management optimization and improvement. For example, RFID can capture meter readings to track energy consumption over time, while accumulated data can analyze vacant parking space patterns during different periods to optimize garage management.

5.2 Cloud-based BIM Management

During the BIM specialized application phase, the project established a BIM information sharing platform through Glodon Cloud for BIM team data management, task distribution, and information sharing. Cloud-based sharing provides unrestricted information access from anywhere with network connectivity. It enables better cross-disciplinary collaboration and sharing, with models stored in the cloud accessible through any network connection. The cloud computing model can save up to 67% in server lifecycle costs and requires virtually zero implementation and maintenance workload.

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Key Words: Software and Hardware Configuration; Organization and Planning of BIM System; BIM Technology; Project Management; Application

Note: Figure translations are in progress. See original paper for figures.