Application of BIM technology in the whole process of cost management of a construction project

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Abstract. With the development of information technology, the construction industry has ushered in a series of innovations and changes. This paper analyzes the specific application of BIM technology in the whole process of cost management of construction projects, explains how BIM technology takes information as a breakthrough, breaks down the barriers in all stages of design, construction, operation and management, and realizes transparent, accurate and timely sharing of construction information and free flow in all stages.

Keywords: BIM technology; whole process cost management; application research; construction engineering.

1 Introduction

Currently, the engineering construction industry faces many challenges such as cost control, schedule compression, quality improvement, etc. BIM is widely used throughout the life cycle of a project to facilitate the creation, collection, management, manipulation, and dissemination of construction data in an efficient manner. Additionally, BIM supports project visualization, scheduling, communication, and collaboration among stakeholders[1]. The introduction of BIM technology can not only improve construction efficiency and reduce operating costs but also improve the quality and safety of the project through predictive analysis[2].

2 Current limitations of cost management

The limitations of the current construction project cost management system and model are becoming increasingly obvious, and the cost standard of each province and city is not uniform. Currently, cost management is limited to internal personnel sharing, and cost engineers are unable to collaborate with other positions. Cost management needs to be refined to different times, components, processes, etc., but the recent process of cost management is completely abandoned. Design changes, visa claims and adjustments to quantities and prices are frequent on-site. Existing management technology for a long time without innovation, relevant professionals in short supply, currently put

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into use in the advanced management technology is only stand-alone software, and computer-related functions have not been fully demonstrated[3].

3 Advantages of BIM technology application in engineering

The visualization mentioned in BIM technology is a kind of visualization that can form interactivity and feedback with the components. The result of visualization can be shown in rendering and report generation. The communication, discussion, and decision-making in the process of designing, constructing, and operating the project are all carried out in the visual state. BIM technology can simulate the actual construction according to the organizational design of the construction, to determine the reasonable construction plan to guide the construction. The complexity of modern buildings mostly exceeds the limits of the participant's abilities, and BIM and its supporting optimization tools offer the possibility of optimizing complex projects.

4 Application of BIM technology in the whole process of cost management of construction project

4.1 Overview of the project

The laboratory building of a university project in Yi bin, Sichuan, has a floor area of 26779.40m², of which the basic laboratory building is 22417.52m², and the metal-working practice base is 4361.88m². The number of floors above ground is five, the building height is 21.9m, and the structure type is a cast-in-place concrete frame structure. The construction progress of this project is a concern for the government and major companies, which puts new demands on BIM technology for cost control.

4.2 Decision-making phase

In the decision-making stage of the project, data from previous BIM models can be used, such as the cost per square meter of similar projects in the region, to create the red line of the site and the red line of the road for the project according to the planning conditions, and to generate the area index. Create a building volume model according to building control conditions such as building density, floor area ratio, greening rate, etc., and carry out architectural conceptual design to preliminarily complete the BIM model design at this stage[4].

4.3 Design phase

Relevant studies at home and abroad show that the cost of the design stage accounts for only 1% of the total cost of the project, but the impact on the cost of the project accounts for more than 75%. In the construction stage through technical innovation and

other means on the project cost of the degree of influence is only 5% to 10%. The design stage is the key link to control the project cost[5]. In the design stage, the work is mainly divided into preliminary design, program design, and construction drawing design. In the preliminary design, the project cost is estimated using the basis of floor area and building index. In the program design, the focus is on an in-depth study of technical difficulties. In the preparation of the construction drawings, specific quantities, and corresponding costs were calculated according to the information on the drawings. The historical data of the BIM model is utilized in this stage to do the limited design, which can ensure the economy of the design works as well as the rationality of the design.

Overall, BIM technology can provide more accurate and comprehensive cost information in the engineering design stage, assist the design team and owners in making informed decisions, optimizing the design scheme, reducing project risks and improving the efficiency and quality of cost management[6].

4.4 Establishment of Quanta Calculation Modeling

The name of this project is A1 experimental building, which is divided into two sub-unit projects, due to the different functions of the two sub-unit projects and the large differences in story heights, the two sub-unit projects are established by GTJ for modeling and measurement. The modeling process is shown in Figure 1.

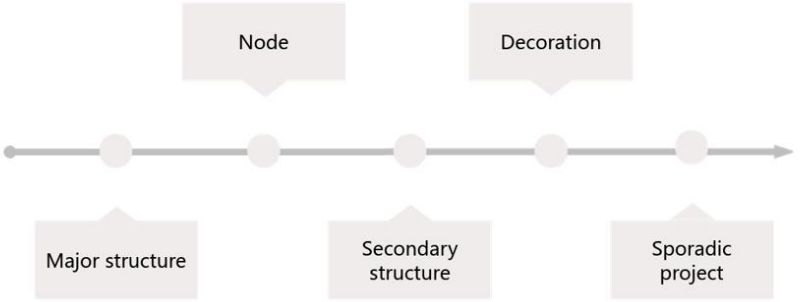

Fig. 1. Model drawing process (Source: Author's drawing)

The traditional rebar measurement process is very complicated and repetitive labor, and easy to make mistakes. We input the rebar information required for each construction through GTJ concerning the drawings, and then the computer can quickly analyze the statistics of various components, which greatly reduces the cumbersome manual operations and potential errors, and it is very easy to achieve complete consistency between the quantity information and the design plan. The completed model is shown in Figure 2.

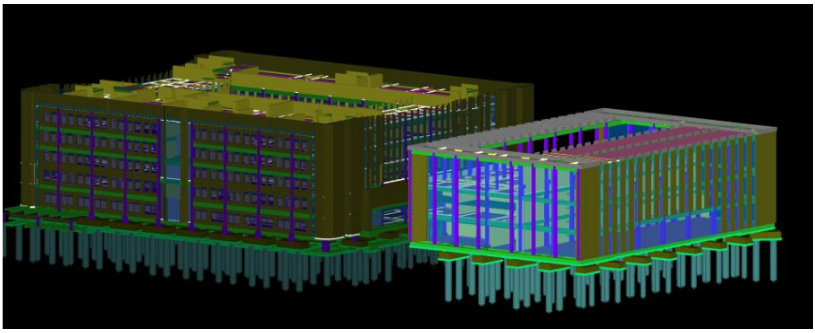

Fig. 2. Completed GTJ modeling (source: author's drawing)

4.5 Bidding stage

At this stage, the cost and comprehensive unit price of the project are calculated by the national standards, and the quotation is made by using the wide material network and other methods. We can also use Guanglianda cloud pricing software to detect unbalanced quotations, and then adjust the quotations, to obtain more ideal economic benefits.

4.6 Construction phase

BIM-based schedule management.

Using BIM5D software, the model will be divided into construction sections according to components, associated with the progress plan, to carry out construction progress simulation, to find out the chaotic nodes of the construction process in advance, and to make adjustments to the plan. The BIM management platform will push the weekly plan to the relevant responsible person, who can start to implement the plan after receiving the information, and real-time recording of the on-site production situation and feedback to the management platform for collaborative management and control. which is conducive to the management of site progress.

BIM-based quality management.

On-site quality and safety inspectors can collect problems through the cell phone terminal and push the relevant problems directly to the constructor by directly taking photos and assigning responsibilities; the constructor carries out rectification and replies by taking photos, and the person who pushes the problems can accept them according to the rectification photos. The quality management process is shown in Figure 3.

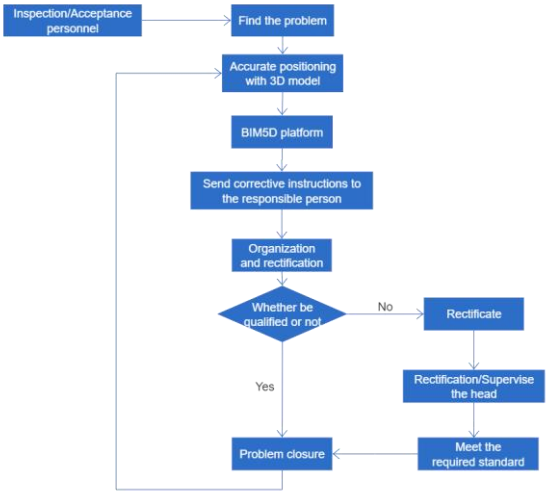

Fig. 3. Project Quality Management Process [7]

Collision checking.

The use of BIM software for three-dimensional level proofreading operations can accurately determine whether there is improper spacing or three-dimensional space cross-collision, etc. The software can also generate the corresponding inspection report, which can realize the automated adjustment of the design scheme and reduce the risk of design changes. Compared with traditional project site management, the rework rate can be reduced by about 60%.

4.7 Completion stage

The final stage of project cost management is project settlement. the introduction of BIM technology coupled with 5D collaborative management can integrate the cumbersome process records on the BIM model so that the documents have three-dimensional attributes of volume, price and time. Most of the checking of the settlement has been completed in the construction stage, which accelerates the speed of the settlement and the formation of the settlement model. According to research data from Stanford University in the United States, BIM technology for construction projects can shorten the construction period by about 10%, save 10%-15% of the cost of inputs, reduce staffing and improve management efficiency by 40%, reduce energy consumption by nearly 15%, and extend the life of the building by 20%.

5 Conclusions

In order to improve project management, support trade crews, and promote a more productive work environment, the construction industry is adopting digitization. Pro-

ject information digitization has emerged as a means for the construction industry to achieve greater efficiency and precision in its processes, thus reducing costs and optimizing production [8,9]. We should expand the breadth and depth of BIM application, cultivate talents in BIM technology, and maximize the advantages of BIM technology.

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