The Application of BIM Technology in the Cost Management of the Whole Process of Construction Projects

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Abstract. The whole process control of construction cost is the most effective way in the current project cost management. However, due to the large number of participants involved in the construction project, the long construction period, and the lack of shared information platforms for all parties, it is difficult to implement truly effective management. The emergence of BIM technology has changed this situation. BIM technology integrates the entire process from design, construction to operation, and the application of BIM technology at all stages helps to control the entire process cost more quickly and accurately.

Keywords: The Whole Process Cost Control, BIM Technology, Collaborative Management

1. Introduction

With the continuous deepening and improvement of the market economy system, the reform of the engineering cost industry is also accelerating. Objectively, construction companies are required to implement the entire process of cost management for construction projects. Only by doing a good job of dynamic management of the whole process of project cost can the company maximize its profits and ensure its survival in the fierce market competition. However, due to the large number of participants involved in construction projects and the longer construction period, each participant lacks a platform for sharing information, making it difficult to implement truly effective management. BIM technology will collect information from all stages of the entire life cycle of a construction project into a platform, so that all construction project participants can share and coordinate, so that the cost management of the whole process can really play a role.

2. Overview and characteristics of BIM

BIM is the abbreviation of "Building Information Modeling", translated as "建筑信息模型"[1]. BIM technology uses information technology to establish a virtual construction project, which
has a logical building information database. Simulate the real state of the building through digital information. BIM technology integrates the entire process from design, construction to operation, and has five major characteristics: visualization, coordination, simulation, optimization, and graphing[2]. Through BIM technology, construction companies can better communicate in the entire project construction process through real simulation and integrated features, so that all parties to the project can grasp the real-time situation, construction period, cost, and environmental impact of the site.

3. Whole process management BIM technology application method

3.1. Project investment decision-making stage

In all stages of project construction, the impact of investment decision-making stage on project cost reaches 70%-90%[3]. For project investors, whether a project can bring reasonable benefits later will directly affect the decision of the project decision maker. The application of BIM technology can accurately estimate the investment required for the project in the future, and the BIM technology has the function of storing and analyzing data, and can establish a huge database to obtain various indicators and parameters from the database for guidance The price of the project improves the accuracy of investment estimates. At the same time, you can also use the BIM model to integrate project management documents and cost documents. By setting different parameters, you can calculate the future benefits of the investment plan. Project decision-makers can choose the best investment plan based on the calculation results[4].

3.2. Design phase

The design stage is very critical for controlling the project cost. It plays a decisive role in the quality, construction period, investment, use and economic benefits of the construction project after completion. The BIM application in the design phase is roughly divided into the following three aspects: firstly, visualized confession and linkage effect. Compared with the traditional BIM visualization, it improves work efficiency and solves the problems that will arise in the future to the greatest extent in the design stage. The utility of linkage can improve the efficiency of designing various majors, reduce the misunderstanding of the project due to the differences between majors, and allow each major to improve work efficiency. Moreover, under the effect of linkage, the model can associate a modification to the relevant places, which solves the problems of errors, omissions, and deficiencies in drawings for a long time, reduces unnecessary waste and rework, and reduces the cost of the entire project. Secondly, parametric design. Building components can simulate some properties other than geometric shapes, such as material fire resistance grade, weight, material heat transfer coefficient, component cost, etc. As long as the corresponding parameters are set, the components can be changed according to the design requirements, thereby reducing the cost of construction Loss of waste products caused by insufficient refinement of on-site processing data. Thirdly, for collaborative work between disciplines, BIM technology can integrate data and information from various phases of construction projects and between disciplines into the platform by establishing a BIM data collaboration platform. Owners, design, construction and operation and maintenance parties can use the collaborative platform to carry out design deepening, construction simulation, schedule control, cost control, etc., to improve the overall process management level of the project and reduce additional expenditures.
3.3. Bidding stage

In the bidding and bidding stages, the owner will issue a bill of quantities. Due to the difference in the professional level of the measurement personnel, it is often because of the inaccuracy of the quantity, which affects the progress of the bidding and bidding. The application of BIM technology can set the benchmark BIM model of the project for both parties. Both bidding and bidding parties can directly load the bill of quantities to avoid the occurrence of miscalculations and omissions in the manual calculation process. This guarantees the amount of work. The completeness and accuracy of the system effectively avoids missing items and wrong items. And once a design change occurs, the engineering quantity can also be updated immediately, reducing a lot of duplication of work.

3.4. Construction phase

The construction period of the construction project is long and the resource consumption is large. This stage is the most difficult to control the cost. At this stage, the use of BIM technology can effectively control the project cost through the following three aspects: first, the use of three-dimensional technology for technical disclosure plays a leading role in actual construction. The previous technical disclosure only stays in form and cannot achieve the purpose of explaining the construction operation regulations and construction techniques of various projects. Construction projects based on BIM technology Technical disclosure can show the construction process through a three-dimensional model, and show the construction details through three-dimensional software, effectively passing the construction technology to the construction staff through the three-dimensional model, greatly improving the quality of project disclosure. The second is to simulate the site layout. After BIM technology creates the site model and the proposed project model, hooks the actual environment around the project and the site to the model, establishes a three-dimensional construction site layout, and imports the project schedule. Intuitively simulate the on-site situation at each stage, and flexibly carry out the site layout, effectively controlling the cost of the construction site. The third is construction simulation, which guides the complex construction process through intuitive 3D model animation combined with construction organization. Carry out construction rehearsal through BIM technology, carry out real simulation and analysis of the construction process, procedure and construction environment, and provide the construction party with reports, so that the construction personnel can grasp the construction process more clearly and thoroughly, and reduce the problems caused by quality and safety issues. Rework and rectification have improved work efficiency[5]. At the same time, BIM5D technology combines project progress, human resource consumption, material consumption and models, and effective project management is helpful to implement comprehensive cost control.

3.5. Completion and settlement stage

In the early stage, through the application of BIM technology in the investment decision-making, design, bidding and construction stages, the amount of data accumulated by the BIM model in the completion and settlement stage has been relatively large, and the actual labor, material and mechanical consumption and other variable information in each stage have been loaded into BIM Among the models, the model engineering volume at this stage is very close to the actual completed engineering volume. This provides an accurate basis for completion settlement, improves efficiency and saves project investment.
4. BIM technology is applied to the realization of the whole process cost management—take Project A as an example

4.1. Project Overview

Project A is a large-scale hotel project with a construction area of approximately 34,000 square meters. It consists of a high-rise and underground garage, and is a core tube structure. The project involves many majors and many machinery, and there are many risk factors that affect quality. At the same time, the owner has high requirements for construction period and quality. There are many interaction problems in professional design, and the piping equipment of large hotels is complicated, which can easily cause rework. There are many electromechanical majors, which are complicated and technically difficult.

4.2. Application in investment estimation stage

We imported the relevant information and drawings in the early stage into the BIM software, simulated the changes in buildings, roads, greening and elevation, and created red lines for land and roads according to the plan. Then create a variety of plans based on building density, floor area ratio, greening rate and other indicators to create a mass model. Carry out general map planning, road traffic planning, and green space landscape planning. By comparing different schemes, the cost changes are obtained, the cost of different schemes is weighed, and one of the schemes is selected for estimation according to demand[5].

4.3. Application in project design stage

On the basis of the preliminary data, professional models of civil engineering, installation, steel structure, curtain wall, etc. were established and closed, collision detection was carried out in the model, and collision reports were output. A total of 6,856 collision points were detected. Include the following:

| Check content            | Problems found                                                                 | Solution                                                                 |
|--------------------------|-------------------------------------------------------------------------------|--------------------------------------------------------------------------|
| Model compliance check   | The multi split air conditioning system is adopted from the 5th floor to the 7th floor. The main pipe of refrigerant pipe in each floor should be connected with the outdoor unit on the 5th floor. In the model synthesis, it is found that there is no main pipe connection route in the drawing design. | After the detailed design, the refrigerant pipe of each floor is connected to the outdoor unit through the pipe well to the roof of the fifth floor. |
| Model integrity check    | In the original design, the refrigerant pipes and condensing pipes of the multi split air conditioning system from the fifth floor to the seventh floor are lack of pipe diameter identification. | Using the model to calculate the pipe diameter demand, simulate the pipeline flow, and form the design model. |
| Model                    | When the installation profession                                             | Rearrange the pipeline well                                             |

When the installation profession
| Specification interaction check | After the spray system model was completed, the pipe diameter was found to be wrong. | According to the design description of the drawing, the label should be Dn40 and DN50. |
|---|---|---|
| Economic optimization | All the fan coil units are right-hand type, and the pipe needs to go to the right. | Through optimization, the right type of fan coil unit is changed to the left type, and the equipment price remains unchanged. In this way, the pipe is directly connected to the fan coil unit on the left side, and each fan coil can save 3M. In the whole project, a total of 600m copper pipe can be saved by changing. |
| Optimization of space and clear height | In the original hotel design scheme, the floor height is 3.6m and the beam height is 0.85m. The corridor is narrow and there are many kinds of pipelines. After the BIM simulation layout, the space occupied by the pipeline is estimated to be about 0.65M. The practical net height is 2.1m. The owner put forward the requirements, hoping to compress the pipeline space and improve the space utilization rate. | The BIM team innovatively proposed that the cable tray should be embedded in the beam, and the structures on both sides should be strengthened separately, which effectively improved the space utilization rate, and the practical net height was increased from 2.1m to 2.275m. |

4.4. Application in bidding stage

The BIM model is used to extract the quantities for bidding bill of quantities. Through accurate measurement, the final bid price of the project with the original estimated price of 99685620 yuan is 87685350 yuan[6].

5. Conclusion

The application value of BIM Technology will change with the innovation of new technology. The purpose of BIM Technology Application is not only to build the model and export the data, but also to optimize the workflow and system by combining project management means[7]. The coordination of BIM can preview the management, reduce the risk in the actual project implementation process, and benefit all parties of the project. The information exchange based on BIM platform enables all participants to share information and promote the innovation and upgrading of management mode[8]. With the development of BIM Technology, the future application of BIM will be used in more aspects.
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