Research on the Application of BIM Technology in the Whole Process Cost Management of Construction Project

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Abstract. Cost management, with the information technology used frequently, is the most important link in the process of engineering construction. It is, however, no longer able to adapt to the trend of information technology development by using traditional work methods. The whole process cost focuses on the whole construction process and the overall interests of the project. BIM technology, as an electronic information modeling, provides an efficient information exchange platform, on which the cost management work can be connected at any stages in series with the result of repetitive work reduced and work efficiency increased. The improvement of work efficiency and way can be realized by applying the suitable BIM software to each stage of cost management can improve work efficiency. The paper studies specifically the integration of the whole process cost management on construction engineering. There is a commercial residential project in the case part in the use of relevant BIM software to realize the systematic collaborative management for the whole process of engineering cost. On the basis of the transfer of the cost data to the whole process of construction by using the BIM software, it concludes the route and method of the whole process cost management in the use of relevant software.

Keywords: BIM Technology · Whole Process · Whole Process Cost Management

1 Introduction

With the increasingly development of the scale and the output value in recent years, the construction market has reached a high proportion of GDP in China, and even up to 12% in 2021 [1]. Nowadays, the development of new technologies is rapidly in all walks of life, so the construction technology has been updated and improved to a certain extent. The efficiency on the construction technology, nevertheless, is still at low level, because of the properties of the products and the trend of industry development. There are problems in the work, including every link in the construction process fails to transmit information efficiently, and participants of the construction work fail to cooperate with

each other, and the repetitive work is emerged at each stage. It will not only lead to low efficiency in the construction process, but also cause serious waste of resources [2].

BIM technology is an effective way to improve the informatization of the construction industry. It turns the construction process into a modern industrialized production model of an assembly line, in which BIM forms a digital production line with a powerful data in all related software and models through a shared work platform, upgrading the production process of construction products to a modern industrial-grade production model. At this stage, the cost management methods of construction engineering are neither able to adapt to the current trend of informatization development, nor to control construction investment effectively. The paper effectively integrates BIM technology into the cost management of all aspects of engineering construction based on a comprehensive and systematic analysis of the whole process engineering cost management and BIM technology [3].

2 Hole Process Cost Management of Construction Project

The whole process cost management of construction engineering includes total cost management, whole lifecycle management, total factor cost management, and whole process cost management. The whole process cost management place emphasis on the work of the cost management which should be involved in advance. It runs through the whole range of construction engineering with the starting point of the construction engineering planning and decision-making stages to the end point of the completion [4].

2.1 Cost Management in Each Stage

First of all, the investor of the construction project needs to take such factors as the amount of capital to be invested, opportunity cost, and actual technical level into consideration so as to make a decision on the scale and usage of the project at the investment decision-making stage. Project cost management staff should grasp the investment of the project as a whole and prepare investment estimation [5].

The design stage is the key point for the actual formation of the project cost and the most effective control. At this stage, the design unit often calculates the project cost according to its proposed construction scheme or construction drawings.

The project price calculated in the bidding stage is not only the basis for both parties to determine the contract price, but also the basis for settlement between both parties in the later stage [6].

The project construction stage is the central link in the whole project life cycle of the construction unit and the contractor. The contractor completes an actual building through the construction process, and most of the project investment will be spent at this stage. This stage is the formation process of the actual project cost [7].

The completion settlement of the project is the process in which both parties calculate all the completed construction products and pay the project price according to the specific provisions of the construction contract after the completion acceptance is qualified. The completion settlement received by the construction party is generally composed of the contract price plus or minus the adjustment amount recognized by Party A and Party B

as well as the deduction of project progress payment and quality warranty deposit paid during the construction process [8].

2.2 Difficulties in the Implementation of the Whole Process Cost

(1) It is difficult to gather professionals to support the whole process cost management at the full stages of the construction process with the result of the small scale in the cost industry.

(2) The key point of cost management focuses on the project pricing business. The quantity surveyors always take the measurement and valuation, rather than focusing on the value management of the entire life cycle of the construction project [9].

(3) There is the situation with slow update speed for the measurement and valuation basis is not fast enough in the whole process of cost management. There is insufficient amount of similar engineering cost data in the estimation and budgetary estimation stage.

(4) At present, the work mode of most quantity surveyors is to take the measurement and valuation in the use of the project cost software and quota data set by government, which is apt to fail to be in accordance with the actual situation [10].

Firstly, on the basis of the combination of the above-mentioned difficulties in project cost management, the quantity surveyors need to use electronic information tools to improve the accuracy and efficiency of engineering measurement; secondly, the information platform should be built for idea exchanges between different professional staff at each stage to record and analyze the whole process cost data; finally, a record carrier of engineering cost data which is practical and reliable is needed to analyze and store the engineering cost data in a structured manner [11].

3 Bim Technology is Applied in the Whole Process Cost to Do Bim Fusion Analysis

3.1 Investment Decision-Making Stage

The application of BIM includes initial modeling, model maintenance, cost estimation, etc. in the project planning stage. According to the existing data, the current 2D drawings are imported into software with BIM technology to build a 3D modeling. Generally speaking, it is the initial project modeling created the early stage. The investment estimation is taken in the use of the BIM technology with a powerful information statistics function based on this modeling. At this stage, relatively accurate engineering quantities can be obtained according to the model, and the further calculation can be taken on the installation costs of the building. At the same time, the project cost data can be used to weigh the pros and cons of different schemes, compare and optimize the schedule, so as to prepare and provide an important basis for project decision making.

3.2 Design Stage

In the past, the drawings were made by different designers with different majors such as civil engineering, water and electricity, and fire-fighting pipelines. Conflicts and collisions as well as size deviation is easy to occurs between different majors and different views of the same major. The designers, auditors and other parties are unable to completely find and correct the unreasonable points, even if they spend a lot of energy to check and compare the drawings. These conflicts are manifested in the construction process, which has caused great uncertainties to the cost management, even quality and safety of the project, and result in an increase in costs. When it comes to the establishment of 3D models, the collaborative design of various professional designers, and the visual analysis of different professional components adopted in the process of the design, the conflicts caused by the drawings will be resolved in time, and the interactive check can reduce errors in the design.

The various dimensional information provided by the BIM model will also simplify the calculation of the engineering quantity in the design stage. It can be directly calculated for the engineering quantity in the use of the BIM model. The data of each component in the model is related to the calculation process of the engineering quantity. When the components in the model are changed, the engineering quantity will also be updated, so that the engineering cost data can be updated in real time. In the design stage, the cost personnel can use the BIM technology to greatly shorten the time for calculating the project quantity, realize the rapid and accurate preparation of the project estimate, and can also discover some conflicting problems that were only discovered during the construction in advance, and reduce the later engineering changes.

3.3 Tendering and Biding Stage

For the tenderer, BIM can truly provide the engineering entity information required in the calculation of the engineering quantity to automate the calculation, improve the accuracy of the calculation, and allow the cost staff to change from repetitive calculation work to thinking and controlling the factors that affect the price of the project, a more scientific budget can be prepared. If bidders want to have their own bidding data, they need to introduce BIM to quickly calculate and fully store the consumption standards during the construction process. Through reuse or rapid establishment of 3D models, fast and accurate calculation of engineering quantities will no longer be a problem. In addition, the bidder can use the 3D design model to quickly locate the structural information of heavy and difficult areas, determine and adjust the construction plan according to the actual situation of the project, correctly evaluate the difficulty of the project, and make accurate quotations.

3.4 Construction Stage

The key point of construction units on costs management is the management of the project construction costs. The cost targets are mostly compared with the unit price and amount of the signed contract. Generally speaking, the post-event analysis is been taken. There is a lack of cost control in the process. The construction schedule only contains the

size of the project and the completion time information, instead of changing the project plan and actual completion; most of the construction schedule of the project department is determined by the sophisticated construction management personnel. There will be deviations between the engineering quantity and the amount of labor, materials, and machinery resources calculated by the project manager and the actual value, with result of the increasing on the engineering cost in the actual construction process. It is usually more accurate for the construction schedule preparation completed by BIM technology. The time information is added to form a 4D model in the use of the 3D model of BIM. The resource consumption required by each construction process and construction node can be accurately calculated, and then cost information is added to form a 4D model. The 5D model of the project, using quota consumption data, etc., accurately calculates the number of labor and construction machinery required for each construction process. In order to prevent insufficient resource input, it is feasible to add progress information, cost information, and construction organization information into the 3D model to calculate the consumption of people, materials, and machines for the entire project.

3.5 Project Acceptance Stage

The settlement data of the project can be obtained by collecting and arranging the project information and data during the design and construction of the construction project. Using BIM technology to collect the information of the building in a complete and structured manner, the completion and settlement of the project can be quickly counted. It can quickly compare and calculate with the contract price, and finally form an accurate settlement price.

4 CASE

We take a commercial real estate project as an example. According to the whole process cost management process, we adopt the bill of quantities valuation method to calculate the engineering cost of the civil works. In the process, BIMMAKE, a kind of Glodon modeling software, is used to establish BIM model, Glodon GTJ is used to calculate engineering quantity, Glodon cloud pricing platform (GCCP) is used to calculate list unit price and project cost, and Glodon BIM5D is used to take construction simulation. At first, Glodon BIM software is used to build a 3D model in this project. The established model is imported into the Glodon GTJ2018 to calculate the construction project volume. Next, the Glodon pricing platform is used to apply the list quota, so as to, on the one hand, avoid the data loss caused by the REVIT model in the process import procedure or the errors caused by manual copying of CAD drawings, on the other hand, it is, in a large extend, to reduce the workload of the cost engineers for modeling.

Here are the specific work of in the use of BIM and related softwares to carry out the whole process cost management of the case project: at the planning stage, the total investment of the project should be estimated; at the design stage, it is mainly for the preparation of budget estimates; at the tendering and bidding stage, the bidding control price is prepared; in the mid-construction settlement, the engineering quantity calculation and engineering change control are carried out; in the completion settlement,

the engineering quantity is calculated and the claim management is carried out; and finally the cost data, the extraction and preservation of the cost target are completed.

In the investment decision-making stage, Glodon software is used for 3D modeling, on which the engineering volume is quickly calculated, and then the Glodon Index Network is used to query and check investment estimation indicators, which is quickly and accurately achieved on the investment estimation documents. This will greatly improve the accuracy of estimation and provide an accurate data source for subsequent cost management work.

At the design stage, the exact engineering quantities should be calculated on the basis of the designed construction drawings, and the cost of the project should be calculated in the use of the current bill of quantities valuation specifications and local quotas. At this stage, BIM software can be used to perform some direct conflict checks of various disciplines. For example, when we check the collision of the drainage pipes, it can be judged whether the engineering pipes collide with the frame beams; when it comes to every view, we would wonder and check that the discrepancies between the structural drawings and the architectural drawings. At the design stage, the mistakes in the drawings should be corrected as much as possible, so as to avoid the occurrence of rework and changes during the later construction, thereby avoiding the increase of the engineering cost.

In the bidding stage, the tenderer needs to use the BIM model to quickly calculate the quantities when preparing the cost documents. The software has built-in list specifications to form a complete bill of quantities; the calculation rules of list and quota have been set. There is no need for cost personnel to remember the calculation rules. The software will automatically deduct according to the drawing of component elements and use them at the same time. The quantities of two calculation rules can be obtained from the same model; the software provides multiple engineering quantity codes, which can be combined and extracted freely; we can use the Glodon cloud pricing platform to calculate the unit price of the bill of quantities, take the fee, summarize and calculate the bidding control price.

The bidder adopts the three-dimensional model provided by the tenderer to calculate the quantities faster and uses the pricing software to prepare the bidding price. The BIM model established by the bidder at this stage can be imported into Glodon BIM-5D software to prepare the schedule, and carry out engineering change cost, monthly settlement and quarterly settlement at the construction stage.

The cost management to be carried out in the construction stage includes change management, process payment management and progress management. The premise of using Glodon's change software to record the design change is to have a model file approved by both Party A and Party B to draw the changed components on the basis. It is convenient to use the change software to see the increase or decrease of the changed parts. At present, the quantities of the general list are settled according to the facts, or the changed parts can be drawn directly. The actual quantities can be counted in the progress settlement or completion settlement. Process payment management and progress management can be realized through Glodon BIM-5D. During settlement, Party A and Party B shall calculate the actual quantities on time according to the comprehensive unit price or price adjustment method signed in the unit price contract. The calculation of quantities

can use the three-dimensional model that has been used in the process to find differences. After modifying the components, you can update yourself and related quantities. With regard to the change of the comprehensive unit price in the list of quantities, the price of materials can be calculated by using Glodon Assistant to calculate the weighted average of the monthly information price or market price. The comprehensive unit price of the list can be calculated automatically by using the pricing software and then the settlement documents can be prepared according to the contract.

In this process, the same three-dimensional model has been used for data flow, which can reduce the modeling time of cost personnel in each stage and avoid data loss and error caused by repeated modeling.

5   Conclusions

This paper introduces BIM Technology to realize the whole process cost management of construction engineering, and mainly obtains the following research results:

(1) Through qualitative analysis, it proves that BIM Technology has the characteristics of simulation and visualization, which can greatly improve the speed and accuracy of cost personnel in calculating quantities, shorten the time of calculating project cost and provide an effective and advanced working method for cost management.

(2) Through quantitative analysis, the initial BIM model is established by using BIM make software, which transforms the traditional two-dimensional drawing into the three-dimensional physical drawing of what you see is what you get, strengthening the intuitiveness of the drawing and easy to understand and find design errors; the BIM calculation model is established by using Glodon GTJ2021, which realizes the rapid and accurate calculation of quantities and can correlate the design change with the calculation results of quantities in real time. After the change, the quantities can be calculated and counted quickly.

(3) This paper analyzes the BIM software used in each stage of project construction and the use process, methods and important functions of the software, which provides practical experience for similar projects to use BIM Technology for cost management in the later stage. Using BIM Technology can greatly improve the efficiency and accuracy of cost management.

From the perspective of cost management in the whole process of construction engineering, the application of BIM should focus on the overall construction process rather than just considering a certain stage. BIM model should be continuously transferred to the whole process of cost management in order to achieve the best use effect.

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