

Research on the application of BIM technology in the whole process cost management of construction engineering

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Abstract

The construction market has a large scale, and its output value is growing steadily, but the construction process is inefficient, waste of resource is serious. Cost management is the most important task of engineering construction, the way it works can't adapt to development. The whole process requires attention to the overall benefits of the project, BIM is an information model that provides an efficient platform for information exchange, connect the cost work together to reduce repeated work and improve work efficiency. The use of the right software can improve the efficiency of the cost work, promote the way of work, and enable the cost industry to grow in electronic information.

Keywords: *Project cost, Whole process cost management, BIM technology.*

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I. INTRODUCTION

Nowadays, the cost management methods of construction projects have been unable to adapt to the current development trend of informatization, and construction investment cannot be effectively controlled through cost management. This paper studies the main work of cost management in each stage of the construction life cycle, and analyzes the difficulties in the implementation of cost management in the whole process of construction projects in China: there are barriers between the data on the construction site and the basic data that form the basis for pricing. It cannot be conveyed accurately, completely and truthfully. Therefore, project cost management needs to add an information system to collect real project cost data, and let the information system form a cognitive learning system and self-growing knowledge base to facilitate the use of data. Using BIM technology can construct a complete information system in real time. It is necessary to establish a virtual digital building model, that is BIM model, to simulate the construction process, and then use this simulation system to make intelligent decisions, analysis, optimization, and then implement its decisions. The effective integration of BIM technology into each stage of project construction can give full play to its advanced functions and endow the project with different benefits. For example, the introduction of BIM in the design stage allows various professional designers to work together, and it also enables cost engineers and builders to observe the design intuitively, thereby reducing design changes to reduce wasted engineering investment. In the construction stage, BIM-5D is used for virtual construction, and resources and construction period are planned first to avoid unnecessary rework, reduce the cost of construction units and increase profits, thus improve corporate efficiency. Through a comprehensive and systematic analysis of the whole-process engineering cost management and BIM technology, the BIM technology is effectively integrated into the cost management of all aspects of engineering construction.

II. THE APPLICATION VALUE OF BIM TECHNOLOGY IN THE WHOLE PROCESS COST MANAGEMENT

The data stored in the BIM technology model is much more comprehensive than the two-dimensional drawings. It can not only express basic matters such as structural information, building information, and mechanical and electrical equipment information, but also automatically and accurately calculate the engineering quantity through the three-dimensional data of the components. And then statistics is classified, finally report can be issued. Because the data of the building components that make up the BIM model contains at least three-dimensional information (ie, the length, width, and height of the component), which occupies a certain spatial position, the type of the component can be identified and the engineering quantity can be calculated according to the attributes inputted by the component in the digital model; If you want to count the engineering quantity, you can use some BIM software or plug-ins to form the corresponding report, and the calculated

engineering quantity is the accurate engineering quantity obtained by combining the calculation rules and the deduction relationship of the 3D model. The engineering cost data is based on local regulations. The cost file format and specification automatically form an electronic file, which can be transferred, shared, modified and calculated among different staff.

Secondly, the use of BIM can realize that the relevant information of various construction projects can only be input once, and applied to each stage of the life cycle of the construction project with the help of the flow of information, as shown in Figure 2.1. When preparing estimates and budgets, the 3D model can quickly calculate the engineering quantity and design review. During the construction stage, the management personnel use the previous 3D model to simulate the construction process; during settlement, the simulated calculation model can quickly count and display the changed quantity and list price.

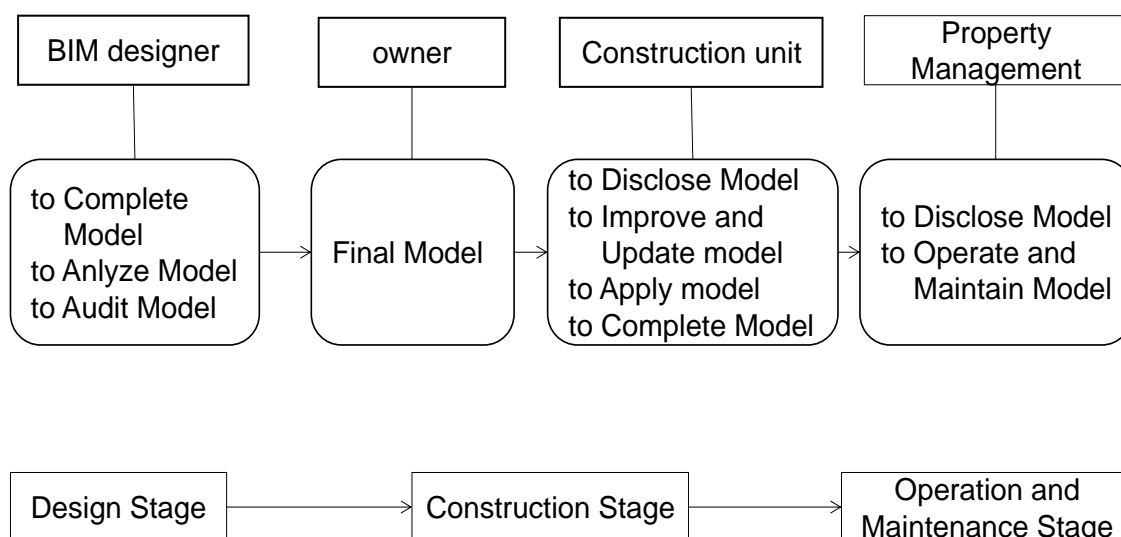


Figure2.1: BIM Model Transfer Process

2.1 Promote the Development of the Cost Industry

Due to the powerful data storage and transfer functions of BIM, the application of BIM technology will make the cost industry "five-ation" (competition internationalization, management digitization, construction industrialization, target integration and implementation integration).

First of all, internationalization refers to the internationalization of the competitive situation in the cost industry. When the cost industry goes out to developed countries, it opens up Chinese cost consulting market, and the cost industry from developed countries will also enter China. Although the scale of construction in China is still very large, most of the domestic construction enterprises have the participation of government funds. If foreign cost enterprises enter my country's construction market, it will have a strong impact on Chinese medium and large construction enterprises. This process will highlight the competitiveness of Chinese construction enterprises and the government's supervision problem of the construction market, which will lead to changes in the business model and operation model of Chinese construction industry. For example, the current model of qualification management in various construction industries in my country may undergo huge changes after joining the GPA agreement, and may even cancel qualifications, because foreign companies do not have qualifications.

The second is the digitization of management tools. It has introduced BIM for more than ten years in China, but the application has not been realized in the whole process of project construction. In practice, it is more used at a certain point. With the development of digitalization in the construction industry, project cost management will use digital work and management methods more deeply.

The third refers to the industrialization of the construction process. The use of BIM can transform the production mode of construction products into a production method with a modern industrialization level. This requires the use of big data as a foundation and a software-based platform to build a digital production line, so that the production form of construction has changed into a modern flow production method, such as the development of prefabricated buildings, which is one of the important manifestations of industrialization.

The fourth is the integration of implementation modes. First of all, engineering cost consulting companies are required to become bigger and stronger, to increase their scale and to attract more professional talents; so that the companies have the ability to accept business entrustment of whole-process engineering cost management. By developing a part of intermediary consulting enterprises with international level and mastering the whole process engineering management, the existing construction organization model can be improved in

China and the implementation process of general project contracting can be accelerated through the intermediary role of consulting units.

The fifth is the integration of project goals. The first priority in the construction industry is to make each engineering project successful. The significance of success lies in accelerating progress, reducing costs, and ensuring quality and safety. The cost management of the whole process and all factors should consider the impact of various goals in the construction process on the building, such as the construction period, quality, safety, environment, etc., which affect the construction cost. The current pricing work, especially the use of the quota pricing method (because the quota is a static data), cannot take into account so many dimensional factors.

2.2 Improve work efficiency

From the micro-level analysis, BIM technology can improve the informatization level of project cost management by improving the calculation efficiency of project cost work.

First, it can deduct and calculate according to the physical space occupied by the established digital components, and automatically output the amount, which greatly reduces the time for repetitive work such as using manual or tables for statistics and basic calculation of engineering quantities.

Second, it can simulate the construction process and reasonably arrange various resource delivery plans for machines. Time information that can be assigned to the quantities automatically calculated by the BIM model, and during the construction process, according to the actual progress of the project, the completed project volume in any time period can be calculated, and then multiplied by the list unit price in the contract. Then the project cost at any time period can be obtained, and cost management during the implementation process can be elemented. According to the dynamic project cost to adjust the investment rhythm of funds and resources, so that the work can be reasonably arranged to achieve the purpose of managing the project cost in the construction process.

The third is to use BIM model visualization, collision checking and other functions to reduce avoidable engineering changes from the source. If there is a change, as long as the data of the changed component is partially modified, all related engineering quantities will be automatically calculated, which reduces duplication. At the same time, the reduction of changes can reduce the probability of contract price adjustment and control the risk of cost changes.

Fourth, it can conveniently and accurately record engineering indicators and indices. The historical cost data of engineering projects is an important data source for us to estimate, estimate and budget. In the past, the cost indicators and contents of the projects were accumulated in the warehouse, and the paper data was difficult to consult. Using the electronic model, the relevant indicators can be accurately analyzed and calculated, and electronic data can be formed for easy access, preservation and sharing.

III. THE SPECIFIC APPLICATION OF BIM TECHNOLOGY IN THE COST MANAGEMENT OF THE WHOLE PROCESS OF CONSTRUCTION PROJECTS

The whole process of project cost management requires not only the owner or construction unit to pay attention to project cost management, but also government construction authorities, design units and supervisors, cost consulting units, etc. should have cost management thinking, and each participant is required in the work of cost management. They all clarify their own work priorities and find their own position on cost management.

Table 3.1: Application of BIM in cost management in each construction stage

Construction Stage	Cost Work Target	BIM Software	The Value of BIM
Design Stage	To Prepare Design Estimates; to Carry out Limits Design; to Avoid Construction Changes.	BIMMAKE/REVIT/NA VISWORKS	3D modeling, intuitive display, and reduce design conflicts
Construction Time	To prepare progress and interim settlement: record changes and claims during construction, and to prepare progress payment settlement in a timely manner	BIM-5D /Glodon CTJ2018 Civil Engineering Measurement Platform/ Glodon GBQ4.0 Pricing Software	Precise allocation of construction resources to reduce waste and rework
Completion stage	To get compilation of completion settlement; to get clear and effective statistics of all project cost data, and to quickly form completion settlement data	Glodon CTJ2018 Civil Engineering Measurement Platform/G lodon GBQ4.0 Pricing Softwar	Quick calculation of change claims, to get statistical data

The whole process cost management requires the cost staff to estimate the investment in the planning stage, calculate the project budget during the scheme design, calculate the bidding control price or the bottom bid during the bidding, and dynamically calculate and summarize the engineering quantity during the construction process. Therefore, BIM technology and related software are required to play an important role in the whole process of cost management from the project decision-making stage to the construction completion acceptance and even the operation stage. As shown in Table 3.1, the application points and functions of BIM-related software in different construction stages.

3.1 Application of BIM technology in cost management in engineering design stage

Due to the use of BIM, the 2D design mode of traditional CAD drawing will be replaced by 3D mode, because the display effect of the 3D model allows reviewers, owners and users to see the design effect of the building at a glance. The designers, the users and the construction contractor can discuss the construction feasibility of the current design scheme, how to optimize the project cost, and the arrangement of the construction progress. Such clear and smooth communication greatly reduces the time for decision-making and helps all construction participants reach a consensus. The earliest stage of using BIM in Chinese construction industry is the design stage, and the most used BIM is also the design staff. BIM has brought a lot of convenience to various design tasks, such as the creation and demonstration of design schemes, building performance analysis and so on.

After the designers have finished drawing the drawings, they need to make design disclosures and review drawings to the owners, construction units, and supervision participants. In the past, CAD software was used for drawing, and different perspectives such as flat, vertical, and cross-section of buildings were reflected in different drawings, and different majors such as civil engineering, water and electricity, and fire-fighting pipelines were designed by different designers, so different conflicts and collisions and inconsistencies between different views of the same major often occur. Even if the design and review parties spend a lot of energy on checking and comparing drawings, they cannot completely find and correct the unreasonable points. These conflicts are reflected in the construction process, which will cause great uncertainty in the cost management, even quality and safety of the project, which will lead to an increase in costs. If the 3D model is established during the design, the collaborative design of various professional designers and the visual analysis of different professional components can solve the problem of conflicts between drawings in time, and the occurrence of design errors can be reduced through collision checking.

The various dimensional information contained in the BIM model will also simplify the calculation of engineering quantities in the design stage. The traditional calculation of engineering quantities requires the cost personnel to read the two-dimensional drawings in detail and list the engineering quantities item by item. Now, when using the BIM model to calculate the engineering quantity, the engineering quantity can be extracted directly through the software, and the accurate calculation result can be obtained quickly. Moreover, 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 be updated accordingly, so that the engineering cost data can be updated in real time. In the design stage, the project cost engineer can use 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 find some conflicting problems that were only found during construction in the past, and reduce engineering changes.

3.2 Application of BIM technology in cost management in engineering construction stage

"Construction Engineering Bill of Quantities Pricing Specification" (GB50500-2013) stipulates that the completion settlement of the project should be based on the visa that has been signed during the construction process. Only the progress plan confirmed by both parties during the construction process, the calculated project quantity, and the confirmed unit price of the list shall be calculated and counted. It is no longer the original settlement, recalculate all the engineering quantities and unit prices of sub-items. Therefore, during the construction process, the construction unit should timely submit the visa and change application to the construction unit in accordance with the methods and procedures stipulated in the contract, and urge Party A to complete the signature of the written materials.

The construction unit's management of construction costs focuses on the management of construction costs. The cost targets are mostly compared with the unit price and amount of the signed contract. Generally, the statistics and analysis of construction costs are carried out after the project is completed or the node work is completed. For post-mortem analysis, there is a lack of cost control in the process. First, because the construction progress plan only contains the information on the size of the project and the completion time, it will not change with the project plan and actual completion; second, most of the construction progress plans of the project department are based on the experience of construction management personnel. There will be deviations from the actual value of the engineering quantity, labor, material, and mechanical resources counted by the project manager, which will increase the engineering cost during the actual construction process. The construction schedule

preparation completed by BIM technology is generally more accurate. According to the 3D model of BIM, the time information is added to form a 4D model, which can accurately calculate the resource consumption required by each construction process and construction node, and then cost information is added to form the 5D model, and the number of laborers and construction machinery required for each construction process is accurately calculated using the fixed consumption data. Adding progress information, cost information, and construction organization information to the 3D model not only calculates the consumption of people, materials, and machines for the entire project, but also prevents insufficient resource input. It is also possible to simulate the construction site layout of each construction node in advance, and determine the placement position of the construction machinery. In general implementation projects, construction management personnel will calculate the monthly resource utilization, control the error between the planned progress and the actual progress, and find and solve problems in the construction process.

Glodon's BIM5D product completes the construction simulation process by importing the BIM model and using the engineering quantities in the model. The five-dimensional BIM model expresses the construction information of projects to be built, built, and delayed through specific and intuitive graphics and data. During the construction phase of the project, BIM software can achieve complete and accurate whole-process construction management. When using BIM for cost management in the construction stage, the deviation value can be combined with the BIM model to achieve the purpose of quickly calculating the amount of change.

3.3 Application of BIM technology in cost management in project completion acceptance stage

During the performance of the construction project contract, both the developer and the contractor need to not only follow the methods and procedures stipulated by relevant laws, but also prepare the completion settlement price in accordance with the contract. The final settlement price not only fully reflects the changes that occurred during the performance of the construction contract, deviation, claim, material price difference adjustment and other project payment adjustment matters, which are also the total contract amount that the contractor needs to pay the contractor after the construction contractor has completed all the contract work in accordance with the contract terms.

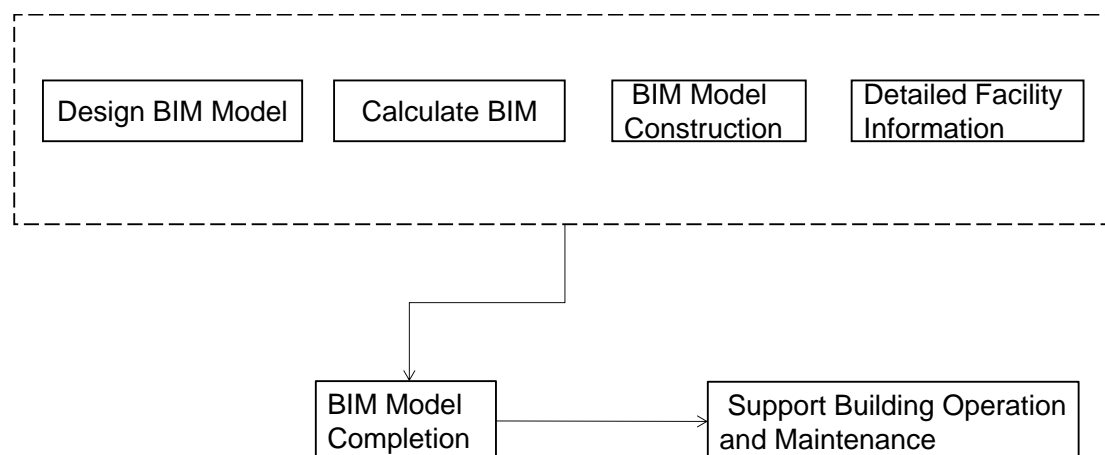


Figure3.1: The Delivery Process of the BIM Model

In theory, 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 the BIM technology to collect the information of the building in a complete and structured manner, the completion of the project can be quickly counted during the completion settlement. The task volume can be quickly compared and calculated with the contract price, to find out the factors and amount of the project price change, analyze the economic benefits of the project, and provide actual and accurate historical engineering data for all parties involved in the construction. The building model that contains complete project information can be used in the process of use and maintenance. For example, during equipment management, the electronic model should contain all the information of the equipment, and the information of its brand, performance and installation can be located directly and used.

IV. CONCLUSION

As an important means of reforming the construction industry, BIM technology can reduce problems such as errors, omissions and faults caused by insufficient design considerations. It not only improves the quality of project construction, but also saves project costs. It will bring new value to the construction industry and the project cost industry. This paper provides an effective path and method for the use of BIM technology for the whole process cost management of construction projects, so it has certain practical significance in reducing the

waste of resources in construction and improving the level of project cost management.

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