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

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Abstract. Engineering construction industry faces the situation of high investment, low profit, rising cost of production factors, etc., the whole process cost management becomes more and more important. Valuation with bill quantity improves the refined management of project cost, but also faced with other problems, such as information sharing, information processing etc., the BIM technology has characteristics of virtualized design, visual decision making, cooperative construction, transparent management etc., the information platform constructed based on a BIM model can be a good solution to these problems.

1. Introduction
With the development of the national economy, the engineering construction industry also witnesses great progress, but at the same time, it also faces such problems as high investment, low profit, rising cost of production factors, etc. Therefore, engineering cost management, as one of the three major objectives of project management, has become an important aspect restricting the development of the engineering construction industry.

The project cost management has developed from the whole factor cost management to the whole-process cost management and then to the life cycle cost management mode. Each management mode emphasizes the influence of various factors and various links in the cost management on the quality of cost management. The whole-process management theory has been widely applied in many industries. The engineering quantity list pricing, to a certain extent, realized the whole-process management of engineering cost. But in the specific implementation process, it faces problems in information sharing and information processing. The information platform based on BIM model can help to solve these problems well. Therefore, BIM technology has very important practical significance for the whole-process management of engineering cost.

2. Problems in current project cost management
Due to the long life cycle of projects and many engineering participants, there are several problems in project cost management:

2.1 Cost forecasting of the previous period is not accurate enough
In the early stage of the project, such as decision-making, the owner can provide little professional information of the proposed project, and there is no virtual model of the project [1]. Therefore, project
cost personnel understand little about the project and can only make estimations using the cost information of similar projects or some relevant indicators. However, the economic indicators published by local cost information websites have problems such as small project coverage, delayed release time, and incomplete types of indicators, failing to provide comprehensive and reliable support for estimation [2], so the investment estimates based on indicators are not accurate enough.

2.2 Information processing speed is slow and slow
Nowadays, China is conducting both fixed pricing and list pricing. During and after the transaction, list pricing is mainly used. In the process of preparing the engineering quantity list, mistakes can occur because there are quantities of project items and the engineering information needs to be provided. At present, data is mainly processed manually, but it is slow in calculating engineering quantity, and the accuracy cannot be guaranteed.

In the actual construction process, the site is complicated, the information opaque, making the construction unit cost difficult to control, the progress difficult to control accurately, the progress payment unclear, the process information collection incomplete, the information processing degree low, and the whole process of construction cost management slow and inefficient.

2.3 Difficult to share information between project participants
Due to the fact that the life cycle of the project is long, project participants in each stage of compiling and managing the cost documents are different, the cost software used by each entity is not always the same, and each entity stores the cost information in their own way, cost information transmission distortion can happen in each stage. The participating entities must collect, process and update the information repeatedly at each stage. The error of the previous stage cannot be corrected in time, and the distortion of information transfer increases the workload of the whole process of engineering cost management, thereby reducing the work efficiency and greatly raising the cost of gaining information for the participants in each stage.

2.4 Outdated engineering cost information preservation method
Most of the completed historical data of most enterprises now are archived in paper documents and word texts, making the engineering cost information stored difficult to be refined from basic data to effective information based on correlation calculation and analysis, thus the purpose of obtaining the cost index for the proposed project is hard to achieve [3].

3. Significance of BIM technology in the whole process of project cost management
BIM (Building Information Model, BIM for short) is regarded as the second technological change in the construction industry after CAD. BIM technology adds information including project cost to the 3D model, forming a relevant information model of the life cycle of the integrated project construction. This model helps to achieve information interaction and collaboration [5], which is the basis for whole-process project cost management. BIM technology is featured by virtualization design, visual decision-making, collaborative construction, and transparent management.

3.1 BIM-based information expression is intuitive and efficient
BIM is featured by visualization, meaning “what you see is what you get”. The engineering model established by BIM is a 3D effect picture, which is more intuitive than the traditional CAD picture. The designer can accurately express the content using BIM, and the constructor can accurately express the expected design requirements, in this way, the risk of design changes can be reduced.

3.2 BIM-based information processing is efficient and accurate
The components in the BIM model contain a variety of attribute information, including the build type, component specifications, and material prices. They can also import the information of completed engineering, quota, and market price into the model. BIM is parameterized, so the project information
can be updated synchronously, and the cost file can be formed on the basis of corresponding information, making investment estimation, design budget and construction draft simpler and more accurate.

**3.3 BIM-based information transfer is authentic and complete**
BIM model can analyze and extract relevant cost indicators at various stages of the completed project in a detailed and accurate manner, and turn it to electronic data for convenient storage and sharing. The cost index and content index of the completed project are very important for the compilation of investment estimates for similar projects.

**3.4 BIM-based information interaction is efficient and convenient**
Information platform of the project can be established based on the information gathered by BIM model, which can be used by each party involved in the project. This helps to break the information silo, which is the most important feature of BIM technology. This technology makes the once disordered and inefficient information interaction orderly and efficient, as shown in Figure 1.

![Figure 1 Comparison of information interaction before and after applying BIM](image)

**4. BIM-based whole-process management of engineering cost**

**4.1 BIM-based whole-process management of engineering cost in decision making stage**
The BIM model is featured by visualization and parameterization. It can be obtained either by creating a new project or modifying a completed one. In the decision-making stage, the constructor can modify the completed project model and use the 3D space design and building roaming functions of the BIM model to eliminate unnecessary components and add missing components that are necessary to obtain the virtual model of the proposed project. The cost personnel can conduct investment estimates more accurately based on the virtual mode, thereby providing a basis for the scientific decision of the constructor, making the investment estimate truly the ceiling of investment of the construction project, and reducing the chance of overestimation.

**4.2 BIM-based whole-process management of engineering cost in the designing stage**
In the designing stage, the project designer is generally divided by professions. In the traditional two-dimensional design mode, there is no effective way to solve the coordination problems between various professions, resulting in multiple shutdowns, reworking, design changes, which causes project
delay. This causes great trouble to the constructor and also increased the construction cost for the development unit. If each profession can use BIM technology to build a model and import it into the software for collision detection, the test results will intuitively reflect the collision conflicts of professions in construction, water supply and drainage, structure, electro-mechanics, fire protection in 3D so that the design changes caused by conflicts between professions during the construction process can be reduced at the source, they can truly work together and reduce the probability of over-budgeting.

4.3 BIM-based whole-process management of engineering cost in the bidding stage

In the bidding stage, time is limited. The tenderer uses 2D drawings to calculate the engineering quantity, but they tend to have their ideas blocked for the design drawings cannot be well matched. After many changes in design ideas and even the scope, inconsistent or missing in calculation result of the engineering quantity is easy to appear. If the BIM model is used, the engineering quantity can be quickly extracted and calculated, a more accurate engineering quantity list can be formed more quickly. In this way, the construction unit can have devote more energy to inquiry and material analysis in bidding and price control so as to improve the rationality of the unit price and ensure the validity of the bidding control price.

For technical target, the bidder can use the BIM model to create the construction scheme animation to reasonably set the construction period and improve the expressiveness of the technical scheme so as to increase the score. For business target, the BIM model can be used to accurately calculate the engineering quantity to reduce the time for calculating, and at the same time, spot errors and problems of the bidder’s quantity lists and drawings so as to spend more time on inquiry and quotation strategy, thereby making r bidding price more reasonable.

4.4 BIM-based whole-process management of engineering cost in the construction stage

During the construction stage, the contractor uses BIM’s visualization feature to establish a plan and simulate the construction process so as to find possible problems, achieve a visualized technical disclosure, and propose the material requirements based on the node. Whole-process control of the amount of material used on each floor helps to avoid the waste and cost of materials rehandling. In the implementation process, field data collection, and data of on-site quality defects, safety risks, and civilized construction are instantly associated to the BIM model.

BIM-based engineering measurement can split the original BIM model according to any construction surface so as to summarize the corresponding engineering quantity. The construction unit does not need to spend time reviewing the engineering quantity. Therefore, the constructor and the contractor can quickly and accurately verify the quantity of the completed project, retrieve the price information in the BIM database, and quickly calculate the corresponding project progress payment. This makes the management of the project progress payment simpler and more efficient.

The BIM model has the feature of parameterization. If there is a design change in construction, the model can automatically updated the information while maintaining the relationship between the original parts, which can effectively prevent repeating or missing of engineering costs due to late or incomplete update of the related content. Design changes in engineering using the BIM model can realize almost real-time, dynamic, accurate, and complete engineering, enabling efficient collaboration and sharing.

4.5 BIM-based whole-process management of engineering cost in completion stage

BIM model in project settlement can help to quickly trace the visa, change and other information in the construction process on the BIM information platform, thus making settlement project quantity and cost accurate and fast, improving settlement efficiency, and reducing the possibility of conflicts in settlement. In addition, the contractors can use the BIM model to compare and calculate the profit and loss of the project.
5. Conclusion
The whole process cost management is an effective way to avoid the problems in this process. Compared with the fixed pricing, the engineering quantity list pricing has, to a certain extent, realized the whole process management of engineering cost. However, it still faces problems such as inaccurate cost estimation, inefficient and slow information processing, difficult information sharing between participants, and outdated storage of cost information. BIM technology has the characteristics of virtualization design, visual decision-making, collaborative construction and transparent management. BIM’s information expression is intuitive and efficient, information processing is efficient and accurate, information transmission is authentic and comprehensive, and its information interaction is efficient and convenient. Therefore, BIM technology can effectively improve the information management quality of engineering cost, and solve the problems encountered in the whole process management of engineering cost.

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