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

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Abstract—China's economic development has entered into a new normal, and the effectiveness of fixed asset investment needs extensive and in-depth participation of social capital. In this context, PPP project has been vigorously developed. Due to the large number of participants in PPP projects, this kind of decentralized participants will lead to the malpractice of multi management and even the absence of management decisions, resulting in a huge loss of public interest. Therefore, based on the whole process cost management of PPP project, this paper intends to establish a set of BIM based simulation of the whole process cost management of PPP project by using functional analysis and implementation path, so as to improve the decision-making efficiency of the government on PPP project and protect the public interest to the greatest extent.

Keywords: BIM, cost management, PPP

I. INTRODUCTION

In the current period, China's PPP project has been greatly developed at the national level, but in the process of project evaluation, the main task is to carry out qualitative evaluation on the target project, but there is a lack of quantitative evaluation and analysis. In addition, the government investors and social capital of the project need a lot of project information for the feasibility study report, lacking the basic data of the construction of the proposed project, so they can only evaluate the proposed PPP project according to the information of similar projects in the past. The PPP project has the characteristics of singleness, high cost, complex quantities and long construction time, which is different from the ordinary project, resulting in the PPP project. The cost evaluation in the scheme decision-making stage is not accurate, which leads to the cost out of control in the whole process. The birth of BIM and the promotion and application of BIM Technology in cost management bring new opportunities to the whole process cost management of PPP project. The core of BIM is data information and model, which is the carrier and expression of information. BIM is not only used for a certain period neither of time, nor for a certain person, but also for the common interests of all participants in the whole life cycle of the building.

II. DEFINITION AND CHARACTERISTICS OF BIM

A. BIM concept

The definition of BIM in American National BIM standard is as follows: "BIM is a digital expression of physical and functional characteristics of a facility (construction project); BIM is a shared knowledge resource, a process of sharing information about the facility, providing reliable basis for all decisions in the whole life cycle of the facility from concept to demolition; at different stages of the project, different Stakeholders support and reflect the collaborative work of their respective responsibilities by inserting, extracting, updating and modifying information in the BIM". The core function of model making is to realize the function of database, which includes abundant three-dimensional models and many kinds of information needed in cost. For example, the spatial information and geographic information of cost buildings, the information of structural parts, and the connection form of various materials, etc.

B. Advantages of BIM

BIM has the following advantages:

1) Three dimensional information model

One of the important characteristics of BIM is the object-oriented information model, which uses the determined rules to determine the geometric parameters and constraints to complete the object-oriented model building. In addition, the basic elements used to represent the building components in the building model are also digital objects, and it is easy to realize intelligent interaction, such as automatic structure and deduction relationship between windows and walls, between wall beams and columns, and collaborative unity of geometric relationship and functional structure. At present, this feature has been widely used in the stage of project budget and bidding. BIM software is used to convert two latitude CAD model into three-dimensional graphics, and the calculation rules are preset in the software, so the project quantity information can be calculated quickly.

Parametric information model is the most important feature of BIM. Compared with the graphic parameters of 2D CAD, BIM directly uses information parameters for intelligent design. At the same time, the parameterization of BIM model also has a profound impact on the collaborative

work mode among disciplines. For example, when the beam section or column interface changes, it will automatically react to other professional engineers through the spatial topological relationship, and can detect and correct the professional conflict in the design stage through virtual collision test.

2) Timeliness of BIM database

The technical core of BIM is a database formed by three-dimensional computer model. This database information is dynamic in the whole process of construction cost management. With the progress of the project and market changes, relevant responsible personnel will revise BIM data, and all participants can share the new data. Data information includes the market price information of any constituent elements, a design change, etc. During the whole life of the project, all relevant cost data of the project from investment planning, project design, project commencement to completion can be stored in the database based on BIM system. No matter in the construction process or after the completion of the project, all relevant data can be set according to the needs of parameters, so as to get the basic engineering data required by a party. BIM, a time-effective database, improves the way of communication, making it possible for the project management personnel of the proposed project and the cost personnel of the later project to timely and accurately select and transfer the basic engineering data. It is this timeliness that greatly improves the accuracy of the basic cost data that cost personnel rely on, thus improving the management level of project cost, avoiding the problem of disconnection between the traditional cost model and the market, and contributing to the accumulation and dissemination of information.

Among the above three important features, building an object-oriented information model BIM software design is mainly realized by software designers and BIM engineers; while the parametric representation of building components is based on the functional representation, which needs the involvement of professional engineers to meet the requirements of users in the future, and finally realizes the design, input, storage, exchange and transmission of parameters; the BIM database Effectiveness is the vitality of BIM Technology.

III. THE WHOLE PROCESS COST MANAGEMENT MECHANISM OF PPP PROJECT

A. Design of the whole process cost management information flow

The whole process cost management proposed by domestic scholars is mainly cost control and cost management in the stages of feasibility study and investment decision-making, design, bidding, construction and completion acceptance of construction projects. The whole process, all-round and multi-level use of technology, economy and means to predict, optimize, control, analyze and supervise the project cost In order to obtain the optimal allocation of resources and the maximum investment benefit of the project. Its core is to measure the cost of the project in different stages according to scientific methods, such as investment estimation, design budget estimation, construction drawing budget, contract price, settlement price, completion settlement price, etc., but they cannot exist in isolation. They should organically link the cost of different stages, realize the former to control the latter, and the latter to control within the reasonable limit of the former, and the latter to accumulate information. It will also provide the basis for the former to calculate the cost.

B. PPP project operation mode mechanism

At present, most of the PPP project operation modes in China belong to the narrow sense PPP mode. The government departments establish partnership with the private sector through preferential subsidies, licensing, purchase of services and supervision. The private sector establishes project companies through loans, consultation, cooperation with operators and contractors, to design, build and maintain the whole PPP project. This model can encourage more private enterprises to participate in the national infrastructure construction, ensure that social capital can obtain corresponding profits, and improve the quality of public services.

IV. INTEGRATED CONCEPTION OF COST MANAGEMENT IN THE WHOLE PROCESS BASED ON BIM

A. Decision making stage

In the project decision-making process, the cost engineer uses the preliminary BIM model established by the engineer to obtain rough quantities data and generate the required estimation indexes, such as the cost per square meter of local construction, the cost per square meter of installation, etc., so that the cost of the proposed project can be estimated without the need for drawings or accurate BIM model; if there is a BIM model of similar projects, it conforms to the decision-making indexes Data requirements, or after correction, such as output, or function, meet the requirements, we can get accurate quantity information, and then extract the cost information issued by the cost department, which can make the accuracy of investment estimation reach the best. Obviously, a similar BIM model will provide help for quick and efficient decision-making, and this similar model needs to be created and stored by special cost personnel after the previous CAD drawings come out, as shown in "Fig. 1" BIM information conversion diagram, to realize the conversion of completed project data to the proposed project.
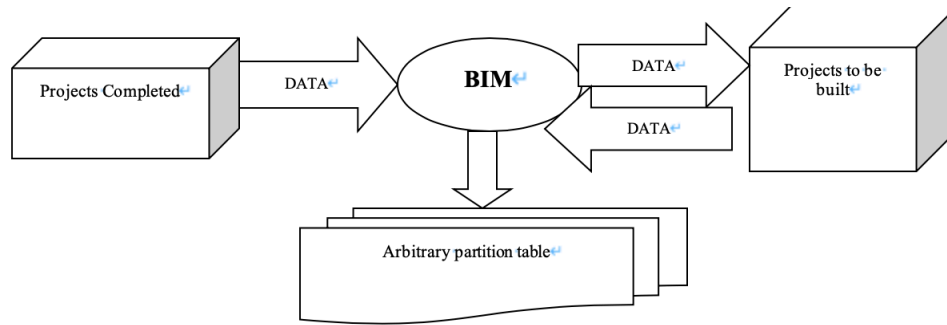
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Fig. 1.   BIM information conversion diagram.

B. Design stage

Generally, the design budget and construction drawing budget shall be completed in the design stage. At present, the most effective way to determine and control the cost in the design stage is to carry out the quota design, that is, to carry out the preliminary scheme design according to the investment estimate approved by the design assignment provided by the construction unit, and the cost personnel will determine the budget estimate cost according to the preliminary design scheme, and then carry out the construction drawing design within the quota. After BIM Technology concept is introduced, designers can extract relevant design indexes from historical data in BIM model database, quickly carry out quota design, and ensure the economy and rationality of design. At the same time, the cost engineer can obtain the project parameters and corresponding quantities data from the BIM model, and quickly calculate the budget cost by comparing the index database or budget database, and control the construction cost and use cost from the perspective of the whole life cycle of the project by combining the value engineering method, so as to optimize the design scheme and control the total investment. The BIM model of this stage needs to meet the technical index requirements of the estimation stage, and must be refined under the same category of investment estimation model, so as to control the estimated cost within the estimation limit.

When the project budget is confirmed and approved by the owner, architect and relevant administrative departments, the construction drawing budget stage will begin. According to the results of construction drawing design, improve or establish accurate and detailed BIM model, cost engineer can obtain accurate quantities information to prepare construction drawing budget, and lay the foundation for subsequent work. In addition, in the design stage, we can make full use of the three-dimensional visual effect of BIM model to carry out collision inspection and virtual construction, communicate with the owner intuitively, find and correct design errors and irrationalities as early as possible, and effectively reduce the rate of change and rework in the construction process, which is an effective measure of cost control in advance. BIM model and BIM number in this stage. The database information will be

classified and stored to provide information support for investment estimation and design budget estimation.

C. Bidding stage

With the promotion of BIM Technology, the construction unit or the cost personnel employed by it can quickly extract the project quantity information according to the BIM model rich in data information provided by the design unit, and prepare the accurate bill of quantities in combination with the specific characteristics of the project, effectively avoid omissions and miscalculations, and minimize the disputes caused by the project quantity problems in the construction stage. In the bidding process, the construction unit can distribute the BIM model of the proposed project to the bidder in the form of bidding documents, so as to facilitate the contractor to check the quantities. Therefore, it is necessary to ensure that the bill of quantities calculated by BIM model conforms to the national and local calculation rules. In this regard, our country should also establish corresponding BIM standards to realize the docking with the current bill of quantities pricing specifications. Due to the limitation of bidding time and manual calculation, it is difficult to check the correctness of bill of quantities in bidding documents. By using BIM model, bidders can easily obtain accurate quantities information and concentrate on formulating effective bidding strategies. At the same time, the application of BIM Technology facilitates the bidding management department to grasp the bidding process in real time and dynamically, which is conducive to the rapid development of e-government. At this stage, a large number of BIM software has been applied.

D. Construction stage

In the traditional mode, based on 2D CAD plane drawings, the construction unit, construction unit, design unit and supervision unit detect the design drawings respectively, so it is difficult to form cooperation and sharing. The most important significance of BIM Technology is to re integrate the construction design process and realize the collaborative design and data concentration of various types of work on the unified data platform. When using BIM model for joint review of drawings, it is convenient for data integration of various disciplines, 3D collision detection, more intuitive discovery of problems, reduction of construction claims caused by design problems, and provision of technical

support for cost control. The construction unit can also use 5d-bim model to reasonably arrange the fund plan and review the payment of progress payment. For example, in the Luban cost management platform, the measurement software and cost software are seamlessly connected, the change of graphics is synchronous with the change of cost, and the effect of block diagram bidding can be achieved at the same time. Through condition statistics and regional selection, phased project cost documents can be obtained, which is conducive to the payment statistics of progress payment by the construction unit. For the construction unit, it can combine the component information arbitrarily, and get the consumed quantities according to the progress, process, construction section and component type, which is convenient for the project cost control and the realization of fine management. For example, according to the time information, we can screen out the current workload to be completed, so as to facilitate the construction company to accurately carry out the dispatch plan and reasonably arrange the manpower plan. Using the material database information in BIM model, we can strictly control the material consumption in accordance with the contract in the construction stage, reasonably determine the material consumption, and make the quota picking really play an effect, so as to dynamically control the cost, which is conducive to multi calculation comparative analysis and real-time grasp of the project cost information. BIM Technology makes data sharing a reality, and relevant parties can call engineering data within their own authority, greatly improving the information level of construction management process. In this stage, the construction unit can also input the production information of the building components into the BIM model by combining the digital scanning technology, which will be the acceptance data that must be delivered for the completion acceptance in the future. When there is a quality problem in the building products, the traceability can be realized.

E. Completion settlement stage

Under the traditional mode, the completion settlement is a rather challenging task for the cost personnel, especially the check of the quantities. The cost personnel of the construction unit and the construction unit need to check the quantities one by one according to each beam, each column, each wall, etc. according to a large number of documents such as 2D CAD drawings, on-site visa and the quantities calculation sheet accumulated in their daily budget. The accuracy is very good. It is difficult to guarantee, and the business level of engineering cost personnel is uneven, which easily leads to the "distortion" of settlement, resulting in the problems of incomplete data, information loss, drawing errors and so on.

BIM model has been perfected in the construction stage, and its information volume can fully express the completed project entity. The accuracy of BIM model ensures the efficiency of settlement, reduces the dispute between both parties, accelerates the settlement speed, and is also an effective means for both parties to save costs.

V. Conclusion

Based on the concept of whole process cost management, PPP project management uses BIM Technology to express the information needed by the project by computer, including different stages from decision-making, design, construction, etc. it is not only the progress and update of existing technology, but also the transformation of construction management mode and project delivery mode, which will certainly promote and develop the application of whole process cost management.

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