

Research on the management of project cost data based on BIM

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Abstract

This article first analyses the differences between the BIM application mode and the traditional mode in the cost data management. With the application of BIM (Building Information Modelling), this article analyses the relationship between the standard framework of BIM and the whole process of cost management, then points out that the BIM application mode has changed the whole process of cost management and refines what the BIM standard framework should reflect about the whole process of cost management.

Keywords: BIM, cost data management, construction stage, participants in project

1 Introduction

The application of BIM in Chinese construction market has already started. Corresponding research on standard framework of BIM has also begun [1]. The standardization of BIM mainly involves two aspects, namely the construction field and IT field. The construction field mainly discusses how to implement the benchmark of BIM. Research based on project integration and full life cycle theory of BIM standards are divided into prophase management, planning management, bidding management, etc. [2].

Among them, the core of investment control management is the whole process of cost management; the most important of whole process cost management is cost data management. Construction projects produce cost data, which has complex types, diverse forms and huge quantities from all participants throughout the life cycle.

2 The conception of construction cost data

Construction cost data is a combination of all information related to construction cost features, conditions and variations. All information could be classified into different categories according to management organization, forms, transfer direction, reflection plane, tense and stability. Construction cost data studied in this article is the representation of this kind of information to meet use requirements. At different construction stages, construction cost managers need to collect construction cost data from all parties involved in the project, and put this data into construction cost management after data processing and arrangement [3].

Data of feasibility study stage and design stage is to meet the requirements of deciding investment estimate, design budget estimate, execution budget estimate and working drawing estimate; moreover, data of construction stage is targeted to determine engineering settlement, completion settlement and complement accounting. With respect to price attribute, the former is virtually estimated, but the latter is settled according to facts; from the point of view of data source, the former comes from quota regulations, price information, contract price and so forth, and the latter is confirmed by all participants in the project. From the perspective of the influence on construction cost, the former barely generates actual cost, however, causes more than 70 % of the construction cost. The latter has larger actual cost, but fewer influence on construction cost. In the view of management requirements, the former is widely used in top management than the latter, which is generally used in basic management. From the collection method, specifically speaking, the former is the data collection and arrangement of the latter. For instance, we can analyse and calculate all kinds of construction cost indexes on the basis of construction cost data. The latter comes from practical engineering field and needs contractors' declaration, the supervisory engineer's audit and the owner's confirmation.

Besides data above, some other functional data about confirming cost is involved in construction cost data arrangement, such as quotas and regulations. In addition to technological process and auxiliary-professional knowledge of construction engineering, some technical figures of special equipment and application of new technique are also included. On top of that, there is relevant information got from the market and network

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system, such as the latest price information of various materials and plant on market, comparisons of construction cost data of various materials and plant from different manufacturers, equipment manufacturers and suppliers.

3 Problems of cost data management in traditional mode

In the process of project construction, all related departments' cooperation is necessary for data's transmission. Firstly, information construction at the early stage of project lacks a long-term planning; only the current requirements are considered for a certain project stage [4]. There is not a unified technical standard for engineering data; the inefficient sharing and connecting cannot make cost data be transmitted accurately and fails to meet user's demand. Moreover, the data cannot be reorganized, thus isolated information islands which have a serious impact on cost data management efficiency are formed.

Secondly, because of lacking scientific data accumulation system, lots of construction cost data cannot be collected, neither can the cost database be updated in time. Competition and game relationships among all participants exist in project construction, and the relationships are more intense in settlement process [5]. As a result, the price offered by contractors in bid, project change and claim are lacking scientific and accurate measurement, and the disputes between the owner and contractors must be solved by negotiation and discussion. Such problems have a severe influence on construction progress.

Thirdly, from the perspective of data accumulation, the cost data in current domestic construction market is short of scientific management; most of the data is only used for participants themselves. With the implementation of project bidding system and the specification of bill of quantities issued, Chinese construction market becomes market-oriented. But the construction cost is still depending on government's quota in the process of investment estimate and design estimate. As a matter of fact, the government quota is going to be given up by the market due to its hysteresis [6].

At last, in China engineering cost is in accordance with regional quota valuation method, so it has obvious regional characteristics. What is more, the loss of cost data and management experience caused by the mobility of construction cost personnel is huge. In construction the building materials not only have great consumption but also have many varieties. According to different types and specifications, the decomposition number is more than 500,000. The existing management process is conducted by the cost information published by various areas, which is inefficient and unscientific. Such problem has caused much inconvenience for cost management.

4 BIM's application in cost data management

4.1 THE CONCEPT OF BIM

BIM is short for Building Information Modelling. It is based on three-dimensional digital technology and integrates all kinds of engineering data models of all related information into construction projects. It is a numerical expression of project facilities and functions [7].

The cost data based on BIM has the following characteristics:

1) Objectivity. BIM is a mature information model [8]. It can combine data, process and resources of different stages in a construction project. It is a full description of an engineering object. With a link between the BIM model and project progress, we can have a dynamic comparison of planned cost and practical cost and real-time supervision on quality and safety, and thus to improve the management level of cost, quality and schedule.

2) Integration. The data in BIM model is produced with engineering projects, and is maintained and updated relying on all participants [9]. In addition, it is synchronously simulated in project construction progress until the project comes to an end; it can be organized rapidly and completely, then form a four-dimensional relationship database. As shown in Figure 1, the problems of isolated information islands exposed among departments' management can be solved.

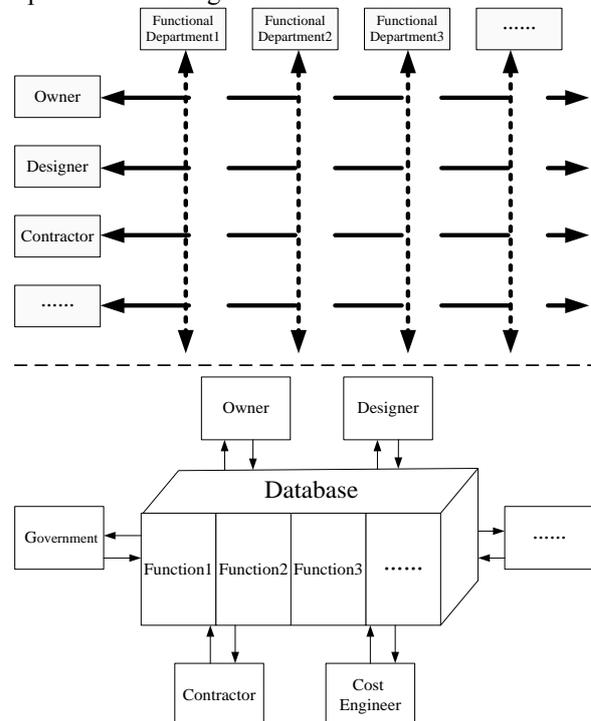


FIGURE 1 Comparison between cost data platform and traditional management mode

3) Accuracy. In BIM database, the data is highly accurate so that it can provide all kinds of data information rapidly for management. It can form the materials and plant list automatically and provide evidence for engineering quantity computation, cost, budget and final

accounts. With the help of BIM technology, the site administrators can compare on-site performance with the planned construction model directly, which can reach a more scientific decision-making level.

4) Real-time. BIM model can reflect construction cost data in a certain time, and provide scientific reference for similar projects' decision-making. At different project stages [10], data can be put in, extracted, updated and shared by different participants, and it has strong function of search, analysis and statistics. This data can also be organized by cost engineers to meet different management requirements.

5) Decision-making. From the perspective of cost management decision, each decision should be based on actual engineering data. BIM model can show the amount of used money, and thus can control money risk and achieve profit target in the short term; it can calculate engineering quantity accurately and rapidly by establishing relevant database, and improve the efficiency and accuracy of construction budget. It can extract project basic information at any time and compare planned consumption with actual consumption, by which we can know project profitability and resource consumption. It can make a dynamic comparison of planned cost and actual cost by combining actual project and BIM model, based on which, we can have a real-time supervision on quality and safety and make adjustments according to the actual situation, then improve the management level of cost, quality and schedule.

These characteristics of cost data based on BIM bring about a change of the cost data management [11]. Compared with the traditional information management model, this kind of management has undergone tremendous changes.

5 Management requirements and construction cost data requirements of all project participants

5.1 GOVERNMENT

The government institution should master and provide information about developing trend of construction cost for society and engineering construction market, and help other participants to make investment decision. The government needs basic data for making construction cost pricing basis and cost management policies and regulations at all stages of project. So the basic data can serve for the government's macroeconomic regulation and control [12].

5.2 OWNER

At feasibility study stage, the owner needs to make project investment estimate, make and examine the project proposal and feasibility study report, make a reasonable determination of project investment to improve benefit, and establish the investment plan. The owner also needs to use the collected construction cost data and the way of

analogy to select out some typical projects, which should be breakdown, conversion and combination. Then the owner should take the factors of plant and materials price changes into account when making investment estimate. At preliminary design stage, the owner makes preliminary design budget estimate. They need to use collected construction cost data to make in-depth and meticulous preliminary design budget estimate when not having the detailed construction drawings. At design accomplishment stage, the owner should make working drawing estimate, then compare it with cost data of similar projects, judge the accuracy, identify causes of deviation and revise construction drawings. Meanwhile, accurate predicting and analysing the unforeseeable factors that will bring cost changes is necessary, as effective control of the working drawing estimate not exceeding the design budget is. At bidding stage, the owner should accurately and reasonably determine contractors' quotation according to accumulative data, and have scientific examination, evaluation and comparison among bids to select out the most suitable contractor. The owner needs to determine the unit price scientifically as well. At construction stage, the owner should get fast, fair and reasonable engineering settlement based on specific work contents. The construction cost data should reflect the actual production level.

5.3 DESIGNER

At preliminary design stage, designers use cost data of typical projects and look for the scientific, economical and rational design scheme to make the engineering technology and economy more effectively integrated and to ensure that the design budget is less than the investment estimate for internal management. Designers should collect and accumulate various types of project cost data, and establish its own database. The required construction cost data is more comprehensive and divided by design characteristics. At design stage, designers should refer to similar projects' design, and reasonably determine project parameters and parameter system design according to the influence of different indexes on cost. At bidding stage, design institute needs make rational design determination. Moreover, design needs to be completed according to the influence of different indexes on cost. At construction stage, design institute should make a reasonable estimate of the cost change in management when design changes occur, as well as scientific economy evaluation.

5.4 CONTRACTOR

Construction contractor should establish its own internal enterprise quota and conduct internal cost accounting for internal management. This kind of construction cost data is professional and divided in detail. At bidding stage, construction contractor should have scientific construction cost data to support scientific quotation. It needs construction cost data from similar projects. At

construction stage, construction contractor needs fast, fair and reasonable engineering settlement, and it should determine specific work contents in strict accordance with the actual situation.

5.5 OPERATION ORGANIZATIONS

Operation organizations should collect engineering data to be convenient for maintenance and management in operation at operational stage. They need various data of complement settlement and engineering information.

5.6 COST ENGINEERS

Cost engineers should organize and take part in measuring work of cost indexes, build their own engineering database system of completed projects, guide industrial development and improve enterprise core competence and technical management. They need to collect various data of different levels, users and purposes, and to accumulate by different use demand.

After the analysis of management requirements and construction cost data requirements of all project participants mentioned above, we need to establish data channel reflected by the standard framework of BIM. Only in this way, can we use the great advantages of the cost data based on BIM

6 Management emphases at different stages for project participants

In order to achieve those goals, the project participants should put the required cost data into BIM model at different stages and get cost data they need, as is showed in Figure 2. Among them, the lines with odd numbers indicate the cost data that a certain participant needs to get from BIM model and the lines with even numbers indicate the cost data that a certain participant should input into BIM model.

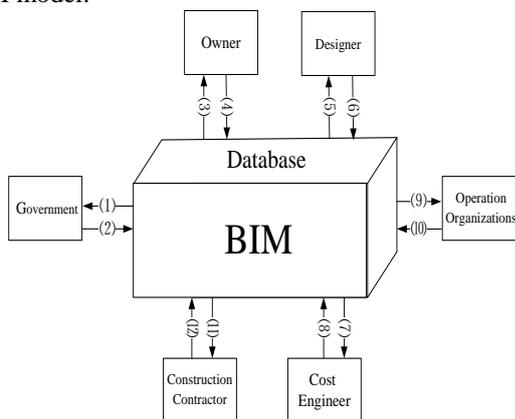


FIGURE 2 Cost data flow of all project participants

- 1) Construction cost pricing basis and cost developing trend.
- 2) Policies and regulations, legal provisions.

3) Survey data, data reference of similar projects (feasibility study stage, preliminary design stage, design accomplishment stage); tender documents, data reference of similar projects (bidding stage); project site management documents, settlement supporting information (construction stage).

4) Feasibility study report, approval of budget estimate, working drawing estimate (feasibility study stage, preliminary design stage, design accomplishment stage); tender documents of the successful bidder, contract items (bidding stage); settlement documents (construction stage).

5) Reference of previous construction cost data in database (project preliminary/internal management, design stage, bidding stage); documents of actual project situation (construction stage).

6) Survey report (project preliminary stage/internal management); design budget estimate (design stage); design contract (bidding stage); construction cost data from designers' site management (construction stage).

7) Reference of previous construction cost data in database (project preliminary stage/ internal management, bidding stage); documents of actual project situation (construction stage).

8) Enterprise quota (project preliminary stage/internal management, bidding stage); tender offer, contract price (bidding stage); settlement documents (construction stage).

9) Documents of complement accounting (operational stage).

10) Report of operating situation (operational stage).

11) Construction cost data collected by use demand (internal management).

12) Engineering database system (internal management). The discussion above specifies management emphases for project participants in engineering construction process. What is more, the cost data is distributed among different construction stages according to construction progress. In actual management process, we need to carry out cost data management according to specific stages. For cost data management, timeliness must be guaranteed, thus the effectiveness can be guaranteed.

7 Expectations

At home and abroad, the idea and technology of BIM has been put into practice. However, there are many difficulties and challenges [13]. Besides, BIM itself has some problems occurred during application. When it applies to construction cost data management, some other difficult points include.

Theoretically, construction cost data management eventually need come to the level of industrial management. At the preliminary stage of establishing database, data only could be managed and accumulated as a unit of enterprises or projects. In addition, due to lacking experience and collected data, many troubles may occur.

Some construction cost data, which is involved in the quota level of construction enterprise, is relevant to commercial confidentiality such as internal cost accounting. As a consequence, the push of BIM technology may meet obstacles.

Technically, different participants in the project choose diverse BIM software for different management demand. Also with the heavy workload of data matching, the data

formats and levels of data detail are varied. Thus, for one project, it is hard to complete the unified data standard and data collaboration. In addition, project construction duration is long. All parties have different technical levels management levels and application levels of BIM.

As a result, in the project construction, it is by efforts of all participants that the advance of BIM can be expressed in construction cost management process.

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