

## Research on Fine Management of Construction Cost Based on BIM

Zhu Fanglin, Tao Xueming, Huang Jiazhen, Cao Yiyun

Xihua University, Sichuan, Chendu 610039

**Keywords:** Fine Management, BIM Technique, Integration, Collaborative Work

**Abstract:** The paper uses the concept of refining construction cost management as the objective to analyze the problems of the existing construction cost management in China including low working efficiency and evident information island. The paper refers to the advantages of BIM technology in information integration and cooperative work, analyzes the application value of BIM technique to construction cost fine management, and tries establishing standardized and processed construction cost fine management mode.

### Introduction

Fine management of construction cost is a new management concept. It aims at breaking organization management units of construction cost into each element and link, and using various economic and technological means to make cost management accurate, efficient and collaborative, which not only improves cost management level, but also achieves the objective of maximizing project benefit. At present, the construction cost management in China has the problem of extensive management, which restricts the efficiency of construction cost and healthy development of construction. However, the booming development of BIM technique brings a new impetus for the process of refining construction cost management.

### Problems of Construction Cost Management in China

#### Computational efficiency of engineering quantity is low

As one of factors of construction cost, the accuracy is the basis of fine management of cost. The efficiency of computing engineering quantity in China has improved significantly from original manual measurement to software with the help of computer EXCEL, Glodon and Rib. However, with the increase of the number, scale and difficulty of engineering projects, and emergency of new techniques, engineering calculation still has the problems of high and complicated workload, and large personal error. It is estimated that statistical quantity accounts for 50%-70% of the process of determining construction cost, but the value created in the process only accounts for 20% of cost management, which indicates that the productivity of engineering cost industry is constrained greatly in the link of engineering measurement.

#### Price data is miscellaneous

The price of engineering materials with different specifications, types and brands is different, and the price of some materials is time-efficient. For example, the price of tertiary screw-thread steel dropped from 4300 yuan /t in January 2013 to 4000yuan/t in May 2013. As the bulk material of construction engineering, price fluctuations has evident influence on construction cost. The information price publicized in cost information websites comes from inquirer seeking price information from supplier, which has the problems of covering incomplete material types and lacking of timeliness. And lots of price data can be inquired by the way of magazine and document, in which the industry parties need to input price information manually for the second time, which undoubtedly reduces construction, cost management efficiency.

#### Construction cost information is difficult to be shared efficiently

Extracting construction cost indicators, engineering quantity indicators and consumption indicators corresponding to engineering types from plenty of completed construction data has positive effect on construction cost management. But the historical completion data of most enterprises is filed with the formate of paper document and word text document, which is difficult

to realize extracting from basic data to effective information and achieve valuable cost indexes. The economic indicators of construction published in cost information websites have the problems of fewer project types, long release cycle and incomplete indicator species, which can't provide comprehensive and reliable support for cost management.

#### **Control effect of construction cost process is not good**

Cost control is the core of construction cost management. There are many manifestations of construction cost from investment decision state to project completion and acceptance delivery stage, so the object and effect of cost control is different. In the design phase, the design is always valued, and cost is often ignored, which neglects the impact of quota control during project design phase. The actual data indicates that the impact of design phase on cost achieves by 70%-80%. During bidding stage, under the condition that preparation time is limited, there are the problems that deviation of quantities is great and project description is not clear. During engineering implementation stage, progress payment is used to reflect image progress of project cts, which belongs to the category of post-action control, and is difficult to start from cost to make early warning on deviation of time-limit cost. During completion settlement stage, the data storage forms in construction cause the problems that claim information is incomplete, drawings are incorrect and information is lost, which makes that engineering settlement is distorted.

#### **Definition of BIM and Analysis of Primary Technologies**

The definition of BIM in the USA is that BIM is digital representation about physical and functional characteristics of a construction project, and it is a shared knowledge resource which not only provides project information, but also provides reliable basis for all decisions in the total project life cycle. In different stages of project, different parties insert, extract, update and modify information to support and reflect collaborative operations. In China, BIM is called building information model. BIM is the process of gathering many technical types of software to realize comprehensive information modeling of engineering project, which finally achieves the goal of improving production efficiency of construction industry.

BIM applies many technologies including visualization, parametric design and simulated collision. BIM modeling software introduces object oriented technology to make that building elements are not two-dimensional point, line and surface any longer, but are basic elements of construction with properties. For example, for wall, girder, board, doors and windows, the designer can directly call basic elements to express objects to establish three-dimensional stereoscopic model. And it introduces perspective rendering effect, which realizes the visual effect of buildings. BIM provides open graphical system. The engineers use parametric components as the basis of building elements, and assign geometric information, physical property and functional information to components according to requirements. And parametric changing technology provided by parameterized modification engine can realize linkage-type change by 3D boolean operation. So it is different from CAD plane figure component. After the property of a building component is modified, the other components will have parametric transformation automatically without needing manual change, which can improve work efficiency greatly. In BIM model, assigning other appreciation attributes to components such as cost of components and planned project duration can realize automated and intelligent statistical and analysis of the data for project decisions. BIM includes many modeling softwares. Different BIM modeling softwares need to be established under the standard of neutral publicity, which can make information change of many parties. The universal standard is IFC standard identified by international standardization organization. The models established by project members are stored with IFC documents. IDM is used to define content of information exchange, for example, the structure of models which is established by Revit architecture can import Revit structure, which makes construction information realize seamless joint. BIM collision detection technology simulates all real information of buildings by digital information simulation. It can comprehensively arrange water and electricity pipes and equipments in 3D architecture model, and can reflect collision problems by 3D model, which not only enhances

communication and coordination of professions, but also can reduce the situations of rework and lost labor.

### Application of BIM to Fine Management of Construction Cost

#### BIM improves accuracy of engineering quantity

Using three-dimensional modeling function of BIM firstly can improve computational efficiency of engineering quantity. The cost personnel can call parametric components of BIM modeling software, and assign correct size, elevation and concrete grade to establish 3D model rapidly. The model outputs engineering quantity by relevance operation, which saves plenty of time of hand calculation. Or the cost personnel use the design documents with standard format to directly import cost software. The cost personnel only need to select correct calculation rule and summarize engineering quantity according to project characteristics. The interoperability of design documents with standard format not only reduces understanding deviation of cost personnel reading map and error of secondary input of data, but also greatly improves accuracy and work efficiency of engineering quantity.

#### Accumulation and share of construction cost information

The essence of BIM model is the large database based on 3D model. The database can store the price information of projects including building materials, manual work and machines. Construction cost management organization can establish price information platform according to BIM data standard. The market inquiry results and the price information which is directly acquired on information platform can be catalogued and regularly published on information platform. The public users can update information price of BIM model in real time, which saves time and error of manual input. Based on the database platform, the construction cost information management organization can collect the indicators of the completed projects for screening and publishing, which not only provides public service for government and society, but also provides professional service of cost information for valuation of construction market subjects. As a structured information which can store calculation, construction cost information based on BIM database not only enhances efficient share of cost industry and reduces human cost for information transmission, but also improves accuracy and value of cost information.

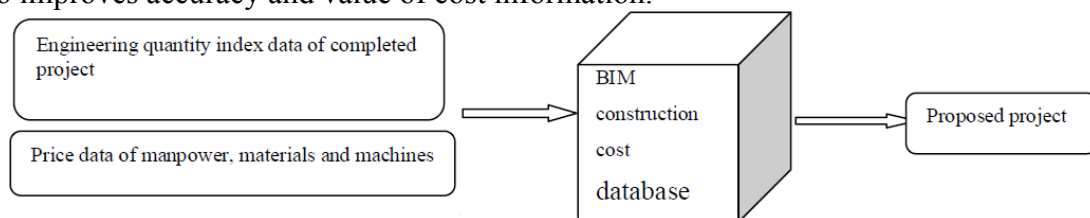


Fig 1 Value of cost information

#### Construction cost during optimal design phase

During the design phase, the project parties including building and structure establish the corresponding BIM model. BIM simulation collision inspection can be made by importing professional checking software, which not only can reflect collisions of different professions in 3D space, but also improves traditional drawing efficiency, reduces the design change in construction, and reduces cost increase caused by the change. The cost personnel can directly import the structure and BIM model into BIM cost software for secondary rapid process to achieve accurate basic data of engineering quantity. And more manpower and material resources are invested into data analysis. With the help of value engineering, the cost data during design phase is deconstructed from the economic perspective. And the historical data indicators of construction which are stored in BIM database are compared. The final economical indicators are feedback to designers for developing optimal design, which not only realizes quota design, but also effectively controls construction cost.

#### Strengthening cost functions during bidding phase

During bidding phase, the bidder can rapidly establish engineering quantity list and bidding control price by using BIM. And the bidder can rapidly achieve data of engineering quantity by

using the function of automatical calculation of BIM. With the help of the similar project data and the latest cost information in BIM database, the bidder can inspect the accuracy and integrity of engineering quantity list and bidding control price, which not only improves the accuracy of engineering quantity list and bidding control price, but also reduces the risk of bidders. The bidder uses BIM model to verify engineering quantity list, uses enterprise database and market cost information to compile the bid quote, and makes deep analysis on bid quote, which can achieve the biggest market competitiveness.

#### **Analysis of multidimensional deviation during construction phase**

In the process of implementing construction project, by comparing schedule and cost, the deviation is found out timely, the reasons are analyzed, and the deviation is corrected, which can realize effective control of cost. It is common that only a dimension is analyzed in the process of construction cost control, and the deviation of other dimensions is ignored. 3D model based on BIM assigns the model information parameters including cost and construction period. The engineering project is split according to the requirements of image progress, and the total engineering quantity is summarized rapidly. Under the powerful computing function of database, the data statistics of 4D, 5D and ND is realized. High-efficient, accurate and multi-dimensional comparative analysis of cost can be realized by BIM cost software, and the value of cost management during construction implementation phase can be improved. For visa change in the process of project implementation, BIM database is used to collect and backup the information, which avoids the lose of visa change. Under the situation that visa change makes engineering quantity change, BIM model is modified to realize correlation calculation, which rapidly checks engineering quantity. The application of BIM technique in construction implementation phase not only strengthens control function of cost management, locates the deviation accurately, and effectively analyzes the deviation, but also controls the expansion of deviation, and realizes fine cost control.

#### **Integration and collaboration of BIM**

Management of construction cost not only involves cost department, but also needs to cooperate with the relevant departments including design, implementation, purchase-ment and contract, which not only realizes accurate transmission of cost information, but also reduces efficiency reduction. BIM is used to establish project cost data center. The design and construction department can upload the variation and claim information influencing cost to data center. And the purchase department can upload the price information and inquiry results, and the contract department can submit clauses of project contract influencing cost with standardized format. Regional project cost department integrates cost information data provided by parties to form cost management mode with information integration, which effectively promotes construction cost management level. The regional cost department can transmit BIM integration information to cost background of group BIM, which makes corporate headquarters implement coordinated management on regional projects. Through information share of BIM cost center platform, the purchase department can effectively make procurement plan, the design and construction personnel can directly enhance cost consciousness according to the expense produced by visa change, and the contract department can enhance normalization of drawing up bidding documents. Construction cost management based on BIM makes cost consciousness and responsibility of relevant departments specified, which fully reflects fine management.

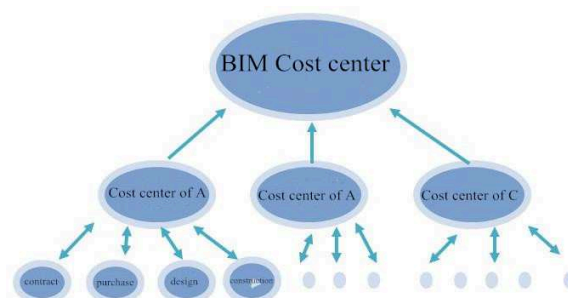


Fig 2 Construction cost workflow based on BIM

**Conclusion**

As the second revolutionary change of construction industry after CAD technology, with the development and improvement of BIM, it inevitably has a profound influence on modernized development of construction industry. With the help of BIM technique, the informatization and refinement level of construction cost management will be improved, which realizes effective control effect.

**Acknowledgement**

Supported by The Innovation Fund Of Postgraduate, Xihua University, ycyj201371

**Reference**

- [1] Ernstrom B, Hanson D. The constructors guide to BIM.2005.
- [2] Martin J, Director B E. UK Government Building Information Modeling (BIM) Strategy.
- [3] He Guanpei, BIM overview , China Architecture & Building Press.2011.
- [4] Yang Baoming, New thought of construction cost management .2010.
- [5] Li Jing, Fang Houchun, Luo Chunhe, Research on cost management based on BIM , Construction Economy, 2012.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.