

Research on Construction of Bill of Quantities of Prefabricated Buildings Based on BIM

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Abstract: Building Information Model (BIM) Technology can be widely used in various construction fields. The construction quality and project cost of the prefabricated construction industry based on BIM can be effectively controlled. Based on BIM Technology, the integration of bill of quantities can effectively control the cost of prefabricated construction and improve competitiveness in the bidding process. Based on this, the characteristics and advantages of bill of quantities pricing based on BIM were expounded in this paper. Besides, the structure and content construction of bill of quantities were analyzed, followed by an analysis of pricing control strategy based on BIM were analyzed for assembly building quantities for reference.

Keywords: Building Information Modeling (BIM); Prefabricated building; Bill of quantities

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1. Introduction

As an application system that can be widely used in various construction projects, BIM can integrate all kinds of information in the whole life cycle of the project, so as to well realize the representation of building information and real-time sharing of data, and provide an opportunity for the progress of cost management. In particular, the modeling characteristics of BIM components and the management benefits of information integration are highly consistent with the component-based and integrated concepts of prefabricated building^[1-4], indicating that there is a certain coupling between prefabricated building and BIM technology, and it can be highly integrated. Therefore, BIM technology can be applied to the cost control of prefabricated buildings to effectively improve the accuracy and efficiency of cost control. However, because the BIM model only contains some geometric and physical information, it does not have the necessary conditions to implement life cycle cost management, and this problem needs to be further addressed^[5-9]. In addition, the importance of data is increasingly emphasized in the era of big data. Cost information resources have important value in project cost management. Making full use of cost information resources and efficiently managing cost information resources are important factors in improving project cost management. Preparing bill of quantities of prefabricated buildings through BIM technology can improve the competitiveness of construction enterprises in the market in the process of project bidding and cost calculation.

2. Characteristics and advantages of bill of quantities pricing based on BIM

2.1 Pricing characteristics of bill of quantities based on BIM

The multi-level bill of quantities of prefabricated buildings based on BIM combines the characteristics of BIM. Based on the characteristics of prefabricated buildings, it has been modified in terms of

decomposition structure and pricing rules. The list has the following characteristics:

- (1) Starting from the characteristics of prefabricated buildings and BIM componentization, we should give full play to the advantages and economies of scale of modular production of prefabricated buildings to help reduce the construction cost of prefabricated buildings. At the same time, the main advantage of the combination of data-driven BIM is to optimize the project cost management mode of prefabricated buildings ^[10].
- (2) According to the general contract mode of the project, it can meet the cost management needs of the whole life cycle. There are many different pricing methods for a project. Adopting different pricing methods in each stage of project construction not only reduces the pricing accuracy of prefabricated buildings on the whole, but also cannot make full use of the characteristics of each pricing method. The multi-level decomposition structure meets the characteristics of different pricing methods at different stages of the project pricing process, and helps to improve the cost management of prefabricated construction ^[11].
- (3) The new price combination mode is in line with the characteristics of prefabricated building components as well as the factory production mode of prefabricated building, which helps highlight the benefits brought by the production mode of industrial building. By reducing the construction cost of prefabricated buildings, the problem of high cost restricting the active promotion of prefabricated buildings can be well solved.

2.2. Construction advantages of bill of quantities BIM

- (1) Improve the efficiency of engineering quantity calculation.
The scientific application of BIM technology in the bill of quantities calculation of prefabricated buildings makes the presentation of information data more efficient, scientific, intelligent and electronic. With the help of visual data platforms, managers can manage the amount of prefabricated construction more scientifically and effectively as well as standardizing it. It effectively makes up for the deficiency of traditional paper information storage and transmission mode, makes information storage more secure, increases the efficiency of engineering quantity management, increase over the control of accuracy of related parameters, and improves overall management efficiency.
- (2) BIM technology can complete cost simulation according to the bill of quantities.
BIM technology has the simulation function of simulating the analysis of engineering quantity calculation scheme. It can organically associate the 3D model of building structure with the bill of quantities, and build a 4D spatially assembled building model and a 5D communication technology platform on this basis. In addition, the calculation links of various quantities can be compared with the actual quantities to confirm whether there are omissions. The building information model based on BIM technology can carry out different modeling for various accessories of different types and sizes, so that the supervision department and relevant technicians can fully understand the bill of quantities information, further optimize the assembly building cost, and control the assembly building cost.
- (3) The whole process of quantities can be traced.
The scientific application of assembly building based on BIM technology can give full play to the role of the Internet of things and mobile devices, and connect the completion process of the bill of quantities organically. By utilizing cloud storage and other technologies, the construction and pricing of bill of quantities can be remotely controlled, and the calculation process of bill of quantities pricing can be strictly supervised and managed in real time. In addition, the indicators and parameters formed in the construction process of the bill of quantities can be uploaded to the cloud simultaneously, so that the relevant staff can comprehensively, timely and wholly understand the actual situation of the quantities,

understand the use of materials more accurately, and achieve supervision and tracking of the whole process of assembly materials use.

3. Structure and content construction of bill of quantities

This paper establishes the bill of quantities according to the construction entity of prefabricated buildings. The specific process is as follows [12-16]:

3.1. Structure establishment of bill of quantities

3.1.1. Research ideas of constructing bill of quantities

In the process of establishing the bill of quantities, in order to perfectly integrate the three contents of the bill of quantities, prefabricated building and BIM technology, it is necessary to compare and analyze the characteristics of the three, then integrate and analyze them, and then decompose the bill of quantities according to different modular theories. The specific decomposition of ideas of the bill of quantities are as shown in **Figure 1**.

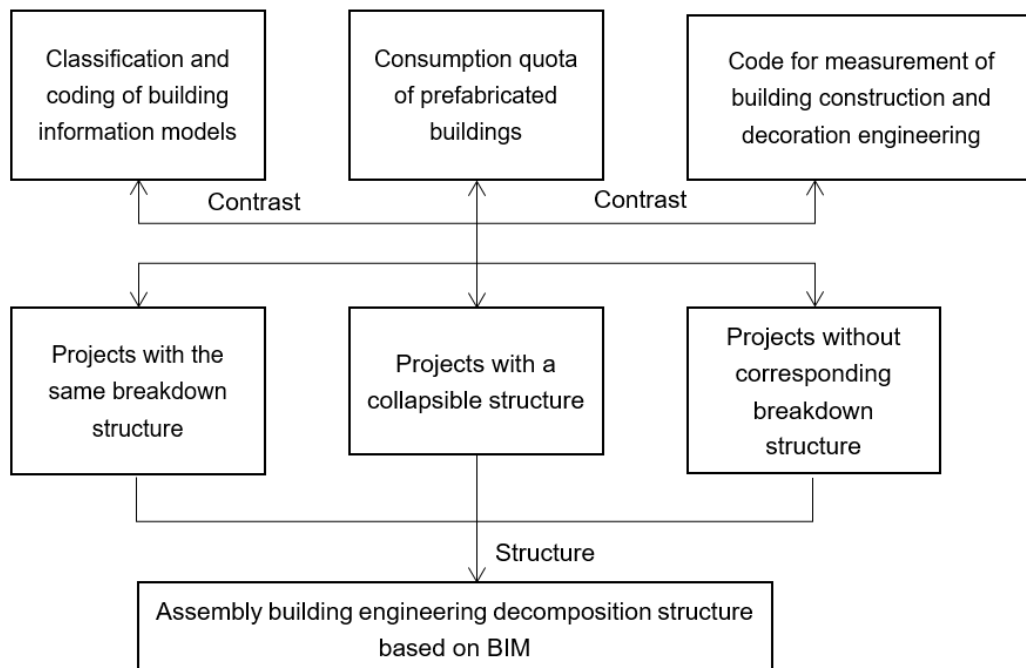


Figure 1. The idea of establishing the prefabricated construction engineering decomposition structure based on BIM

3.2. Application of modular theory

When using BIM technology for modular design of prefabricated buildings, we should first analyze the characteristics of prefabricated buildings. According to its characteristics, the construction projects of prefabricated buildings can be segmented, and the modular analysis of product processing, product structure, product purchase and other contents can be done according to the characteristics of modular list construction. The specific process is as follows:

- (1) Modularization of product structure refers to the disassembly of prefabricated buildings according to different functions and production methods. “The unified standard for the application of building engineering information models” includes architecture, structure, electricity, water supply and drainage, heating, ventilation and air conditioning, intellectualization, fire protection, decoration, divisional

quantities, conceptual design, BIM modeling, and project estimation.

- (2) The modularization of product manufacturing process includes the processing and manufacturing the components of prefabricated buildings according to various production processes and methods. Among them, the structural module is divided into foundation structure and precast concrete structure. Next, precast concrete structures are divided into precast columns, precast beams, etc. Then, precast columns are divided into precast frame columns and precast shear wall hidden columns.
- (3) Products can be manufactured by purchasing, subcontracting or processing. The construction unit determines the capacity of these prefabricated components and outsources them to component contractors, while module suppliers manufacture according to their own design parameters and standards. In other words, the modularity of procurement subcontracting. These prefabricated components can be refurbished, disassembled and manufactured. For example, precast columns require a variety of materials such as steel and concrete, as well as labor and machinery. The process of manufacturing these prefabricated frame columns (sub modules) is modular. Processing and manufacturing, according to the rule of the assembly of multiple sub-modules, is a new product integration.

3.3. Establishment of bill of quantities structure

According to the above construction ideas and modular application theory, taking the structure as an example, this paper constructs the contents of the bill of quantities of prefabricated building structure, and the specific contents are as follows:

- (1) The structure of a first level of the list includes architecture, structure, electricity, water supply and drainage, heating, ventilation and air conditioning, intellectualization, fire protection, decoration, divisional quantities, conceptual design, BIM modeling, and project estimation.
- (2) As for the second level of the list, the foundation, precast concrete slab, other precast concrete components, precast concrete columns, precast concrete beams, post cast strips, precast concrete walls, concrete beam column joints, structural joints, precast concrete stairs, embedment and rings are all carried out by the components in the primary list. The second level also includes sub item quantities, preliminary design BIM modeling, and design estimates.
- (3) In the third level of the list, in addition to the distribution of sub-divisional quantities, BIM modeling of construction drawing design, construction drawing budget and other contents, flat plates, hollow slabs, grooved slabs, grid frames, broken line slabs, ribbed slabs, large plates, trench covers, well covers, well rings, etc. are all carried out by the prefabricated concrete slabs in the two-level list, sleeve grouting, post cast concrete pouring and tamping, post cast concrete reinforcement, post cast concrete formwork are all carried out by the post cast strip, construction joints Anti-seismic joints and contraction joints are developed by structural joints, and iron parts and bolts are developed by embedded and lifting rings.

For prefabricated buildings, other bill of quantities can be further established according to the bill of quantities decomposition model, and finally integrated and summarized by the BIM software platform to complete the final bill of quantities calculation, summary and pricing.

4. Pricing control strategy of bill of quantities of prefabricated construction based on BIM

4.1. Reasonable cost management

In the design stage, we need to have a sense of rationalization of cost control in order to complete the docking of engineering projects. It is necessary to apply reasonable cost management measures, good behavior and more scientific overall design scheme, focus on reducing some unnecessary materials, simplify the architectural design process, and highlight the designer's intention of low cost, high functionality and high cost performance. In general, in order to realize the design intent, we should adhere

to practical, scientific and reasonable working methods in the design stage, which will be of great help to cost control.

4.2. Scientific accounting process in the design stage

In terms of process management, scientific process division should be carried out according to the investment quota of construction projects. For example, a preliminary design is made according to the declared quantity in the existing design sheet, and then fine tune the parameters of the drawing in a step-by-step way. In practice, reference information should be strictly implemented in order to reduce costs on the basis of function realization. In addition, we should control the scientificity of the planning, take strict implementation as the measurement basis, understand the process of architectural design, and prevent the construction from exceeding the budget or exceeding the budget settlement. We should avoid technical limitations and inconsistencies of concepts. In terms of kinetic energy distribution, technical schemes should also be formulated to avoid the problem of insufficient total investment and the design concept cannot be completed. The cost management organization can make scientific accounting and implementation plans to insure the project. It is necessary to comprehensively consider uncontrollable factors and uncertainties such as environment, technology and manpower, and improve the feasibility of overall cost management.

4.3. Estimate the design budget scientifically and reasonably

The preparation of design estimate is important mainly because it can provide a basic reference for the preparation of project investment planning and cost management. Based on the approved construction drawings, further cost estimation of the drawings is carried out on this basis. Reverse calculation is carried out according to the design budget after the initial overall estimation of the project. The drawings are within the budgeted cost, so as to reduce the problems of over-budget caused by the design drawings. When reviewing the budget of the design drawings again, the needs of the initial budget can be fully integrated, so as to provide theoretical data support for the later construction and avoid the increase of the overall cost of the construction project.

5. Summary

In conclusion, the construction of the bill of quantities of prefabricated buildings based on BIM can effectively improve the efficiency of the calculation of quantities. BIM technology can complete the cost simulation according to the bill of quantities, realize process traceability of quantities, and ensure the construction quality and cost control of prefabricated construction projects. Taking the prefabricated structure as an example, BIM technology can be applied to build the bill of quantities, which can be operated on the BIM platform to achieve multi-party coordination and drive the development of prefabricated construction companies.

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