Optimal Design of Prefabricated Building Based on BIM

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Abstract. Currently, China is in the rapid development stage, and the speed of urbanization is getting increasingly fast. The application of prefabricated construction in the modern construction industry is more and more common. The BIM technology emerges as the times require, which is developed by some technicians to improve the work quality and efficiency at the construction site. With the acceleration of urban construction, the technical means of construction are also improving day by day, and the application of BIM is more and more common. Attributing to its features, it appears more and more frequently in the prefabricated construction. This advanced technology is highly practical, contributes greatly to the construction of modern buildings, and plays a significant role. It has dramatically improved the technical level of modern construction and vigorously driven the rapid development of the construction industry. It can accelerate the construction speed and shorten the construction period considerably. Multiple advantages make BIM technology the favorite of the modern construction industry. Certainly, this technology is still in the development stage, and there is a long way to go. Constant research and upgrade by developers are required to make it more outstanding.

Keywords: BIM technology, Prefabricated Building, Building Construction, Design Mode, Engineering Quality

1. Introduction

In construction, BIM is compelling and extensively used. The reasonable application of the technology can improve the quality of construction effectively [1-2], reduce the construction cost, and help beneficiaries get the most benefits [3-4]. In this paper, some advantages of the BIM technology are analyzed, such as coordination, intelligence to establish a big database based on the whole project supervision data model, which is a high-end technology model run by computer. From the practical significance of the application of BIM technology in the construction, the design and application of BIM technology in the construction of prefabricated buildings are described [5-6].
2. Practical significance of bim technology in the construction of prefabricated buildings

Traditional site information and instructions are usually recorded and communicated by paper documents, which will inevitably delay the time and bring great uncertain factors to the information transmission and often result in the fact that the information transmission is not timely and the information transmission is wrong. In the past, some traditional sites often used 2D images to carry some equipment parts. This model has different degrees of impact on the drawing of some precision equipment and components, and also has an inestimable effect on the later stage of the project. Also, the traditional paper form of the drawing has a significant influence on the speed, because the paper to read, the search of materials need to consume much time, require the investment of human and material resources, and have a high influence on the project process. BIM can present some 2D and non-composable images from a 3D perspective, which is more intuitive. It can reduce and avoid some quality problems due to inaccurate drawing or data deviation effectively. The BIM system makes all data into electronic information, which has greatly improved the speed of information transmission, convenient for a unified design. The BIM model is not an independent 3D model, but the core BIM a collection of model-based multiclass models with different functions. The BIM model requires the use of professional modeling tools. The common BIM modeling software is shown in Figure 1.

![BIM Modeling software type](image)

**Figure 1.** BIM Modeling software type

Under the protection of the system, the quality of the BIM can be guaranteed, and the whole project ensures the monitoring of the construction site. real time at any time and anywhere. Once the project encounters problems, it can track and locate the issues through data search and analysis. The intelligent program chain ensures the orderly progress of the project.

3. Design and application of bim technology in the construction of prefabricated buildings

As is known to all, a large-scale construction project often requires massive labor force to participate, which involves a regulatory issue. In the former construction site, the mode of supervision is often used. However, people and machines are fundamentally different, while computers can be in a stable
state for a long time. Currently, the application of BIM can make the whole construction site transparent, so that all personnel and every detail of operation can be exposed in the eyes of the designer and computer, which will greatly improve the progress and quality of the project, without dead angle supervision, and effectively prevent some illegal dangerous operations from happening. Hence, the application of visualization based on BIM can help designers to solve many severe problems.

The BIM system can simulate all construction sites. In the initial design, usually, designers need to change continually, improve the previous drawing plan, and effectively reduce the disadvantages caused by unreasonable design. Therefore, it is a rather cumbersome process to complete the design task ultimately. This traditional design method is time-consuming and laborious, it is challenging to meet the needs of the current design, as designers can not accurately predict what will happen on the construction site, resulting in frequent problems in the construction stage. Designers can simulate the building environment in advance to better and more reasonable engineering design. By simulating the construction and various situations in the project, the designer can calculate the consumption and funds of building materials of the components, which can give the project an accurate budget and make the whole design scheme more suitable and feasible. To a great extent, BIM greatly reduces the probability of design error. This is because the early days, the defects of engineering design can be exposed through simulation construction, which can avoid design errors and improve the quality of the project effectively.

The duration of the architectural construction design can be calculated as follows:

\[ D_t = \frac{w_i}{n_t} + M \]  \hspace{1cm} (1)

If there is no supervision, it assumes that labor productivity is the optimal 50% participation. Using this assumption, use the following formula to calculate the build factor:

\[ PF = 1 - 0.5 \frac{1}{e^R} \]  \hspace{1cm} (2)

Where PF = Productivity factor

\[ R = \frac{Number \ of \ foremen}{Number \ of \ operatives} \]

Then, the productivity coefficient shown in formula 3 is calculated as the maximum duration.

\[ D = \frac{D_{(max)}}{PF} \]  \hspace{1cm} (3)

4. Optimal design analysis of prefabricated buildings

Compared with the traditional construction process, the former process is much more complex, but the information obtained is also various. Where BIM is extensively applied in the construction process of prefabricated building, it plays a significant role in the design and research of the construction schedule. Compared with the past, the way of information transmission in the current era has changed. The expression method of previous engineering projects, basically using paper for storage and
transmission, has low efficiency. Once there is data error, the difficulty of engineering quality design will become very large. Before the BIM technology is applied in the prefabricated construction project, most of the construction sites will process the information in the form of paper, and a large number of data and drawings will appear in each component, so it is very difficult to find the relevant information. Hence, the difficulty of quality design in the construction of prefabricated buildings can be imagined. However, after BIM technology is introduced into prefabricated buildings, the situation will not be very different. BIM can build a model, which will be an information integration platform. It will change the data together into a 3D visual mode, which brings convenience to the storage and transmission of information and can be more intuitive to understand. It can play a significant role in the progressive design of technology.

The cost management of construction stage based on BIM technology is different from the traditional management mode. Based on the BIM model established in the design stage, the dynamic BIM model of construction stage is developed by combining the dynamic information of construction period, price, visa change claim, etc. in the construction stage. By using the functions of BIM technology parameterization, data, the required aspects of dynamic cost control are quickly and accurately retrieved. The effective management of dynamic cost can be realized by analyzing cost deviation and calculating visa change cost based on the data of engineering quantity and cost. This process avoids the split management mode between the early stage and the construction stage of the project cost, where the BIM model established in the design stage is used to reduce the workload of repeated measurement and pricing by the cost management personnel. The workflow based on BIM cost management in the construction phase is shown in Figure 2.

| Price change | Construction period | BIM design model | Claim damage |
|--------------|---------------------|-----------------|--------------|
|              |                     | BIM construction stage cost model |

**Figure 2.** BIM-based construction management process

To improve the quality of the whole project, we have to make all preparations from the beginning of the project construction. In the preparatory stage, if we want to calculate the relevant data of the project, we need the cooperative units to fulfill the various treaties as scheduled and carry out the construction according to the pre-determined construction guidelines, so as to ensure the scientific and practical construction plan and scheme. In the whole process, the BIM system takes on many responsibilities, such as quality design. In the prefabricated building construction, the BIM technology needs to mark a lot of equipment parts and structures to reduce the pressure and provide convenience
for the later quality design. Meanwhile, BIM technology is used to integrate the quality standards, structural models, and other contents in construction engineering. Subsequently, the big data are consolidated to establish a complete data structure. Finally, based on different features of the functions of various building components, the requirements of each detail are arranged in place, which is conducive to the general design of the overall construction. In this way, the parameters of parts and equipment involved in the engineering construction can be established to ensure that the quality requirements and standards are met. BIM technology can collect and consolidate various data and information, and integrate them into a complete database, which will reduce the occurrence of some accidents and ensure construction quality better.

5. Conclusions
BIM technology is a full collection of modern digital technology, electronic information technology, and big data analysis systems. Based on these technologies, BIM can accelerate the construction speed of the whole construction project. Hence, we should develop and perfect BIM system functions, which can not only enhance the quality of the project but also provide a more powerful guarantee for the construction quality. As an advanced technology that has yet to be fully developed, BIM still requires continual improvement in practice, so that the defects can be transformed to improve construction efficiency more effectively and achieve better building effect. Hence, BIM technology is very promising in architectural design, which is also the future trend in the construction application.

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