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Application of BIM Technology to the Design and Construction of Prefabricated Building Projects

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Abstract: *With the rapid change of reform and development, breakthroughs have been achieved in all aspects of society. As the leading industry of social development, the reform of the construction industry has promoted the progress of society. The transformation of the construction industry is an important measure to realize the national sustainable development strategy. To achieve the modernization and intelligence of the construction industry, it is necessary to realize the reform and transformation from traditional buildings to Prefabricated Building (for the convenience of the following, Prefabricated Building is abbreviated as PB). PBs are developing better and better. This article proposed to apply BIM (Building Information Modeling) technology to the design and construction of PB projects, and designed relevant simulation comparison experiments and questionnaires. The results of the comparison experiments showed that it took 60 days to use the traditional design process to carry out on-site construction of PB projects. However, it only took 37 days to plan, design and construct the simulation model of the PB using the design process of BIM technology, which saved 23 days compared with the traditional design. The construction schedule took the longest time in the construction process, with 21 days in the former and 14 days in the latter, saving 7 days compared with the traditional design process. It can be seen that BIM technology modeling can not only show the construction progress of PB projects, but also design and modify the undeveloped projects at any time according to the actual situation, greatly optimizing the engineering management mode of PBs. This article hoped that the application of BIM technology in the design and construction of PB projects can effectively promote the improvement and upgrading of the industrial structure of PBs and enhance the competitiveness of the industry. In addition, this article provided reference value for the design and construction of PB projects.*

Keywords: *Architectural Design, BIM Technology, Building Construction, Prefabricated Building*

1. Introduction

The growth scale of the construction industry has become larger and larger. With the construction reform moving towards the direction of industrialization and upgrading, PBs have been vigorously developed. The construction industry has become more and more intelligent, with the increase in the application of science and technology in PBs. Science and technology have made buildings realize the transformation from traditional buildings to intelligent PBs. As the emerging technologies applied in PBs become more and more diverse, the application of BIM technology in PBs has been popularized. Based on the role of BIM technology in saving money, improving building structure and meeting the development needs of PBs, this article studies it.

The PB is of great significance in society, so the PB has attracted the attention of many scholars. Luo Ting aimed to introduce a systematic knowledge system through scientific metrological review to guide the sustainable transition from traditional buildings to PBs [1]. Dou Yudan believed that PBs are the solution to the unsustainable construction [2]. Zhang Shengxi said that building information models and PBs are increasingly used in the construction industry [3]. Zhang Wennan put forward the evaluation model of PBs to guide the supply chain with controllable cost. Due to the area limitation, PBs are very common [4]. Gumusburun Ayalp Gulden believed that PB technology can build building structures relatively faster and easier with lower project costs [5]. Zhang Hong believed that the delivery of prefabricated components may be interrupted due to low productivity and various traffic restrictions, thus delaying the PB project [6]. Zhai Yue studied the multi-period buffer space hedging coordination between construction contractors and logistics providers [7]. Roque Eduardo said that

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large building solutions are always associated with better thermal performance and are more suitable for easy compliance with different performance and building codes and standards [8]. With the increasing proportion and number of PBs, their design and application have also become the focus of attention. However, the design and construction of PBs have not been deeply explored in previous studies, and there are still some limitations in actual operation.

The PB has become a representative topic in the transformation of the construction industry, and the design and construction of the PB has also attracted many scholars' research. Gunawardena Tharaka believed that the design and construction methods of PB systems need a thorough understanding of their unique characteristics [9]. Li Xiao-Juan believed that PBs are an effective and efficient way to improve the construction process, productivity, quality and cost-effectiveness [10]. Du Juan discussed the coordination mechanism of design change risk of PB projects [11]. Wasim Muhammad believed that by combining the concepts of manufacturing and assembly design, construction practice and technology can be further improved [12]. Yan Xuzhong believed that PB construction projects are sensitive to uncertainty. Because installation activities need to be highly coordinated and interdependent, this may lead to schedule delay [13]. Antonina Yudina considered a method of selecting pile foundation construction technology for multi-purpose PBs, taking into account the analysis of existing loads and structural characteristics [14]. Wuni Ibrahim Yahaya said that for many types of buildings, prefabricated volume structures are increasingly becoming the preferred alternative construction method [15]. There are still some problems in the design and construction of existing PBs, which can not fully meet the development needs of PBs. Based on the role of BIM technology, it is studied.

In order to reflect the positive role of BIM technology in the design and construction of PB projects, this article has carried out simulation comparative experiments and questionnaires. The results of the questionnaire survey showed that 91 engineers said that the construction efficiency of the PB project has been improved after the introduction of BIM technology. The maximum number of people who believed that the construction cost of PB projects would be reduced after the introduction of BIM technology was 97, and 95 people believed that BIM technology can effectively help the reasonable planning and budget of PB projects, making the design planning more reasonable and accurate. This showed that BIM technology can bring positive effect and influence to the design and construction of PB projects.

2. Methods

2.1 Overview of BIM Technology

BIM is the building information model. It can integrate and manage building information through 3D digital technology, and display various types of building information through models. This can not only effectively display the construction information and construction process of the whole construction project at different stages, but also fully display the data resources generated in the whole process.

BIM technology has two major advantages. First, BIM technology can realize the transformation from two-dimensional design to three-dimensional design. The building model of three-dimensional design is more intuitive and visual. The architectural model designed by three-dimensional design can greatly shorten the architectural design cycle and save time for the construction project. Second, BIM technology can improve the accuracy of design. Especially in PBs, BIM technology can simulate all stages of PBs through modeling, which plays an important role in the development of PBs.

2.2 Overview of PBs

Construction can also be manufactured in batches and packages as the products of the production line. As long as the relevant components of the house are prefabricated and transported to the construction site for assembly, the PB can be formed. The early PBs did not have many shapes. The PBs gradually increased flexibility and became diversified. So far, PBs have developed in full swing.

2.3 Application of BIM Technology in PB Design

The traditional PB design process is mainly based on two-dimensional design, while the BIM design process can integrate the data information of the building components of the PB through three-dimensional design, and transmit its information to the relevant manufacturers to realize the integration of design and production. Moreover, through three-dimensional design, PB design can be more intuitive and transparent. BIM technology can be employed to model the design of component assembly building, plan and sort out the relevant data, and design and allocate the budget cost required for project construction, which is to form a cost management system. In addition, BIM technology can also set up real-time monitoring links in the design process of PBs to ensure that management people control the situation of the construction site and deal with emergencies in a timely manner, so BIM technology can better meet the engineering needs of subsequent PBs. Figure 1 shows the comparison between traditional design process and BIM design process.

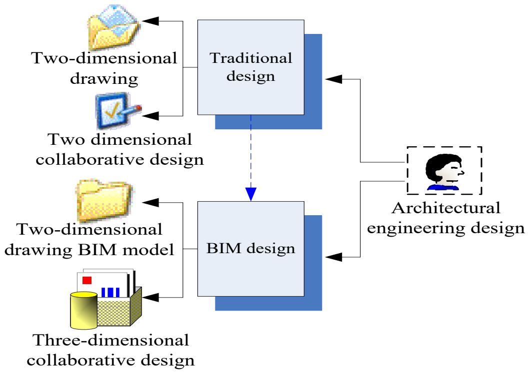

Figure 1 Comparison between traditional design process and BIM design process

In Figure 1, the biggest difference between the design process of traditional design and BIM technology application is the difference between two-dimensional and three-dimensional, which shows that BIM technology can make the PB design more three-dimensional and intuitive.

2.4 Application of BIM Technology in PB Construction

Because the PB is to produce the relevant components and then transport them to the site for matching, the design of the PB is more important than the construction of the traditional building. With the gradual improvement of market development demand, the design of PBs becomes more important. However, in the design of PBs, the construction of relevant components cannot be cut off. Therefore, the concept of environmental protection and economy is adhered to and BIM technology is adopted to carry out more modern development of PBs. BIM technology can carry out three-dimensional modeling of the construction process of PB projects, and restore the construction site by simulating the construction process of PB projects, so as to predict the construction progress, unexpected events and the error rate of the quantities during the construction process, and realize the operation requirements of low cost and high quality.

Many calculation formulas would be involved in the construction of PBs. This article lists the weight calculation formula of several types of steel in construction. Among them, D represents the diameter, and the unit is mm; L represents the length, and the unit is m; D_O is the diameter of the opposite side, and the unit is mm; W represents the side width, and the unit is mm; T is the thickness, and the unit is mm. Then, the weight calculation formula of steel can be defined as:

1) The weight calculation formula of deformed steel and round steel is:

$$SW_1 = D \times D \times L \times 0.00617 \tag{1}$$

2) The calculation formula of square steel weight is:

$$SW_2 = W \times W \times L \times 0.00785 \tag{2}$$

3) The weight calculation formula of flat steel is:

$$SW_3 = W \times T \times L \times 0.00785 \tag{3}$$

4) The weight calculation formula of hexagonal steel is:

$$SW_4 = D_o \times D_o \times L \times 0.00068 \tag{4}$$

The application of BIM technology in PB construction has three functions:

1) Managing construction progress

The construction progress of the PB project with the application of BIM technology would be faster than that of the traditional PB project. Because the construction process of traditional PB projects would encounter various unexpected factors, the project cycle would also be delayed due to these emergencies. These emergencies would also have some deviation from the original design scheme, which would eventually hinder the construction progress of the PB project, prolong the construction period and affect the construction efficiency. The PB project can greatly improve this problem. BIM technology can build a simulation model for the PB project and plan the construction progress in the model. In this way, the situation of the construction site can be displayed in the simulation model in an all-round way, which is conducive to investigating the construction progress, facilitating the management personnel to watch the construction situation of the construction site in real time, and timely adjust the scheme for the unfinished construction projects to cope with the emergence of emergencies. In this way, people can continuously optimize various unknown situations encountered in the construction progress of PB projects.

2) Reducing construction cost

In the PB project, the allocation of the construction cost of the project is a very important link. The project cost management in the traditional PB project is the budget design by employing professional personnel based on personal experience. This method has strong subjective consciousness and can not cope with emergencies. Therefore, it often causes serious waste of human and material resources in the actual operation process. The BIM technology can use the power of digital technology to reasonably allocate and plan the construction cost, and can simulate the area and volume of the building in all aspects during the modeling process, so as to provide more accurate construction data for the construction personnel and avoid unnecessary material waste. The BIM technology is of great significance for the cost control of PB projects.

3) Guaranteeing construction safety

Accidents often occur, so the construction safety of PB projects is a matter of great concern. Traditional PB projects often wait for the emergency to occur and then notify relevant personnel to take corresponding treatment measures, sometimes resulting in irreversible life consequences due to untimely rescue. BIM technology can establish a safety management system for the model and on-site construction of PB projects in the process of modeling. The management personnel can inspect the safety problems at the construction site through the management system, and the safety management system can also intelligently transmit the emergency and handling process to the mobile terminal, so that the rescue personnel can carry out rescue treatment in a short time to avoid accidents.

3. Results and Discussion

3.1 Experimental Results

This article has carried out a simulation experiment comparison on a PB, using the traditional design process to carry out construction design on the site of the PB, and also using the design process of BIM technology to carry out construction design on the simulation model of the PB. Among them, the construction site using the traditional design process is set as the control group, and the construction site simulation model using the BIM technology is set as the experimental group. The differences between the construction time allocation, emergency handling timeliness rate, construction cost, route planning, and the error rate of the quantities under the two methods are compared.

The project name is Smart office building, with a total construction area of 25000 square meters; The number of floors is 6 above ground and 2 underground. The design standard is to comply with local building regulations and green building standards. At the level of architectural structure, its main structure is a steel frame structure; The external wall material is glass curtain wall and lightweight insulation board; The roof material is granite tiles. At the level of prefabricated components, the exterior wall panels are modern energy-saving composite panels; Stairs and corridors are prefabricated concrete components; The internal partition is a light steel keel gypsum board partition wall system; The roof components are steel structure roof trusses and solar photovoltaic panels. In the experimental group, this article uses Autodesk Revit for building information modeling, including building components, system layout, collision detection, etc; In the control group, Auto computer aided diagnosis was used for two-dimensional drawing design, with the main design process including

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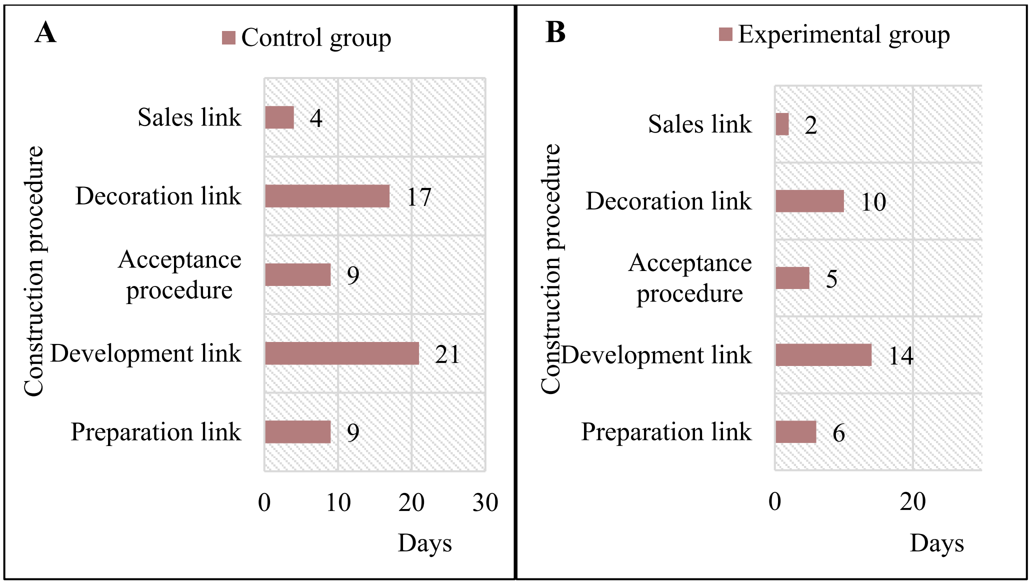
graphic design, facade design, and detailed design.

(1) Comparison of construction time allocation

The two methods in the experiment are compared in construction time allocation. By comparing the time spent on the construction site under the traditional design process and the time planned by the simulation model of the PB project under the BIM technology, the differences between the construction progress of the project are reflected, thus reflecting the impact of the BIM technology on the construction efficiency of the PB project. The results are shown in Figure 2.



A: Construction time allocation of control group
B: Construction time allocation of the experimental group

Figure 2 Comparison diagram of construction time allocation

Looking at the data comparison chart in Figure 2, it can be seen that the application of BIM technology can effectively improve the construction progress of PB projects. The time spent on the construction site under the traditional design process was 60 days, while the planning and design time of BIM technology in the simulation model was only 37 days, saving 23 days compared with the traditional design. In the construction site under the traditional design process, the construction progress took the longest time in the construction phase, and it took 21 days to carry out the project construction. The time spent in construction and decoration was the second, which took 17 days. The time required for construction preparation, acceptance and sales was 9 days, 9 days and 4 days respectively. In the construction schedule designed in the assembly building model using BIM technology for simulation modeling, the longest construction process only took 14 days, which was 7 days less than the traditional design process. The decoration process also saved 7 days and took 10 days compared with the traditional design process. The other three links, namely construction preparation, acceptance and sales, took 6 days, 5 days and 2 days respectively, which were shorter than the project construction schedule allocation time in the traditional design process. It can be seen that BIM technology can effectively shorten the construction period and improve the construction efficiency of PB projects. Moreover, BIM technology modeling can not only show the construction progress of PB projects, but also design and modify the unfinished projects at any time according to the actual situation, greatly optimizing the engineering management mode of PBs.

(2) Comparison of timeliness of emergency handling

During the construction of the project, accidents often occur. Whether the emergency is handled in time is related to the life safety of the construction personnel. Therefore, this article studies the processing time of BIM technology and traditional PBs to deal with emergencies. Figure 3 shows the comparison of the time spent in dealing with 30 emergencies in the two ways.

Through the analysis of the comparative data in Figure 3, it can be found that the building design with BIM technology application responded to emergencies faster and more timely. The data showed that the processing time of the control group in response to emergencies was mostly controlled between 300 and 360s. However, there were four times when the time exceeded this range, namely 171.41s,

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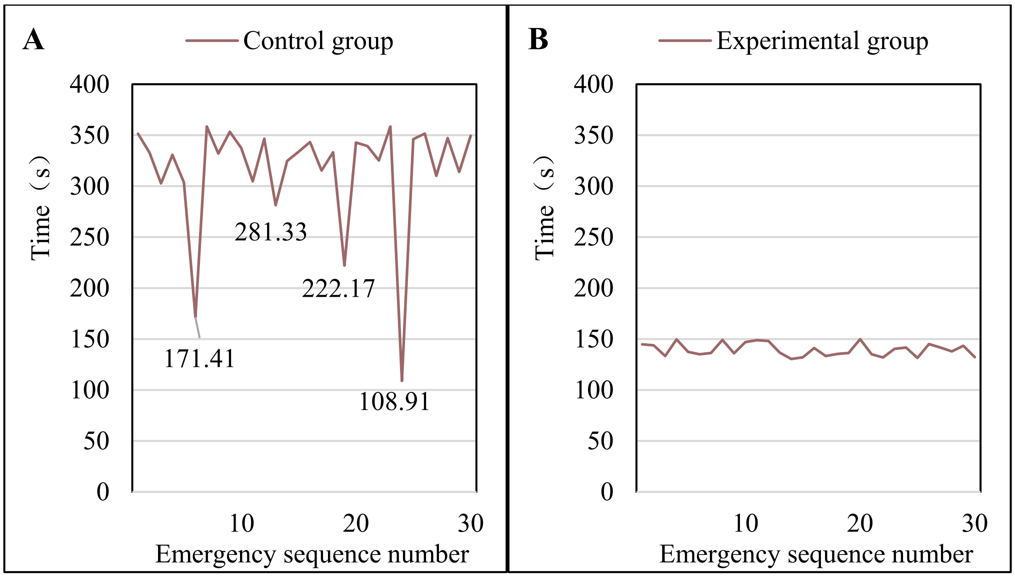
281.33s, 222.17s and 108.91s. It showed that the emergency means to deal with emergencies during the project construction process in the traditional assembly design was not stable. Although the processing time of these four times was faster than the average time, people should have stable and real-time response strategies in the face of different emergencies. However, the building design of BIM technology application had a stable response time to emergencies between 130 and 150 seconds, and there has been no time use beyond this range. It showed that BIM technology can effectively improve the construction safety of PB projects and ensure the timely handling of emergencies.

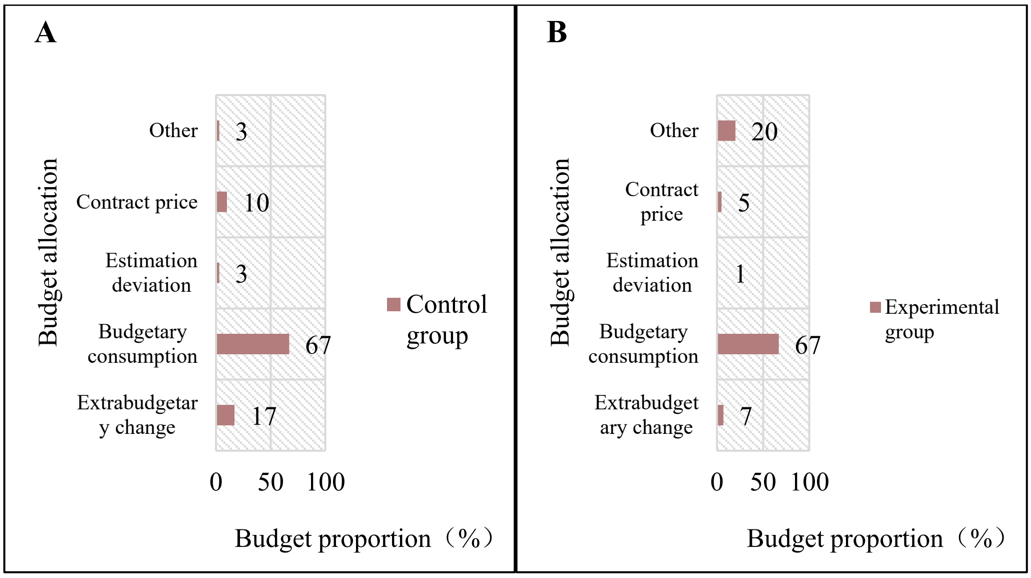


A: Time spent by the control group in handling emergencies
B: Time spent by the experimental group to deal with emergencies

Figure 3 Graph of time spent processing an emergency

(3) Comparison of construction costs

BIM technology can not only effectively control the construction progress and safety of PB projects, but also control the construction cost of projects. In order to make this conclusion more credible, this article compares the cost of the construction site of the traditional design process with the cost saved by the construction site simulation model of the design process using BIM technology. The results are shown in Figure 4.



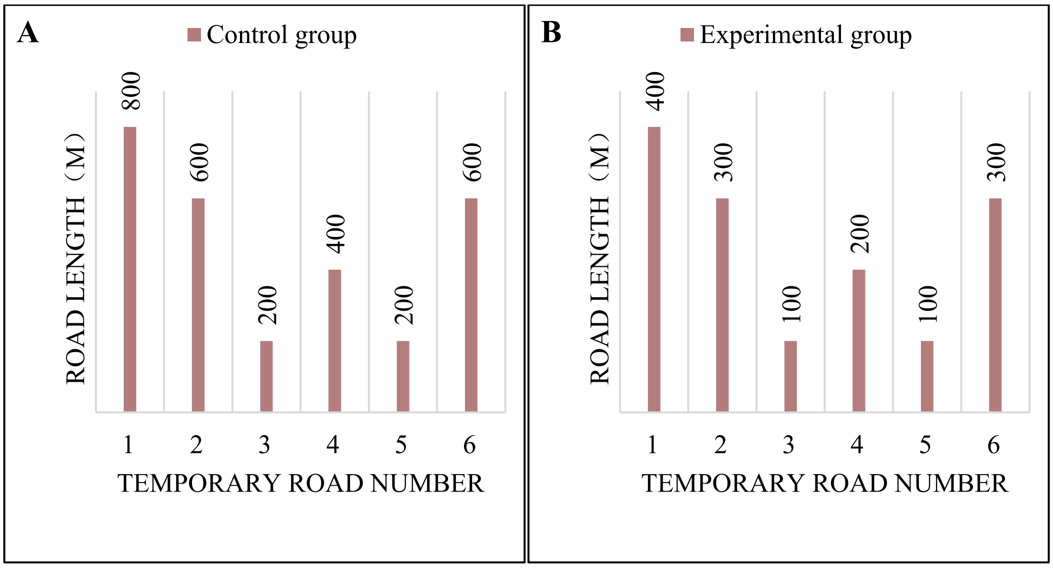
A: Budget allocation proportion of control group
B: Budget allocation proportion of experimental group

Figure 4 A comparison of budget cost allocations

It can be seen from the two sets of data in Figure 4 that BIM technology can make the construction cost allocation of buildings more reasonable and effective. In the control group, the largest cost consumption was the consumption within the budget, that is, the actual construction consumption cost accounted for 67% of the total cost. However, the cost of extra-budgetary changes accounted for 17%; the proportion of estimated deviation was 3%; the proportion of contract price cost was 10%; 3% was other additional expenses. Such budget cost allocation was obviously unreasonable. During the construction of PB projects, there would be many unknown situations. Allocating only 3% of other budgets was not enough to support in case of emergencies, so it was easy to increase budget costs. However, after using the BIM technology to manage the cost, the consumption cost within the budget remained unchanged at 67%, and the change outside the budget was reduced to 7%. Because the BIM technology can simulate the construction site, the budget allocation made was more accurate, and there was no need to spend too much money to hire professionals to carry out budget design. The experimental group also reduced the estimated deviation and the contract price to 1% and 5%, so that more costs could be saved in other budgets. This can better control the cost and ensure that the budget would not exceed the limit.

(4) Comparison of route planning

In order to reflect the impact of BIM technology on the design of PB projects, this article examined the route comparison of PB project design under two forms. The advantages of BIM technology in the design of PB projects were explored by recording the data of the construction of temporary roads designed in two ways. Figure 5 shows the data of six temporary roads.



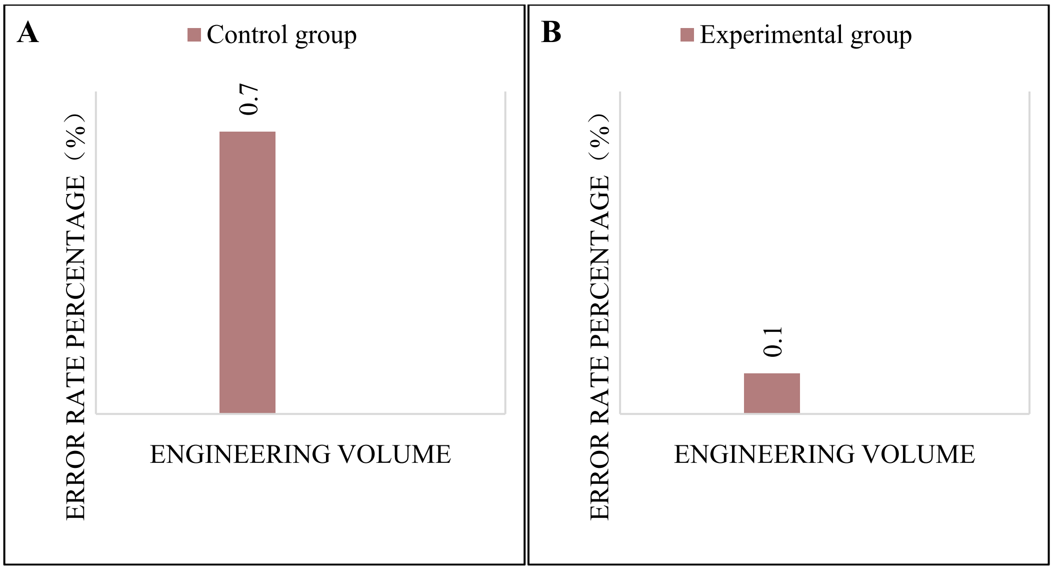
A: Construction length of temporary road in control group
B: Construction length of temporary road in experimental group

Figure 5 Comparison of construction lengths of temporary roads

The data in Figure 5 shows the length design of temporary roads in two ways. In the control group, the design length of six roads was 800M, 600M, 200M, 400M, 200M and 600M respectively. In the experimental group, the length design of temporary roads simulated by BIM technology was 400M, 300M, 100M, 200M, 100M and 300M respectively. The research data would find that the length of roads in the experimental group was reduced by half compared with that in the control group. In the traditional design process of PB projects, temporary roads would be designed as much as possible to prevent the whole project from being affected by road irregularities. The BIM technology can visually view the length of temporary road construction through the simulation model. The model shows the optimal route of the road route, which can not only ensure the smooth operation of road vehicles, but also avoid the waste of human and material resources caused by secondary transportation. In addition, through the simulation model, the best route of the construction site can be excavated to maximize the efficiency of the project construction.

(5) Comparison of error rate of quantities

In the traditional design process of construction engineering management, because the calculation of engineering quantity and cost management require talents from relevant aspects to calculate, this not only takes a long time, but also has a higher labor cost, and can not guarantee that the engineering quantity is not wrong. In order to explore the impact of BIM technology on the error rate of engineering quantities in the design and construction of PB projects, this article records the data of the two methods, and the comparison results are shown in Figure 6.



A: Quantity error rate of control group
B: Quantity error rate of the experimental group

Figure 6 Comparison of engineering quantity error rate

From the data in Figure 6A, it can be seen that the error rate of engineering quantities was generally controlled below 0.7% in traditional PB projects. In fact, for a whole project, the error rate of 0.7% was not too high, but the error of the project quantity would lead to many concurrent situations, such as security risks, cost consumption, human waste, and so on. The BIM technology was an engineering calculation using advanced intelligent and automatic electronic calculation. It had certain control ability on the project cost management and the error rate verification of engineering quantities. The data in Figure 6B also showed that the BIM technology can control the error rate of engineering quantities below 0.1%, and the error rate below 0.1% can ensure the smooth construction of PB projects.

(6) Questionnaire on PB projects

1) Questionnaire reliability

This article conducted a questionnaire survey on 100 engineers. 150 questionnaires were distributed and 130 were recovered. The number of questionnaires with errors and omissions was 30, so the final number of questionnaires included in the statistics was 100. The questionnaire results were analyzed by SPSS (Statistical Product and Service Solutions) software, and the Cronbach's alpha α was selected as the reliability coefficient. The reliability coefficient of this questionnaire was 0.9114.

2) Questionnaire results

This questionnaire investigated the role of engineers in the design and construction of PB projects after the introduction of BIM technology. The results of the questionnaire were shown in Figure 7 (multiple choices were allowed).

According to the results of the questionnaire in Figure 7, 91 engineers said that the construction efficiency of PB projects has been improved after the introduction of BIM technology; 93 engineers said that the construction safety of PB projects has been improved after the introduction of BIM technology; the maximum number of people who believed that the construction cost of PB projects would be reduced after the introduction of BIM technology was 97, accounting for 97% of the total number of people surveyed; the number of people who thought that the architectural design of PB projects has been improved after the introduction of BIM technology was only second to the number who thought that the construction cost has been reduced, which was 96; another 95 people thought that BIM technology can effectively help the reasonable planning and budget of PB projects, and another 87 people put forward other functions that were not shown in this article. This showed that the design and construction of the PB project after the introduction of BIM technology has indeed been effectively

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promoted and developed in a better and more convenient direction, which had a positive role in shortening the project duration and improving the management of the entire project team.

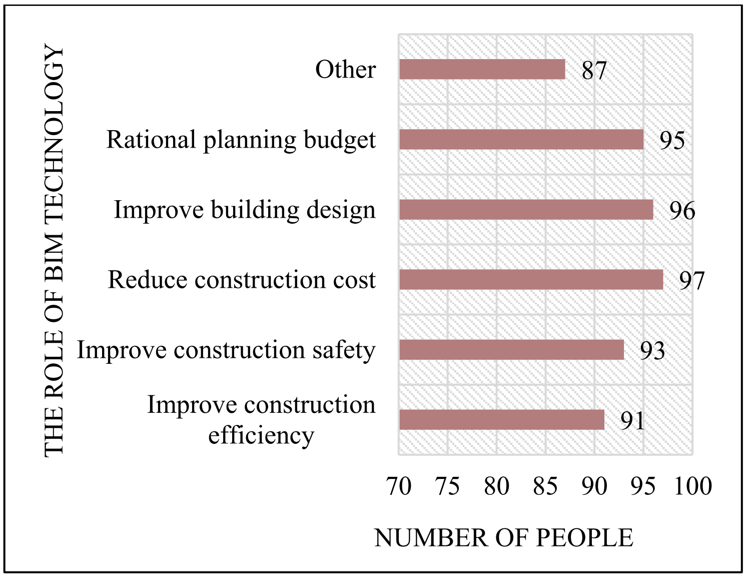

Figure 7 Questionnaire survey results

Through the research on the application of BIM technology in the design and construction of PB projects, there are many unreasonable aspects in the design of traditional PB projects. There are certain problems in both route planning and budget allocation. If PBs want to follow the trend of the times, they must introduce new science and technology as a source of strength. BIM technology can effectively prevent problems in the design and construction of PB projects through simulation modeling, not only saving construction costs, but also finding problems in time through simulation, so as to solve problems in time and ensure the smooth construction of PB projects. The experimental data also showed that BIM technology plays a promoting role in the design and construction of PB projects, fully reflects its advantages, and has very practical significance for the development of PBs.

3.2 Discussion

With urbanization and population growth, the demand for fast, efficient, and controllable quality buildings is constantly increasing. Prefabricated buildings, as a solution, need to better meet market demand. Although prefabricated buildings can reduce waste and improve efficiency, some high initial investment, production line construction flexibility, and cost issues still need to be addressed. In order to improve building structure and save construction costs, this article conducts in-depth research on the design and construction of prefabricated building projects using BIM technology. To verify the effectiveness of BIM technology application, this article conducted experimental analysis from the perspectives of construction time allocation, emergency response timeliness, construction cost, route planning and engineering quantity error rate, and questionnaire survey. With the support of BIM technology, the design and construction of prefabricated building projects not only promote the construction progress to a certain extent, optimize the engineering management mode, but also ensure construction safety, save construction costs, and achieve good planning and control of the construction process, reducing the error rate of engineering quantity. The results of the questionnaire survey indicate that BIM technology can effectively improve the design and construction level and quality of prefabricated building projects. Although the design and construction of prefabricated building projects based on BIM technology can to some extent promote the scientific development of construction projects, this article still has limitations. Due to limitations in project time and resources, this study covers some aspects, but fails to cover all possible scenarios. Secondly, the implementation of BIM technology relies on industry standards and specifications, which may vary across different regions and industries. These limitations need to be further investigated in future research.

4. Conclusions

The design and construction of PB projects based on BIM technology is of great significance. The

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experimental data showed that the introduction of BIM technology into the design and construction of PB projects is an inevitable trend. By comparing the experimental data, it can be seen that BIM technology can effectively predict the information between different disciplines, find problems in time, and prevent them. In this way, it can save money, avoid unnecessary waste, and maximize the advantages of PBs. However, there are some problems in this study while achieving certain results. First of all, due to the urgency of time, the time of this experiment is not long, which may lead to some errors in the experimental results. Secondly, in terms of experimental data collection, this article only selected a building as experimental data, without considering the conditions of other buildings, and the experimental data capacity was small and not representative. Finally, with the in-depth development of science and technology, it is still unknown what changes and challenges the PBs would encounter in the future. However, the development and changes of science and technology would certainly inject new strength into the PBs, and the solutions to these problems would be in sight. The analysis results would be further improved in the follow-up study based on these issues.

References

[1] Luo, Ting. "Exploring a body of knowledge for promoting the sustainable transition to prefabricated construction." Engineering, Construction and Architectural Management 28.9 (2021): 2637-2666.

[2] Dou, Yudan. "Measuring the factors that influence the diffusion of prefabricated construction technology innovation." KSCE Journal of Civil Engineering 23.9 (2019): 3737-3752.

[3] Zhang, Shengxi. "A holistic literature review of building information modeling for prefabricated construction." Journal of Civil Engineering and Management 27.7 (2021): 485-499.

[4] Zhang, Wennan, Kai Kang, and Ray Y. Zhong. "A cost evaluation model for IoT-enabled prefabricated construction supply chain management." Industrial Management & Data Systems 121.12 (2021): 2738-2759.

[5] Gumusburun Ayalp, Gulden, and Ilhami Ay. "Model validation of factors limiting the use of prefabricated construction systems in Turkey." Engineering, Construction and Architectural Management 28.9 (2021): 2610-2636.

[6] Zhang, Hong, and Lu Yu. "Resilience-cost tradeoff supply chain planning for the prefabricated construction project." Journal of Civil Engineering and Management 27.1 (2021): 45-59.

[7] Zhai, Yue. "Multi-period hedging and coordination in a prefabricated construction supply chain." International journal of production research 57.7 (2019): 1949-1971.

[8] Roque, Eduardo "Lightweight and prefabricated construction as a path to energy efficient buildings: Thermal design and execution challenges." International Journal of Environment and Sustainable Development 19.1 (2020): 1-32.

[9] Gunawardena, Tharaka, and Priyan Mendis. "Prefabricated building systems—design and construction." Encyclopedia 2.1 (2022): 70-95.

[10] Li, Xiao-Juan. "Research on investment risk influence factors of prefabricated building projects." Journal of Civil Engineering and Management 26.7 (2020): 599-613.

[11] Du, Juan. "Multi-agent simulation for managing design changes in prefabricated construction projects." Engineering, Construction and Architectural Management 27.1 (2019): 270-295.

[12] Wasim, Muhammad, Paulo Vaz Serra, and Tuan Duc Ngo. "Design for manufacturing and assembly for sustainable, quick and cost-effective prefabricated construction–a review." International Journal of Construction Management 22.15 (2022): 3014-3022.

[13] Yan, Xuzhong, Hong Zhang, and Wenyu Zhang. "Intelligent monitoring and evaluation for the prefabricated construction schedule." Computer-Aided Civil and Infrastructure Engineering 38.3 (2023): 391-407.

[14] Antonina, Yudina, Sychov Sergey, and Gaido Anton. "Construction system for the erection of prefabricated buildings out of factory-made modules." Architecture and Engineering 5.2 (2020): 32-37.

[15] Wuni, Ibrahim Yahaya, and Geoffrey Qiping Shen. "Critical success factors for management of the early stages of prefabricated prefinished volumetric construction project life cycle." Engineering, Construction and Architectural Management 27.9 (2020): 2315-2333.