

Application and Development of Smart Construction Technology in Prefabricated Buildings

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Abstract. The construction industry has been developing continuously, and the industry is in need of construction methods that keep pace with the times. Prefabricated buildings, as a modern construction method, have attracted much attention for their ability to shorten the construction period and offer greater convenience. Due to factors such as the short development time and weak foundation of prefabricated building technology in China, a series of problems have arisen in the actual construction process. For instance, the quality of prefabricated components varies; the on-site placement of components is disorderly; and the placement of various equipment at the construction site is non-standard. This paper summarizes the application and development in prefabricated buildings, and also summarizes the existing problems in prefabricated buildings through BIM technology and blockchain technology within intelligent construction. Through BIM technology and blockchain technology, the whole-process data of prefabricated buildings is summarized and managed. Core data is encrypted and stored to ensure data security. This helps reduce losses in construction projects, plays a guiding role in the projects, and enhances the control over construction progress and construction sites. The application of intelligent construction technology in prefabricated buildings is currently in good condition, and it will have broader application prospects in the future.

Keywords: Intelligent construction; Prefabricated building; Building information modeling; Blockchain.

1. Introduction

The construction industry has been continuously evolving with the times, modern construction methods different from traditional ones have emerged, such as prefabricated buildings. Prefabricated building is a modern construction method, characterized by carrying out key production processes—for instance, the manufacturing of building components—in factories through machines for standardized and modular production, and then transporting these components to assembly, thereby completing the construction of buildings.

Compared with traditional construction, it is more convenient and can shorten the construction period [1, 2].

Their application began in Western Europe in the late 19th century overseas and was widely adopted in the post-war reconstruction during the 1950s. Additionally, different countries exhibit distinct characteristics in the development of prefabricated buildings. For Germany, it emphasizes the unity of performance and structure, and the country has already achieved this goal. Moreover, Germany has established relevant systems that require high standards and strict supervision. Compared with other countries, it also places greater emphasis on energy efficiency and sustainable development [3].

Looking back at domestic prefabricated buildings, from the 1950s to the 1980s, they relied on Soviet standards, but their development was slow due to limited technical levels. Then, from the 1990s to 2010, prefabricated products began to be used in some residential projects, yet the overall proportion remained low [3].

The construction industry has entered the stage of informationization in recent years. The new method of constructing buildings that integrates informatization and industrialization. It requires information

technology as a tool, and information technology constitutes the construction mode of intelligent construction. It can be seen from this that the problems existing in prefabricated buildings can be improved by means of intelligent construction [4, 5].

Against the above background, this paper summarizes intelligent construction in prefabricated buildings. With a focus on the analysis of BIM technology and blockchain technology. Specifically, BIM technology is very important for construction process of prefabricated buildings, thereby alleviating the problems arising in prefabricated buildings.

2. The Application of BIM Technology in Prefabricated Buildings

BIM technology (Building Information Modeling), as a tool based on digital technology, has its core in collecting data and information, creating a visual 3D building model, and enabling information sharing and collaboration among project participants to achieve integration across all stages. BIM demonstrates its advantages in processing complex design information and optimizing the construction process, connecting the entire process of design, production, and construction to achieve the goal of rapid construction of prefabricated buildings [5, 6].

2.1. The Application of BIM Technology in Prefabricated Buildings

2.1.1. Statistics of engineering quantities

In prefabricated buildings, BIM technology is used to build architectural model. Then, the required materials are counted, and the data of the model and the required quantity of materials are extracted and calculated to generate a clear engineering procurement list. Materials are packaged and distributed in different zones according to the needs of different installation areas, which avoids waste caused by on-site material collection and thereby reduces costs [7, 8].

2.1.2. Virtual construction

For the components used in the project, BIM technology is applied to build virtual models. This allows for an intuitive expression of design intentions and component construction methods. Moreover, the created virtual models can demonstrate the actual manufacturing procedures, the sequence of intersections during assembly, and the construction methods at key nodes. Additionally, they help unify standards, thereby playing a guiding role in the execution of construction [7].

2.2. The Application of BIM Technology in Prefabricated Building Construction Projects.

2.2.1. 3D simulation

By creating a model of the construction site using BIM, the on-site conditions at different stages of the construction process can be intuitively reflected. For example, it can show whether the layout of temporary buildings is reasonable, the plan for separating pedestrians and vehicles when construction causes road congestion, the stacking of materials on the construction site, and the positioning of large machinery. By simulating the on-site situation, corresponding adjustments can be made, and the time for site layout can be reduced [5, 9].

2.2.2. Application of Smart Construction Site

A smart construction site platform supported by data from the design and production stages is built. This platform utilizes intelligent technologies. The establishment of this platform enables more accurate and timely data collection, more intelligent data analysis, and more precise prediction of safety issues. Thus, it ensures the quality of the engineering project during construction, guarantees the safety of the construction site, and secures the construction progress [7].

However, China is still in the initial stage of BIM-based model construction, theoretical research, as well as software development and application, and there remains a gap compared with developed countries abroad. Nevertheless, with the continuous development of domestic intelligent construction

technology and the gradual improvement of BIM software, domestic BIM technology is bound to make breakthroughs and be applied in a large number of actual domestic projects [10].

3. The Application of Blockchain Technology in Prefabricated Buildings

Blockchain is a new type of database composed of technologies such as distributed networks, encryption technology, and smart contracts. It is an important part of the new generation of information technology. Characterized by non-falsifiability, full-process traceability, and traceability, it provides technical support for prefabricated buildings [11].

3.1. Storage and transmission of large-volume data files

Compared with traditional construction methods, prefabricated buildings involve additional processes of prefabricated component manufacturing and component transportation. During these processes, a large amount of data is generated, including texts, videos, pictures, and BIM multi-dimensional data. Blockchain can be used to store and transmit such data. Thanks to its smart contracts and openness, blockchain can ensure the permanent storage of information as well as the accuracy and timeliness of traceability [12, 13].

3.2. Protecting data privacy and preventing data leakage

Blockchain is divided into three types based on the size of the participating groups: public blockchain, private blockchain, and consortium blockchain. Public blockchain is completely open to the outside world; private blockchain is highly centralized; while consortium blockchain only allows access to authorized accounts. The use of consortium blockchain can, to a certain extent, maintain data to prevent data leakage and facilitate the exchange of confidential data and information among multiple enterprises [11].

Due to the unique characteristic of prefabricated buildings being composed of different components, they result in a wide variety of components and massive amounts of data, which in turn make information transmission and sharing prone to congestion. Therefore, when blockchain is applied in prefabricated buildings, there is a lack of effective solutions for how to obtain complete and authentic information and data. Thus, building a blockchain platform can adapt to the unique products in construction projects, so as to more quickly achieve the goal of information transmission and sharing for quality traceability [11, 14].

4. Future Trends in Smart Construction Technology

Smart construction technology in China is still in its initial stage. Currently, most of the technologies are imported from foreign countries, and China has been accelerating the development of its own smart construction technology by learning from foreign enterprises' technologies. However, there is a lack of development in basic technologies and support from basic theories. Therefore, it is necessary to explore methods for technological breakthroughs and technology integration. In the future, smart construction technology will embrace broader development prospects. Digitalization and intellectualization will become the core trends in the construction industry. As technologies such as BIM, artificial intelligence, and blockchain continue to mature, and with the application of intelligent systems throughout the entire process of building construction, the construction industry will shift more deeply towards digital development [12, 15].

5. Conclusion

(1) Through the statistics of engineering quantities, BIM technology can accurately determine the required amount of materials, thereby reducing costs in the procurement process. Moreover, by means of virtual construction, before the project starts, it enables the staff to clearly understand the operation procedures and steps, thus playing a guiding role.

- (2) BIM technology enables model-based construction of the site through 3D simulation, allowing for timely handling when situations arise and reducing the time spent on site layout. Furthermore, by applying BIM technology to build smart construction site applications, it achieves rapid data collection.
- (3) The smart contracts and openness of blockchain technology can be used to store and transmit the data to prefabricated buildings. Additionally, they can protect the data privacy between enterprises involved in the project and prevent data leakage.
- (4) Training technical talents can facilitate the development of prefabricated buildings. However, at present, China is still in the primary stage in terms of smart construction technology. Issues such as weak technical foundation, low integration level, shortage of talents, unbalanced regional development, and insufficient attention have led to an unsatisfactory situation of smart construction technology in China.
- (5) In the future, efforts should be made to strengthen the cultivation of talents in smart construction technology, promote research on smart construction technology, break the foreign monopoly on cutting-edge technologies, increase capital investment in smart construction, and improve the problem of unbalanced regional development.

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