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# Analysis of Intelligent Construction Technology of Building Prefabricated Components Based on BIM

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**Abstract**: In this paper, the intelligent construction of prefabricated components is analyzed based on building information modeling (BIM). It includes an overview of BIM-based prefabricated components and intelligent construction, intelligent production lines in BIM-based intelligent construction systems, and analysis of the application of intelligent manufacturing in BIM-based prefabricated components. It was found that the determination of construction goals, the establishment of intelligent construction systems, and the application of intelligent construction systems are all areas that need to be emphasized in producing prefabricated building components through intelligent construction. It is hoped that this analysis can provide some reference for the application of intelligent construction and the improvement of the quality of prefabricated building components.

**Keywords**: Construction engineering; Prefabricated components; Intelligent construction technology

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## 1. Introduction

In the process of manufacturing prefabricated building components through intelligent construction, relevant units and staff first need to be knowledgeable about intelligent construction and fully understand their intelligent production line. Besides, the requirements for manufacturing the prefabricated building components should also be considered. In this way, intelligent construction can be applied appropriately.

## 2. An overview of BIM-based intelligent construction of prefabricated components

### 2.1. Introduction of BIM and intelligent construction

BIM technology is a digital management tool that has been widely used in modern engineering design, construction, and management. It enables the creation of digital, information-based models using specialized software and facilitates the intelligent production of diverse prefabricated components. Intelligent construction involved introducing advanced intelligent technology and other related technologies into building construction. Intelligent construction serves to reduce the dependence on labor, thereby improving the cost-effectiveness,

reliability and safety of building constructions [1]. As intelligent technology develops, the application of intelligent construction technology in the field of modern construction has also been increasing. The application of intelligent construction is especially evident in the manufacture of prefabricated building components, intelligent construction technology.

### 2.2. The advantages of BIM-based intelligent construction in prefabricated component manufacture

As far as the current manufacturing of prefabricated components in construction projects is concerned, the application advantages of BIM-based intelligent construction technology mainly include the following aspects: (i) It can comprehensively transform the extensive production process of traditional building prefabricated components to achieve industrialization, standardization, digitization and Intelligent component manufacturing effect. (ii) Intelligent supervision and management of various process links such as the design, production and application of prefabricated building components can be carried out to ensure the manufacturing and application effects of prefabricated components to the greatest extent and meet the actual application needs of modern construction projects. (iii) It can realize information sharing in each prefabricated component production link, so as to achieve good communication and coordination effects between various organizations and staff. (iv) Through intelligent monitoring and management, significant savings in human resources can be achieved in the production of prefabricated components, and the adverse impact of human factors on production and manufacturing quality can be effectively avoided, thereby saving more manufacturing costs for relevant enterprises. With these advantages, intelligent construction technology has been widely used in the manufacturing and processing of modern building prefabricated components, and its application prospects are also very bright.

## 3. Intelligent production lines in BIM-based intelligent construction systems

### 3.1. Basic overview

In the intelligent construction system based on BIM, the intelligent production line is an integrated intelligent system based on information and physics. Intelligent production lines can integrate the physical construction process and the information computing process, allowing real-time interaction between the two. In this way, a closed-loop system composed of status monitoring, real-time analysis, optimization decision-making, and precise control modules can be formed. With this system, many problems in the production and manufacturing of building prefabricated components can be solved effectively. This not only enables a better allocation of manufacturing resources, but also enables dynamic and intelligent management of the entire prefabricated component manufacturing process.

### 3.2. Main components and functions

The intelligent production line includes several components. (i) Design (BIM): Utilizing BIM technology, the architectural, structural, interior, and mechanical and electrical elements are seamlessly integrated, resulting in the creation of a three-dimensional visual design effect. (ii) Enterprise resource planning system (ERP): ERP involves the management of projects, sales, quality, technology, laboratories, component delivery, procurement inventory, and construction sites. Intelligent decision-making in cost accounting, construction period forecasting, financial management, and other aspects can be made through comprehensive acquisition of all kinds of real manufacturing data. (iii) Manufacturing execution system (MES): MES involves the management production planned orders and production orders. After issuing the production plan, the BIM component

design data will be analyzed and sent to the digital production and manufacturing workshop, thereby realizing the automatic setting of production equipment parameters [2]. At the same time, production line information can also be uploaded to the intelligent decision-making layer to achieve timely feedback and adjustment of production progress. (iv) Digital workshop: Leveraging the computer-aided manufacturing (CAM) system and the supervisory control and data acquisition (SCADA) system for issuing prefabrication instructions, data acquisition, intelligent monitoring, video surveillance, and event notifications, the production process is automated based on the specific design data of prefabricated components. At the same time, all operating data of the automation equipment can be uploaded to the MES in real time. (v) Automated equipment: All equipment on site is controlled through Programmable Logic Controller (PLC) or Computerized Numerical Control (CNC) system to strictly implement various production process instructions or parameters issued by the digital workshop, thereby realizing automated production of prefabricated building components. (vi) Integration of the intelligent production line functions: Cloud platforms and various production factors are horizontally integrated under BIM technology, and various types of intelligent production and manufacturing information are vertically integrated through MES and ERP systems. At the same time, the organic integration between the production line and artificial intelligence can also be achieved, thereby realizing the comprehensive application of intelligent construction.

## 4. Application analysis of BIM-based intelligent construction of prefabricated components

### 4.1. Objectives of BIM-based intelligent construction

There are several objectives of producing building prefabricated components through BIM-based intelligent construction. (i) With the help of industrial IoT, all logistics information in the factory can be traced across the board and controlled. Engineering configuration, component production, and product quality should also offer auxiliary decision-making support for specific component production. (ii) Through the rational application of intelligent and highly integrated information management systems, each segment of the production line can be made more transparent, thereby comprehensively improving the manufacturing process of prefabricated components, and realizing a seamless connection between the production site and operations and sales. (iii) Utilizing production management information services can improve internal control, boost production efficiency, and enhance product quality while reducing manufacturing costs for prefabricated components. This helps achieve the goals of lean production and digital and intelligent production management [3]. (iv) Through the reasonable application of intelligent construction technology and its systems, intelligent production, data visualization, and quality traceability can be achieved.

### 4.2. Establishing a BIM-based intelligent construction system

When manufacturing prefabricated building components through BIM-based intelligent construction, the entire production process of prefabricated components, including the design, simulation, manufacturing, and optimization of BIM-based components all need to be included in the overall framework. In this process, advanced measurement and control technology should also be applied accordingly to build an intelligent data collection and production control system. This integrates the database, data collection, process control, and production management systems in the system. Intelligent algorithms perform real-time analysis and optimization of production data, which is then promptly fed back to the system's operating end.

In the construction of BIM-based intelligent construction systems, an integrated production planning service empowerment model is used for information management. MES and SCADA are used to supervise the

entire manufacturing process of prefabricated building components and all automated production equipment involved, thereby achieving real-time collection of all production data, real-time monitoring of the production process, and intelligent production scheduling, equipment management, and data analysis [4]. With digital twin technology, the production process of components can be visualized, thereby building a high-efficiency, high-quality, and low-cost intelligent manufacturing system for the manufacturing of prefabricated building components.

## 4.3. Applications of BIM-based intelligent construction system

When manufacturing prefabricated building components through a BIM-based intelligent construction system, the intelligent construction of prefabricated components needs to be carried out based on the BIM digital information model, which includes several aspects.

(1) During the overall production process and the operation of each automated equipment, various types of data are collected in real time mainly through the MES system and SCADA system. The production process is continuously monitored, with real-time management of production equipment and quality. Intelligent production scheduling is conducted through real-time statistics and analysis of production data. In this process, data interaction and data sharing can be achieved between various subsystems on the intelligent production line. At the same time, with the help of digital twin technology, the overall production process can be visualized, and the actual operating status of each automated production equipment can also be monitored remotely.

(2) The SCADA system communicates with the access bus PLC in real time through a fieldbus, allowing it to read the status data of the PLC register in each device. This data is used as the basis for a comprehensive analysis of the status of various automation equipment [5]. Simultaneously, the system can write automated production and manufacturing instructions in the PLC register. These instructions guide the PLC to execute the appropriate production equipment operations automatically, thereby achieving the objectives of automated and intelligent prefabricated component production.

(3) In intelligent manufacturing, the MES system acts as the execution center and the ERP system acts as the resource management platform. Through the combination of these two systems, various types of intelligent manufacturing resources can be vertically integrated to further improve the overall operation efficiency and the quality of prefabricated components. The MES system facilitates lean management of all prefabricated component production processes, optimizes resource allocation, digitizes equipment operation, maintenance, and quality management. It is seamlessly integrated with ERP, establishing excellent interoperability across all levels of the intelligent construction system, ensuring comprehensive digital coverage [6].

(4) The EMS system is used as the basis to establish an intelligent construction architecture, and all the functions of project order, quality management, procurement management, equipment management, warehouse management, and finished product yard management are incorporated into a warehouse management system (WMS) and ERP system. This results in the construction of a visual, flexible, and intelligent information production management system for building prefabricated components [7]. In this process, relevant units and staff should introduce the information architecture of manufacturing enterprises from the International Organization for Standardization to achieve seamless integration between BIM systems, ERP systems, MES systems, and other related systems. This will enable the effective application of intelligent construction technology in the production and manufacturing of prefabricated building components.

(5) The MES system serves as the fundamental architecture for establishing a connection between the system and the BIM design end of building prefabricated components. It comprehensively acquires material and process information in line with the specific BIM design plan for prefabricated component production. The system interfaces with the underlying prefabricated component manufacturing equipment, enabling seamless transmission of various production process data. This transmission is based on the control instructions derived from the analysis of component process information, combined with the bottom-level system control instructions provided in the CNC program. The ultimate aim is to achieve flexible production of prefabricated components [8]. Technical personnel should create a data interface within the intelligent production line to establish a connection with the enterprise ERP system. This connection enables real-time data exchange between the intelligent production line and the entire production enterprise, facilitating seamless information integration across the entire production enterprise. As far as the current prefabricated component intelligent management system is concerned, the main components should include authority control, design and research and development, data import, production planning, production supervision, finished product storage yard, logistics and delivery, and report center. Through the reasonable construction and application of this system, the entire production process of modern building prefabricated components can be optimized [9].

(6) Considering the comprehensive construction status of the intelligent production line and leveraging existing research and development achievements, such as the material foundation and quality control system, a digital, automated, and intelligent production management platform will be established for the entire production process of prefabricated components within the construction project.

(7) By using advanced database technology and allowing multiple data systems to work together through effective communication, a close link between the MES and ERP systems can be created. This connection will enable the automation and smart control of the entire manufacturing process for prefabricated components [10]. This can effectively solve various quality problems in the traditional production methods of prefabricated components, improve the production efficiency and quality of the components, and lay a solid foundation for the healthy development of modern construction projects.

## 5. Conclusion

In summary, BIM-based intelligent construction plays an indispensable role in the production and manufacturing of prefabricated components in construction projects. Therefore, relevant units, researchers and technicians must strengthen the research of BIM-based intelligent construction. By aligning it with real-world scenarios and practical production requirements, a well-structured BIM-based intelligent construction system can be established. This will ensure the judicious utilization of each subsystem within the system. In this way, it is possible to achieve the intelligent design and manufacturing of prefabricated components in modern construction projects. Moreover, the manufacturing efficiency and quality can also be maximized, and the actual needs of prefabricated components in construction projects can be met.

## Disclosure statement

The authors declare no conflict of interest.

## References


[1] Cui B, 2023, Technical Application of Intelligent Construction Technology in Railway Tunnel Construction. Railway Construction Technology, 2023(08): 151–154.

[2] Wang W, 2023, Research on the Impact of Intelligent Construction Technology on the Safety Performance of Construction Projects, dissertation, Shandong Jianzhu University.

[3] Teng M, 2022, Analysis of Patents for High-Speed Railway Catenary Intelligent Construction Technology. China Science and Technology Information, 2022(19): 42–45.

[4] Zhang Y, 2022, Research on Construction Management of Prefabricated Buildings Based on Intelligent Construction Technology. China Construction Metal Structure, 2022(07): 131–133.

[5] Zhao W, Liu H, 2022, BIM Technology Helps Construction Enterprises Upgrade Intelligent Construction Management. Construction Enterprise Management, 2022(07): 50–52.

[6] Linghu Y, Ni Y, Su Y, et al., 2022, Research and Application of Intelligent Construction Technology of Industrialized Building Information. Construction Science and Technology, 2022(7): 125–128.

[7] Jiang H, Liu P, Zhu J, et al., 2022, A Review of Automated Production Process and Technology of Bridge Prefabricated Component Steel Skeleton. Shanghai Construction Science and Technology, 2022(6): 40–43 + 51.

[8] Liu J, Xiao W, Wei J, et al., 2022, Research on Automatic Assembly Process of Prefabricated Underground Building Structural Plate Components. Municipal Technology, 40(11): 1–5 + 65.

[9] Li S, Liu Z, Liu C, et al., 2022, Important Progress has been Made in Key Equipment Technology for the Production of Prefabricated Components for Prefabricated Buildings. Management and Research of Scientific and Technological Achievements, 17(7): 75–76.

[10] Sun Y, Zhang Y, 2021, Thoughts and Innovative Research on Intelligent Construction of Prefabricated Buildings. China Residential Facilities, 2021(8): 47–48.