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# Research on Comprehensive Benefit Analysis Method of Prefabricated Buildings Based on BIM and RFID Technology

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***Abstract:***

There are safety problems among mechanical equipment, prefabricated components and construction personnel during the construction of prefabricated buildings. We use building information model and RFID technology to build a prefabricated building safety early warning platform. Firstly, through the demand analysis and system function design of the security early warning platform. Through the accident tree analysis of the dangerous sources of prefabricated building construction, it is obtained that the dangerous sources of prefabricated building construction are the unsafe behavior of people, the unsafe state of objects and the unsafe environment. Then we established three subsystems of security early warning platform based on BIM and RFID technology: data collection subsystem, data transmission subsystem and security early warning subsystem. At the same time, we display the corresponding area in red, green and yellow in the BIM model. The results show that the combination of RFID technology and BIM can quickly and accurately provide early warning of dangerous sources in the construction of prefabricated buildings.

***Keywords****: Prefabricated Building; BIM Technology; RFID Technology; Schedule Management.*

## I. INTRODUCTION

In March 2017, the "13th Five-Year Plan" Prefabricated Building Action Plan issued by the Ministry of Housing and Urban-Rural Development pointed out that by 2020, the proportion of national prefabricated buildings in new buildings will reach more than 15%, of which the key areas will be promoted. 20% or more, more than 15% in actively promoted regions, and more than 10% in encouraged regions. In the context of Chinese vigorous promotion of prefabricated buildings, researches on prefabricated buildings are also emerging one after another. The prefabricated building is different from the traditional cast-in-place structure building. It produces building components in an industrialized assembly line mode, and then transports them to the construction site through transportation equipment [1]. The final assembly process is similar to building blocks. This change in production mode makes the progress goals of prefabricated buildings very different from traditional methods, and there is not much research on the content and methods of prefabricated building progress management.

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To obtain the actual progress of the construction site, on-site personnel are required to collect information, and then compare the data with the planned progress. This method cannot check the construction progress anytime and anywhere, adjust the network plan in time, and control the construction speed in time, which is not conducive to refined management. The prefabricated building construction is an industrialized construction. The construction site is very limited, and there can be no shortage of certain components or excess of some components. Therefore, the progress control of the assembly construction requires both rhythm and refined management. Radio Frequency Identification (RFID) is a non-contact communication technology that can remotely read radio waves. It can identify specific targets through radio signals to identify the EPC code of an electronic tag. The use of RFID technology can accurately identify and locate the specific location of components, track and locate prefabricated components, and automatically collect data to achieve progress collection anytime, anywhere. Building Information Modeling (BIM) technology is the latest technology in the development of information technology in the construction industry. It can transmit the information of components from the design stage to the construction stage, and then to the operation and maintenance stage. has been widely used. The integrated application of RFID and BIM technology can control the progress management of prefabricated buildings in real time [2]. At present, there are few studies on the application of BIM-RFID technology to the production quality control of prefabricated components of prefabricated buildings. This paper will combine the production characteristics and quality requirements of prefabricated building components, discuss the application of BIM-RFID technology to the quality management process of component production, and establish an optimized quality management process to improve the production quality and management efficiency of components.

## II. PROCESS FLOW AND QUALITY INFLUENCING FACTORS OF COMPONENT PRODUCTION

Quality management activities run through the entire technological process of component production. Clarifying the technological process of component production has an important impact on determining the quality influencing factors and establishing a targeted quality control process. Through on-the-spot investigation of several prefabricated component production plants in China, combined with the production characteristics of prefabricated components, the process flow of component production is summarized as shown in Figure 1 (the picture is quoted from Integration of BIM and Energy Consumption Modelling for Manufacturing Prefabricated Components: A Case Study in China). Different types of prefabricated components have some differences in the process flow, but it does not affect the research on quality management [3]. According to the production characteristics of the factory and combined with the quality management requirements, the component production process is divided into the preliminary preparation stage, the component production and inspection stage, the stacking and transportation stage, and the operation and maintenance stage. In the preparatory stage, it emphasizes the mastery of technology, the procurement and inspection of materials, and the establishment of labor organizations; the component production and inspection stage emphasizes the strict quality control of each production link and the inspection and maintenance of finished products; the stacking and transportation stage emphasizes based on the external environment. The formulation and implementation of the management plan under the conditions of the component itself; the operation and maintenance stage emphasizes the transmission

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and extension of the component quality information, and realizes the management of the component's full life cycle.

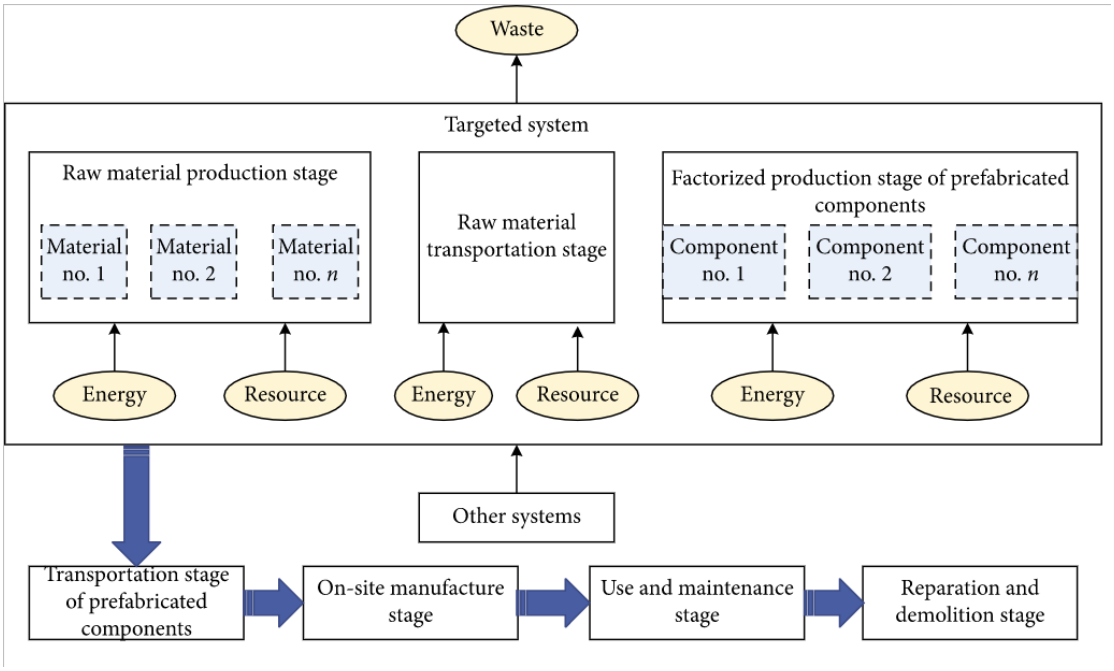


**Fig.1 Production process flow of prefabricated components**

## III. ANALYSIS OF HAZARD SOURCES IN THE WHOLE PROCESS OF PREFABRICATED BUILDING CONSTRUCTION

### 3.1 Scenario analysis of safety accidents at the construction site of prefabricated buildings

In the safety accidents of prefabricated buildings, there are many factors that affect people's unsafe behavior, such as construction workers' lack of awareness of safety hazards, managers' inadequate safety management of construction sites, and poor psychological conditions of construction workers. Factors affecting the unsafe state of objects include excessive weight of prefabricated components during the hoisting process, resulting in decoupling of components, unsecured installation of temporary support systems, resulting in component sliding, instability, and unreasonable transportation routes for prefabricated components [4]. Unsafe environments include unreasonable layout of the construction site and climate reasons. When the three motion trajectories cross, it will lead to the occurrence of security risks. Figure 2 is the trajectory of the safety risk of prefabricated buildings (the picture is quoted from Supply Chain Management for Prefabricated Building Projects in Hong Kong). Among them, improper management of managers is the basic cause of construction accidents of prefabricated buildings. Insufficient safety knowledge, lack of safety awareness and lack of safety habits of construction personnel caused by improper management are indirect causes of construction accidents; The unsafe state and unsafe behavior of people are also indirect causes of construction safety risks.

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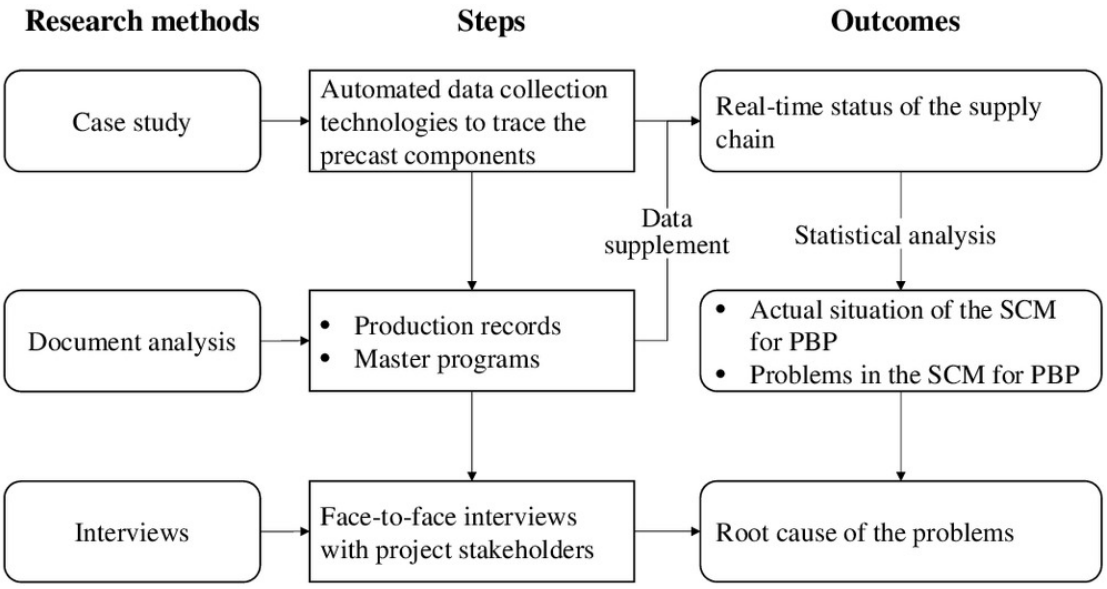


**Fig. 2 Development trajectory of prefabricated building construction accidents**

### 3.2 Analysis of Hazardous Sources in Prefabricated Building Construction

In order to more systematically analyze the hazard sources of prefabricated building construction, according to the literature analysis and summary, the hazard sources that affect the safety of prefabricated building construction are obtained [5]. According to the accident tree analysis of the conditions (see Figure 3, the picture is quoted from Risk Assessment of a Battery-Powered High-Speed Ferry Using Formal Safety Assessment), there are three factors that lead to the safety risk of prefabricated building construction: human insecurity Factors, unsafe factors of objects and unsafe environment, only the simultaneous occurrence of these three risk factors will lead to the occurrence of safety risks, so these three events are AND-gate relationships.

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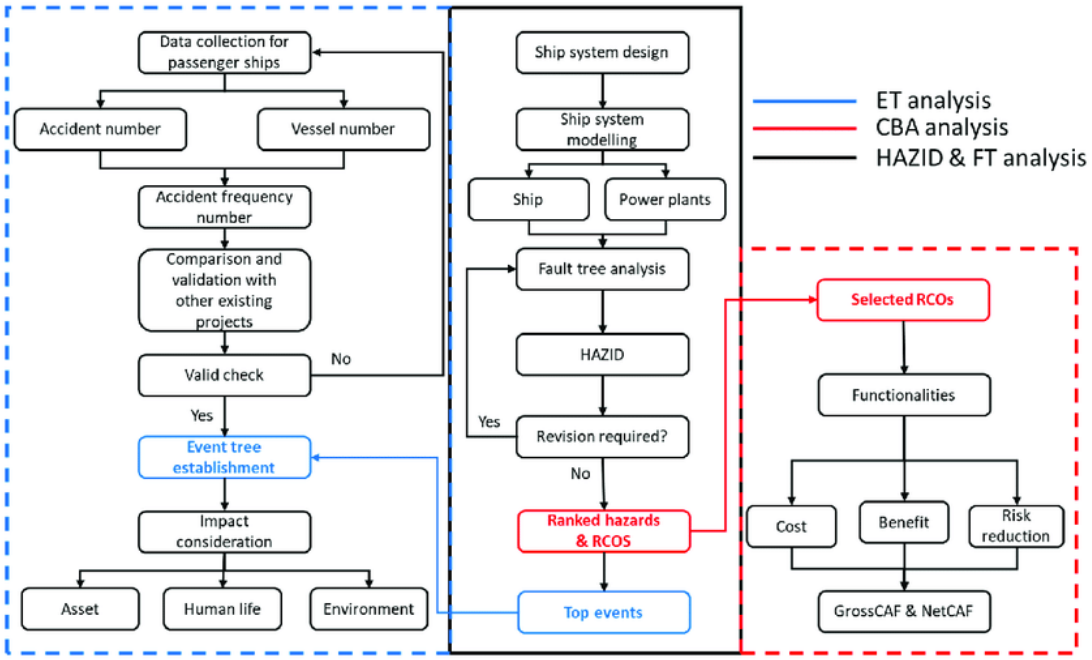


**Fig. 3 Accident tree of prefabricated building construction hazards**

## IVAPPLICATION OF BIM-RELATED INFORMATION TECHNOLOGY

A production management platform combined with a multi-dimensional visual information model is an important way to achieve efficient management. Use BIM technology to carry out the detailed design of prefabricated components, form a component production information model, and link with the management system to form a basic component production database; use RFID and 3D scanning technologies to track and record the information in the component production process in real time, and feed it back to production management. In this system, production managers can scientifically and effectively control all aspects of component production. Figure 4 is a diagram of the application of related information technology in the production stage of prefabricated components (the picture is quoted from A Framework for Prefabricated Component Hoisting Management Systems Based on Digital Twin Technology).

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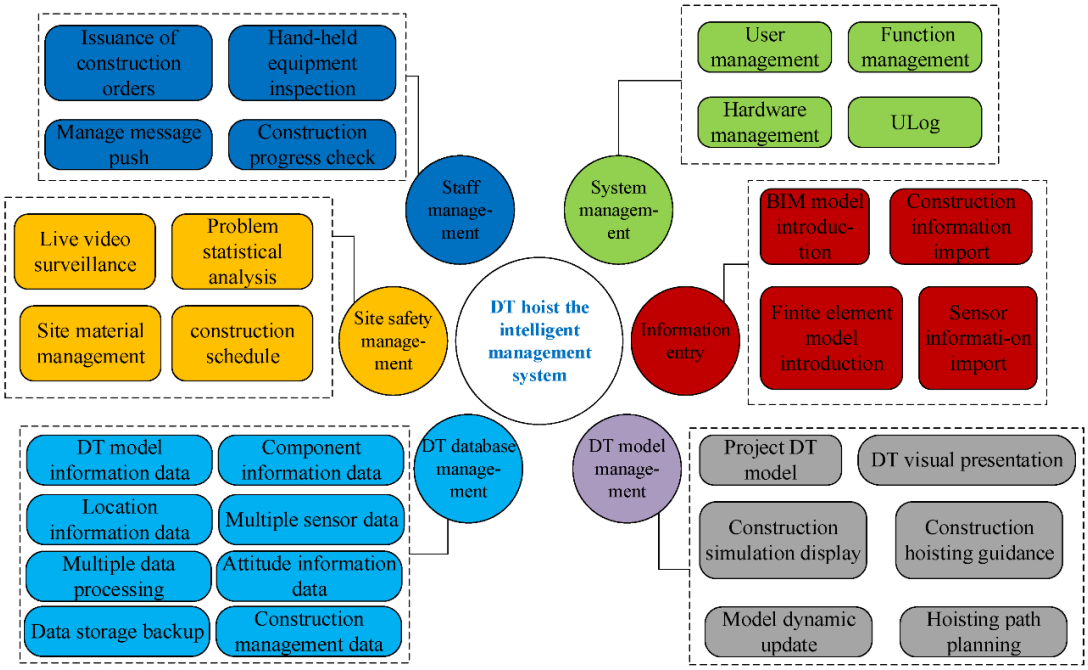


**Fig. 4 Correlation diagram of the application of related information technology in the production stage of prefabricated components**

### 4.1Establishment of component production process model based on BIM technology

Give full play to the advantages of BIM technology, such as synergy and visualization, to carry out the preliminary design and detailed design of prefabricated components, and store the production information of prefabricated building components with the BIM model as the carrier. Visually express the information in the production process and support information sharing among all participants. According to the requirements in the actual production process of the components, the geometric dimensions of the components, the location of the steel bars and the embedded parts are further designed to form the component production process model [6]. All production-related information can be extracted from the BIM model, allowing production managers to manage production information intuitively and quickly. Secondly, when connecting with the ERP system, the BIM model can be used as the basic data for production management calculation and interaction, which significantly reduces the user's data entry workload in the ERP management system.

### 4.2Real-time tracking of component production with the help of RFID technology

The application of RFID technology generally requires related equipment components such as transponders, readers, middleware and software systems. In the field of prefabricated buildings, for the production of prefabricated components, it is mainly used for information collection and tracking such as incoming inspection of prefabricated components, production process tracking, quality inspection feedback, and stacking management. Compared with traditional quality management, it is more efficient in automated data collection and information management, and ensures the integrity of information

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throughout the production process. The problems in the actual use process mainly include: the adhesion problem of the label, which is easy to be damaged if it is directly pasted, and inconvenient to read or replace if it is embedded in the component; the identification problem of the label, there is misreading or multi-reading. In the actual production process at this stage, in order to improve the recognition rate and reduce the cost of labels, the information is stored in the form of two-dimensional codes.

### 4.3Use 3D scanning technology to automatically detect the production quality of components

3D scanning technology obtains point cloud information of physical objects through scanning, and uses algorithms to achieve denoising and rapid reconstruction of model surfaces. Match the BIM model of the component with the reconstructed model of the component, and check the allowable error according to the comparison, so as to realize the automatic inspection of the production quality of the component. Due to the low degree of automation in factory production and the high cost of applying scanning technology, there is less research on the application of 3D scanning technology in the production stage of prefabricated building components at this stage.

### 4.4Prefabricated component production management information system

Through the combination of BIM and ERP, an integrated data-based prefabricated building information interaction platform is established to carry out information-based integrated management and prefabricated component tracking management for the production process of prefabricated components, so as to improve management efficiency and benefits. The production management system mainly includes management modules such as workshop information, orders, production progress, production quality, inventory, workshop report and process production [7]. Using the production management system can include: component production plan management; component production labor, material and machinery management; component production cost management; component production schedule management; component production quality management; component inventory management and component delivery management.

## V. COMPONENT QUALITY BASED ON BIM-RFID TECHNOLOGY

The production process of prefabricated components of the management information system has the characteristics of complex procedures, large number of products, many types of finished products, many process information, and high requirements for staff collaboration, which determines that components not only need a large and complete data information system for quality management At the same time, the information in the database should also meet the timeliness and convenience of updating with the progress of the production process, which is the focus of the quality management of the entire component. BIM technology and RFID technology have outstanding advantages in this regard. By building a comprehensive service system integrating rapid identification, data collection, and information transmission, component tracking and information sharing can be realized, and the traditional inefficient management mode can be changed.

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This paper realizes the information automatic exchange system by integrating BIM technology and RFID technology. In this system, BIM technology provides a quick and easy method for information retrieval through the model interface. However, as the complexity of the BIM model changes and the number of component units increases, it is a tedious and time-consuming task to identify and record building component units. At this time, RFID technology is introduced, through the read and write functions of RFID tags and readers Simplify the information entry operation, improve the efficiency of information collection, and strengthen the traceability and transparency of components. The combination of these two technologies automates the exchange of information and promotes the seamless connection of information between building component entities and the BIM database.

The interactive integration environment in the RFID-BIM data information system is shown in Figure 5 (the picture is quoted in Visualization of Component Status Information of Prefabricated Concrete Building Based on Building Information Modeling and Radio Frequency Identification: A Case Study in China). The system consists of BIM model, BIM database, computer application system, RFID tag information and RFID reader. The BIM model includes the architectural BIM model obtained from the design unit and the BIM model produced by the component manufacturer. The former is the refinement of components. Production provides blueprints, the latter provides help for component production management, and both can generate BIM databases to facilitate information exchange and sharing.

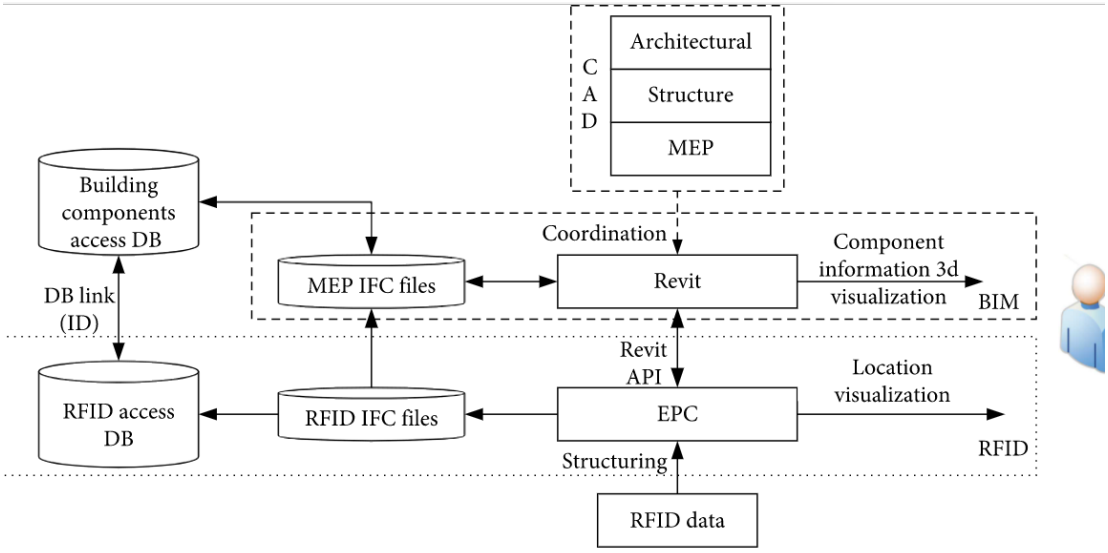


**Fig. 5 BIM-RFID information system interactive integration environment**

The automated information flow in the BIM-RFID environment is shown in Figure 6 (the picture is quoted from Integrated BIM and VR for Interactive Aerodynamic Design and Wind Comfort Analysis of Modular Buildings). The application system reads and writes the RFID tag information through the RFID reader and writer. It realizes component positioning and information collection, and transmits the information to the BIM database through the computer interface. The BIM database and the BIM model are bidirectionally associated, thus realizing the seamless connection between physical information and data information.

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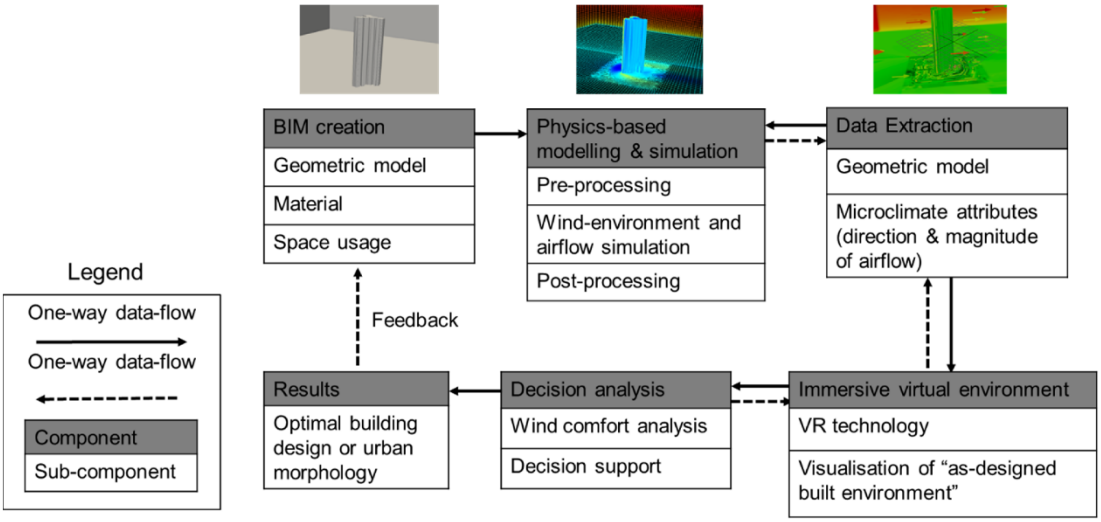


**Fig. 6 Automated information flow in a BIM-RFID environment**

Technology introduction based on component production process flow, using RFID technology to read and write data information and the integration advantages of BIM technology model and parameters, to build a comprehensive service system BIM-RFID data information system integrating rapid identification, data collection, and information transmission As shown in Figure 7 (picture quoted from RFID Integration in BIM and Material Handling).

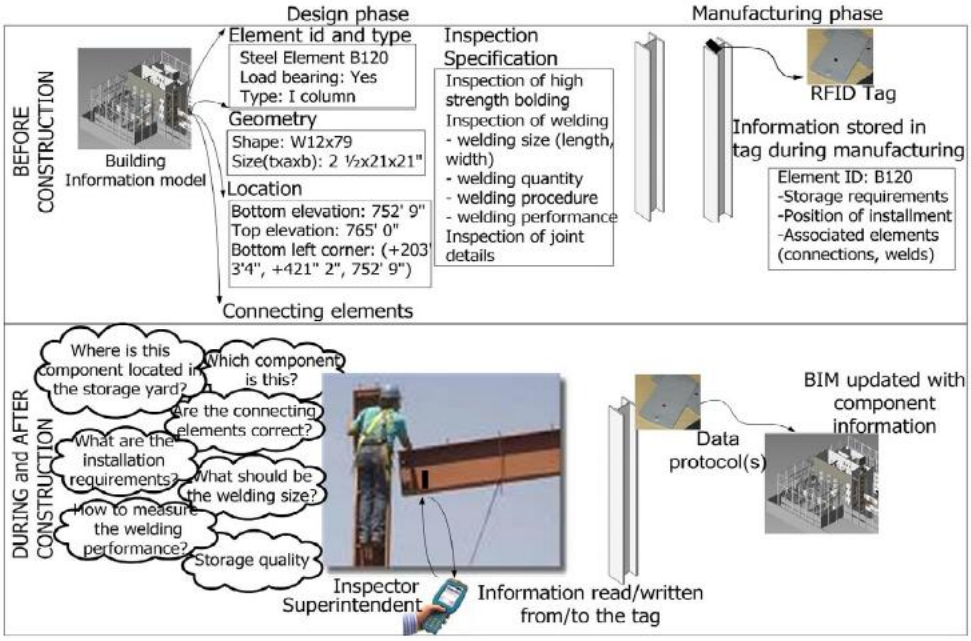


**Fig. 7 BIM-RFID data information system**

The BIM-RFID data information system includes six subsystems: basic information system, label management system, quality supervision system, progress control system, positioning tracking system and operation and maintenance system. The information between each subsystem is crossed, and different

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access rights are set for different categories of workers, and the relevant personnel can only read and query the data within the scope of rights.

## VI. APPLICATION EXAMPLES

This project includes many high-rise buildings and small high-rise buildings, and is a community built in an industrialized way. The project adopts a prefabricated shear wall structure, and the industrialized parts include external walls, internal walls, floors, balconies, air-conditioning panels, stairs, and lightweight internal partition walls. The project has realized the standardization of design, factory production of parts, on-site construction and assembly, integration of structural decoration and management informatization. The project has created a whole-process collaboration platform based on BIM, integrating all aspects of industrialized housing construction on the same visual service platform, realizing the mutual transfer of relevant data between design, component production and construction, and timely correction [8]. To achieve the purpose of scientific management and control of the quality, construction period and cost of the project, and effectively improve the construction quality and construction efficiency of the project. The system includes three subsystems: BIM design management, component production management, and assembly construction management, serving design units, component production units, and construction units respectively. The system flow is shown in Figure 8 (the picture is quoted from Collaborative Working in a BIM Environment (BIM Platform)).

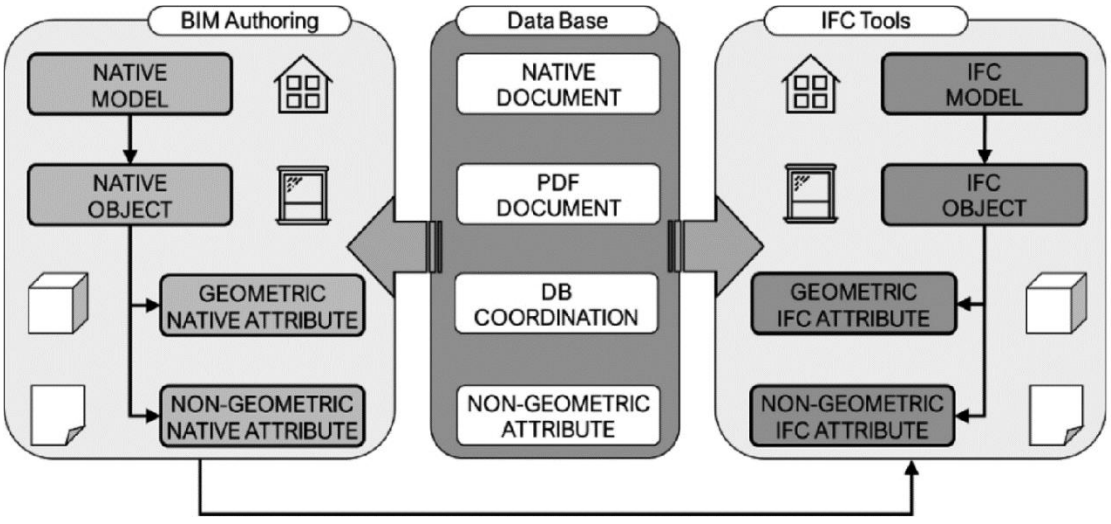


**Fig. 8 Process of BIM Collaboration Platform**

The application of BIM technology in the entire construction process of design, production and construction provides a strong guarantee for the smooth completion of the project. Valuable engineering experience has been obtained in the following aspects, and it has been proved that BIM technology can help improve the level of construction management.

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### 6.1 Application and beneficial effects of construction preparation stage

The project makes full use of the three-dimensional visual effects of BIM to guide formwork processing, steel bar cutting, embedded parts installation, component production and installation in the construction process. BIM technology was used to simulate construction and detect collisions, and a number of technical difficulties were discovered and solved in advance, such as assembly construction process, node reinforcement arrangement, collision between pipelines and civil parts, etc., which ensured the accurate production and installation of prefabricated components.

### 6.2 Applications and beneficial effects of component management

Component control is mainly applied in the production management subsystem and assembly construction management subsystem in the BIM platform. Including project information, contract management, customer information management, component management, mold management, plan management, stacking management, production statistics, mobile terminal production inspection records, remote production line monitoring, automatic QR code printing, real-time query of steam curing data, steam curing Data quality traceability, comprehensive query of components, management of component entry and exit, mold table identification management, component construction information management, component identification, various production reports, real-time monitoring at each stage, real-time monitoring of project completion, and component operation and maintenance management. module. According to the production characteristics of prefabricated concrete components of prefabricated buildings, the quality control methods are solidified in the system, and RFID technology is used to realize traceability management of components such as production inspection, transportation and storage, and inspection records can be recorded in real time through handheld terminals and network access according to authority. Review and sign; real-time recording of mixing, temperature control, project production progress, production line operation, yard usage, completion of yard usage plan and site demand plan, and the year, month and day of completion based on the aforementioned records production statistics.

### 6.3 Application and beneficial effects of construction schedule management

During the construction process of the project, real-time demonstration, monitoring, management and statistics are carried out through the BIM collaborative platform. For the interspersed and resource allocation of important working conditions in the construction process, BIM visualization technology can be used to simulate, and then the feasibility of the entire project can be identified. At the same time, the construction of collaboration and integration platform is carried out, and various information is gathered together through the BIM model, so as to realize the understanding of relevant information at any time. The real-time visual progress interface of the project is shown in Figure 9.

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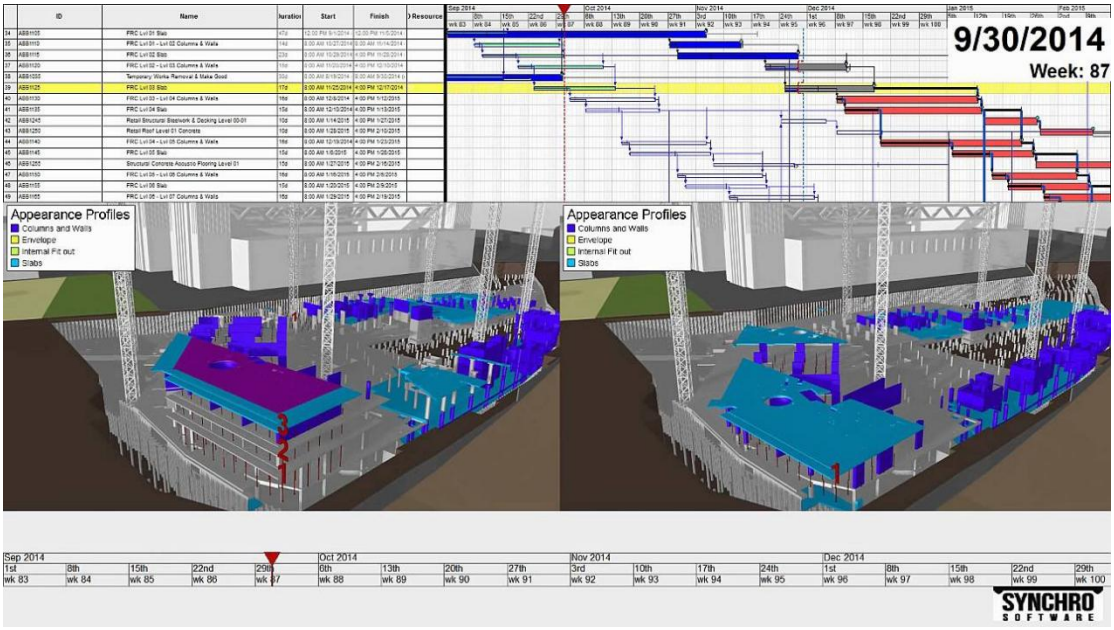


**Fig.9 Schematic diagram of construction progress simulation**

### 6.4 Application and beneficial effects of dynamic site layout

Before the components enter the yard, the BIM model is used to arrange the yard in advance, the yard is divided according to the area[9], and each partition is divided into classified storage areas. After the components are shipped from the factory and transported to the construction site, the construction personnel use the handheld scanner to scan the components, and all the information of the components can be seen at a glance, check the storage information of the components, and confirm the completion of the storage[10]. This process is similar to the scanning principle of "QR code" in supermarkets. The auxiliary function of "QR code" makes construction easier and more convenient. 6.5 Application and beneficial effects of construction cost management In the cost accounting process, with the help of the BIM collaborative platform, the rapid extraction of data information is realized, the workload is reduced, and the work efficiency is improved. At the same time, because BIM technology finds and solves a lot of technical difficulties in advance, it avoids a lot of work and rework, and also brings considerable time and economic benefits[11].

## VII. CONCLUSION

With the continuous development of prefabricated buildings, the management of prefabricated component hoisting operations is not in place, and the lack of accurate positioning and installation of informatization is becoming more and more obvious. The combination of BIM technology and RFID technology is applied to the precise positioning and safety management of component hoisting operations. Provide scientific guidance for hoisting operations. Through research, it is found that BIM and RFID technology can solve some data related to prefabricated buildings and real-time location tracking and monitoring problems, ensure the accuracy and timeliness of information transmission, and realize

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information sharing. The effective application of BIM and RFID technology in the management of the component hoisting process can realize the rapid installation, positioning and tracking and retrieval of components. The safety management level of component hoisting is improved, and safety accidents at the hoisting site are avoided. It has a positive role in promoting the development of Chinese construction industry.

## REFERENCES

[1]. Jiang Lin. Exploration and Analysis of Prefabricated Building Modeling Method Based on BIM Technology. Engineering Seismic and Reinforcement Reconstruction, Vol. 42(2020) No.1, p. 22-29.
[2]. Sun Bing. The application of BIM technology in the design of prefabricated building structures. Building Structure, Vol. 50(2020) No.13, p. 17-19.
[3]. Yue Naihua, Yu Dehu. Research on the tracking management of prefabricated building components based on BIM and QR code technology. Construction Economics, Vol. 41(2020) No.4, p. 59-62.
[4]. XieLinlin, Chen Yajiao. Research on intelligent management platform for prefabricated building project scheduling based on BIM + digital twin technology. Construction Economics, Vol. 41(2020) No.9, p. 55-59.
[5]. Ma Hui, Zhang Hongbin, Wang Yanna. BIM-based work space conflict identification for parallel construction of prefabricated buildings. China Safety Production Science and Technology, Vol. 16(2020) No.2, p. 77-82.
[6]. Kou Yuanyuan, Liu Kai. Research on refined construction management of prefabricated buildings based on BIM technology. Journal of Engineering Management, Vol. 34(2020) No.6, p. 64-67.
[7]. Lin Shenzheng, Luo Hengyong. Research on cost control of prefabricated buildings based on the integration of BIM technology and neural network. Construction Economics, Vol. 42(2021) No.2, p. 44-51.
[8]. Zhao Jiamin, Chen Jin, Chen Yonghong. The application of BIM technology in the design of prefabricated buildings. Building Structure, Vol. 51(2021) No.4, p. 11-15.
[9]. Wu Jingya.Optimization application of BIM technology in the whole process cost management of engineering. New Industrialization, Vol. 24(2021) No.3, p.72-75.
[10]. Yang Zhiming, Feng Yixi, Zhao Xiaoming.Application and discussion of BIM technology in the whole process cost management. China Building Materials Science and Technology. Vol. 14(2021) No.2, p.56-59.
[11]. Long Yinhui. Discussion on the whole process cost management idea based on BIM. Real Estate World, Vol. 12(2021) No.3, p.213-216.