Analysis on the Application of BIM and RFID in Life Cycle Management of Prefabricated Building

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Abstract. In the whole life cycle of prefabricated building construction, the application of BIM and RFID technology can solve the problems that traditional architectural design and construction methods cannot solve, by improving the precision and efficiency of architectural design and construction and guaranteeing the construction quality of buildings. In this paper, the application value of BIM and RFID technology in the whole life cycle of fabricated buildings is systematically analyzed. And this article explores the methods for participants to edit the building information model in a timely manner and the technical system for communicating and connecting information data at each stage. Finally, it provides theoretical support for the development of life cycle management of prefabricated buildings.

1. Introduction
A prefabricated building is a building technology system in which some or all of the components are prefabricated at the factory and then transported to the construction site for assembly. In recent years, the technology level of our country's prefabricated buildings is constantly improving and the scale of construction is constantly expanding. The newly built area of prefabricated buildings in China increased from 73.6 million square meters in 2015 to 290 million square meters in 2018 (accounting for 13.9 percent of the newly built area), with a compound growth rate of 59 percent.

Compared with the traditional construction system, the prefabricated building has the advantages of mechanization of assembly, standardization of design and industrialization of component production, which can greatly shorten the construction period, improve component accuracy and quality, and minimize environmental pollution by complying with green building design and construction standards. However, there is still a problem to be solved in prefabricated buildings: the incremental costs of prefabricated components brought by the application of prefabricated buildings is still higher than the drop in labour costs, the overall design planning ability is poor, the technical level of building parts and supporting materials is not high; the precision and standardization of production are not enough, and the construction management system does not match the prefabricated building construction; there is no diversity in the appearance and style of the building.¹¹

In today's fabricated construction industry, technical research is mainly focused on structural engineering fields such as component production process, structural mechanic analysis and on-site assembly technology. Engineering management technology lacks technological innovation and mature management systems for fabricated buildings. The problems encountered in the development of prefabricated buildings in China are more due to engineering management problems caused by inaccuracy and inaccurate information flow between the various stages and participants. For example, in the component manufacturing and assembly stage, construction collisions and dimensional errors
due to the lack of an integrated building information model can lead to waiting for work at the manufacturer and the installation site, extending construction time and increasing construction costs.

In response to the above problems, Building Information Modelling technology can provide a platform for each participant and each stage to extract and edit engineering materials in a timely and accurate manner. The Radio Frequency Identification technology can perform information collection, transmission and feedback control based on the BIM platform to achieve the connection between the virtual information model and the engineering reality, thus playing an active role in project management.

2. Introduction to BIM and RFID technology

2.1. Definition and characteristics of BIM

Building information modelling (BIM) is a process involving the generation and management of digital representations of physical and functional characteristics of a facility. The resulting building information models become shared knowledge resources to support decision making about a facility from earliest conceptual stages, through design and construction, through its operational life and eventual demolition.[2] Broadly speaking, BIM is a management information system that collects production and management data throughout the life of a project. Compared to traditional 2D design drawings, BIM has the following characteristics:

- The 3D stereo model established by BIM software is the final result of the design. The corresponding flat plane, 3D model and other drawings of the model are exported from the BIM model.
- Each component model is a collection of data, so that the data information of the same component can be consistent and can be edited collaboratively.
- The model information is bidirectionally related. When a component information changes, the associated component information changes accordingly. For example, if the bolt is offset by 1 mm, the hole on the joint plate will also move by 1 mm.
- The application of the BIM model runs through the entire life cycle, and the model information can play different roles in different stages such as planning and design, construction management, and operation and maintenance.

2.2. RFID technology

Radio Frequency Identification (RFID) is a technology that uses radio frequency signals to automatically identify specified objects and obtain related information. It usually includes the RF part of the front end and the computer information management system in the background. The radio frequency part is composed of an electronic tag and a reader/writer. The electronic tag has a chip, and the tag and the reader/writer exchange information through electromagnetic waves of a specific frequency.[3] At present, electronic tags that store key information of components are placed on prefabricated components, which can be used for logistics and warehouse management of construction projects.

3. Analysis on the Application of BIM and RFID in Building Life Cycle Management

Building Lifecycle Management (BLM) will refer to the way and strategy of combining the various stages of the project process and managing them in a unified manner. There are fragmented data and information at all stages of the construction project: in the design and decision-making stage, there is a large amount of cost and design information; in the implementation stage, in addition to the information transmitted from the design and decision-making stages, a large amount of material consumption is also generate; in the operation and maintenance phase, it is necessary to create information such as space utilization and equipment maintenance based on construction and design information. Therefore, to implement BLM, it is necessary to establish a management system that communicates the information of each participant and each stage of the construction project to prevent
the lack of effective and timely connection and transmission of information at various stages of the life cycle.

3.1. BIM is the key technology to solve the existing problems of Building Life Cycle Management
BIM technology can create models and data that is consistent and bidirectionally linked throughout the building process. In view of the problems at the current stage of the BLM concept, projects using BIM technology can achieve efficient and accurate delivery of data and model information throughout the life cycle and the collective extraction, editing and management of data by all participants. In order to achieve the lossless transfer of information to the next stage and the coordinated management of engineering data without time difference, BLM must use BIM as its key technology to solve existing problems.

3.2. Application value of BIM and RFID technology
There are two main factors affecting the progress, cost and quality of the project: 1. The planning and design plan conflicts with the actual construction. 2. The collaborative management of engineering information cannot be synchronized in real time. For example, when the construction activities are carried out according to the design scheme, the problems such as pipe network collision and incomplete information of the scheme will result in on-site sabotage and construction errors in the construction site; And using the traditional paper report to collect the data of material consumption and construction progress will lead to delayed information transmission and feedback and even affect the construction progress.

The value of BIM and RFID technology in BIL integration is that it can solve the core problems in construction management - real-time progress updates and timely analysis. For the first problem mentioned above, BIM can provide a building information model that integrates design information of various professions. With this model, engineers of different professions can detect construction collisions to achieve coordinated work. For the second problem, RFID technology can transfer the construction progress and material consumption information collected at the construction site to the BIM model. This will enable a realisation of the connection between data simulation systems, ensuring the synchronous management of engineering information.

4. Application Strategy of BIM and RFID in Life Cycle Management of Prefabricated Building
According to the characteristics of the prefabricated building, the construction phase should be split into the prefabricated component production stage and the site construction stage system management. That is, information such as Prefabricated component detail and design parameters, Prefabricated component production schedule, and Warehousing and logistics process management of prefabricated components of the Prefabricated component production stage are connected and fed back and forth with BIM and RFID technologies. The system framework for the application strategy of BIM and RFID in life cycle management is shown in the figure below.
In the planning and design stage, the problems in the traditional design mode, such as the difficulty of collision detection and the complexity of multi-disciplinary collaborative design, can be solved by BIM technology. Based on the concept of parameterization, bidirectional association, and real-time collaboration, BIM technology can aggregate information such as each professional design plan, construction management plan, and collision check report into the same building information model.

At the prefabricated component production stage, an RFID tag containing various kinds of information of the prefabricated components is placed at a suitable location on the component. After the Reader identifies the RFID tags in key points such as warehousing, transportation, and construction hoisting, the actual information can be quickly aggregated to the BIM platform. The BIM platform can deliver the aggregated information to all stages and participants in real time to achieve the goal of fine management of zero inventory.

At the site construction stage, RFID technology can track the progress of the construction by summarizing the location and quantity information of the components, and then connect to the BIM construction simulation system via a wireless network. In this stage, the combination of RFID and BIM can be used to accurately collect and transmit information without human intervention. For example, when an accident occurs at the construction site and the construction progress is delayed, the RFID technology can transmit the actual situation and related data to the BIM construction schedule simulation system in real time, so that the construction company can adjust the construction progress and respond in time.

In the operation and maintenance stage, in addition to the application of RFID technology to the equipment monitoring and access control system, it is also possible to judge whether the component is load-bearing or recyclable according to the information in the RFID tag and the BIM database when the building is modified or constructed.

5. Conclusion
Both BIM and RFID technologies are important technological innovations that drive the development of the construction industry. BIM technology can provide a platform for all participants and stages to extract and edit engineering materials in a timely and accurate manner; And RFID technology can connect virtual information models with actual conditions of the construction project.
combination of the two technologies is transformative for the Life Cycle Management of Prefabricated Buildings. This paper proposes the system framework for the application strategy of BIM and RFID in life cycle management, and hopes to explore the application value and strategy of BIM and RFID technology in engineering management. Guided by the 2016-2020 Construction Industry Informatization Development Outline, BIM and RFID technologies will be applied more comprehensively and deeply to the Life Cycle Management of Prefabricated Building.

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