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Application of BIM Technology in Building Operation and Maintenance Management

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Abstract: *The operation and maintenance stage is the longest key stage in the whole life cycle of a construction project. In this stage, not only a large amount of data information needs to be processed, but also many aspects such as building safety, space and equipment maintenance need to be considered. Compared with the stage of building design and construction, its management is more difficult. To solve this problem, this paper introduces BIM technology into the operation and maintenance management stage, and elaborates the application of BIM technology in five aspects in the operation and maintenance management stage in detail. Finally, it studies the actual situation of BIM technology application in the operation and maintenance stage by swot analysis, which is of practical significance to promote the application of BIM technology in building operation and maintenance management, and will further promote the in-depth popularization of BIM and maximize its value.*

Keywords: *BIM technology, operation and maintenance management, swot analysis*

1. Introduction

At present, the building operation and maintenance management is more of a process of "integrating personnel, technology and facilities, dividing and integrating building space, allocating human resources, and maintaining and managing facilities, with the aim of meeting the needs of users, improving operation and maintenance efficiency and reducing operation and maintenance costs." [1] Although the operation and management mode is relatively mature, there are difficulties in solving the problems such as increasing cost, increasing difficulty of artificial management mode, and coping with sudden disasters. Building information modeling (BIM) is the product of the construction industry that should be born with the information of the times. This technology was first proposed by Autodesk Company in 2002. Essentially, it is based on 3D digital technology and related to all engineering data information in the whole life cycle of mobile port, PC port and computer port integration construction project, so as to realize information integration and sharing among different participants, different application stages and different application softwares in the process of project construction. It has the characteristics of visualization, coordination, optimization, simulation and plotting. Therefore, the combination of BIM technology and operation and maintenance management has become the main research direction of current scholars.

At present, the research on the application of BIM technology to operation and maintenance management in China is still at the initial stage. At present, there are interactive BIM equipment and facilities operation and maintenance management model [2], theoretical model combining radio frequency identification (RFID) with BIM 3D technology [3], BIM-FIM 2012-based electromechanical equipment management system [4], simulation combining BIM technology with Pathfinder software, etc. However, at present, the research on BIM technology in the operation and maintenance stage is still less. Therefore, this paper sorts out the current application of BIM in the operation and maintenance stage, and makes an empirical study on the application status with SWOT analysis method, in order to provide some theoretical basis for BIM technology to further improve the operation and maintenance efficiency, reduce investment cost and form a unified standard.

2. Application of BIM technology in building operation and maintenance management

The application of BIM technology in building operation and maintenance mainly includes five aspects: space management, equipment management, concealed engineering management, emergency management and energy management.

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(1) Space management

Space management is mainly used in equipment space positioning and evacuation systems, which can change the number or text part used in the building into a three-dimensional graphic position, which is intuitive and easy to find. For example, the integration with BIM model can be realized by using RFID radio frequency technology and various automation technologies, which can provide good support for building component identification, indoor positioning, personnel escape and so on. In the past, traditional building information existed in 2D drawings and various equipment operation manuals. When using it, professionals searched and understood the information, and then took appropriate actions on the building. Now, the database and BIM model are integrated together to provide the collection and organization of spatial information and further optimize the efficiency of spatial use according to actual needs.

(2) Equipment management

Management, that is, building component data and equipment operation information are integrated into the operable system through BIM technology, and then the visual function of BIM technology is used to dynamically observe the operation and maintenance situation in real time. BIM technology can provide coordinated and computable information about buildings, make the information shared and reusable, and reduce the cost loss caused by the lack of interoperability and interoperability of operation and maintenance information between owners and operators. In addition, important equipment in construction projects can be remotely controlled, and the equipment management system can display the equipment conditions in real time and collect them to a platform for management and control through RFID technologies. Operators can fully understand the operation status of construction equipment under remote operation, and achieve the purpose of providing better operation and maintenance management environment for owners.

(3) Management of concealed works

In traditional construction projects, the hidden pipeline information may not be fully defined in the design stage, especially with the increase of the service life of buildings and improper storage of construction project information, which will cause data loss and make it difficult to carry out the safety management in the future operation and maintenance stage. BIM technology can manage complex water supply and drainage pipes, wires, ventilation pipes and related pipe wells after the project delivery, and can directly obtain the relative position relationship in the project information system it constructs. The existing pipe network position can be circumvented during reconstruction or secondary decoration, and it is also convenient for internal staff to carry out pipe network maintenance, equipment replacement and real-time positioning for construction projects.

(4) Energy management

Energy management, which is the combination of BIM technology and Internet of Things technology, mainly includes the collection and analysis of energy usage data and energy alarm management, and is the core part of project cost management. Reasonable planning of daily energy monitoring and management becomes more convenient, for example, installing electric meters, water meters and gas meters with sensing functions in construction projects, setting the upper limit of energy use, and when the upper limit is reached, the system can give timely warnings to help operators stop losses in time. In addition, scientific analysis of the energy consumption data collected by the usual operation and maintenance system can help the operation and maintenance managers to accurately control daily energy consumption and solve unnecessary energy waste problems.

(5) Emergency management

Three-dimensional scene simulation based on BIM technology can help managers quickly locate and identify possible hidden dangers, quickly and efficiently locate facilities and equipment or the location of disasters when emergencies occur, and formulate emergency evacuation plans. Relevant rescuers can accurately identify evacuation routes in BIM 3D information model, and understand the environmental hazards inside community buildings, so as to ensure the life safety of evacuees and reduce the loss of life and property.

3. SWOT analysis based on BIM technology in the application of building operation and maintenance

SWOT model analysis method was put forward by K.J. Andrews of Harvard Business School in 1970s. It mainly consists of internal and external influencing factors, including advantages and

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disadvantages, and opportunities and threats. [5] Through the analysis of internal and external factors, it clearly affects the development of BIM technology in building operation and maintenance. The application of BIM technology in operation and maintenance management stage is summarized and analyzed by SWOT analysis:

(1) Advantage analysis (S)

Based on the original building model, BIM technology can endow it with relevant operation and maintenance information, or directly import application information to match the model. Using 3D model to visually display the equipment construction inside the building, it can simulate the operation status of equipment and conduct fault detection, break the limitation of personnel management in traditional operation and maintenance management, and realize efficient management in operation and maintenance period. For example, Wuhan International Expo Center has applied BIM technology to three-dimensional demonstration of building space usage, equipment pipeline positioning and building operation state detection; [6] In the operation and maintenance stage of the longest period in the whole life cycle of a building, there are a lot of information and data that need to be collected and updated frequently. The application of BIM technology makes the operation and maintenance stage more simple and effective, and greatly saves the cost of the operation and maintenance period.

(2) Weakness analysis (W)

Although the application of BIM technology in the construction industry has brought certain economic benefits, there are some problems in BIM technology in China, such as poor data security, lack of BIM operation and maintenance industry standards, lack of talents for BIM technology application, etc., which leads to the research in the construction operation and maintenance stage remaining in the idealized concept and model of operation and maintenance management. At present, China's operation and maintenance management based on BIM technology is generally realized in three ways [7]. First, use and develop complete commercial BIM software, such as ArchiBUS and AichiFM in the market. The second is to develop on the basis of BIM information model, which can develop and build the system framework independently according to different functional requirements. The third is the secondary development of BIM software, that is, the secondary development based on BIM software platform.

(3) Opportunity analysis (O)

In the report of "Information Architect", it is mentioned that architectural expression technology is welcoming a new revolution, that is, the use of three-dimensional display of architectural information, combined with modern computer technology, gives birth to a new architectural operation mode-BIM mode [8]. The contradiction between the growing demand of modern construction industry and the insufficient development of traditional operation and maintenance management is becoming increasingly fierce, which will promote the application of BIM technology in the construction operation and maintenance stage as the whole life cycle of buildings. At present, China has a large building base, and the urbanization process and the renovation of old urban residential areas are being strengthened. Traditional property management can hardly meet the management needs at this stage, which provides a large market demand for operation and maintenance management based on BIM technology and effectively promotes its development.

(4) Threat analysis (T)

At present, all parties in the construction industry have different understandings and expectations of BIM technology. According to the survey data in China Construction Industry BIM Application Analysis Report (2020) [9], 10.18% of all projects use BIM technology, 10.18% of enterprises with more than 75% of projects use BIM technology, 15% of projects with 50%-75% of projects use BIM technology, and more than 50% of projects use BIM technology. From the above data, it can be seen that the application of BIM technology in enterprises is still weak, and most enterprises are still in the stage of watching and trying, without using BIM technology deeply. At present, the application of BIM has not yet formed a system and there is no sound legal and regulatory system, which seriously hinders its development.

4. Conclusion

With the development of the times and the advancement of building intelligence, the application of BIM technology in building operation and maintenance stage can not only improve the efficiency and level of operation and maintenance management of construction projects, save the cost of construction projects, but also prolong the service life of buildings as much as possible. Through SWOT model

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analysis, this paper analyzes the current situation of BIM technology development and application. The realization of BIM technology operation and maintenance stage has a long way to go, and it needs the government, construction parties and even the whole society to update their ideas, improve their level and make joint efforts, so that this excellent technology can fully exert its powerful functions and functions in the future.

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