Building Digital Operation and Maintenance Based on BIM

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Abstract. This paper analyzes the difference between digital operation and traditional operation, expounds the obvious advantages of digital operation and maintenance by comparing in many aspects, and expounds the importance of BIM technology in digital operation and maintenance management. However, the digitalization of operation and maintenance management has just started, so this paper analyze the operation process of digital building operation and maintenance system, and put forward the prospect of digital operation and maintenance management in the future.

1. Introduction
With the continuous improvement of China's national economic level, people's definition of high quality of life is constantly refreshing. Nowadays, as there are more and more large office buildings, office workers have higher and higher requirements for working environment. In recent years, more and more organizations and companies have come to believe that maintaining a well-organized management and efficient equipment maintenance system is essential to the success of enterprises. At the same time, the application of artificial intelligence in all walks of life once again attracted attention. Digital operation and maintenance system is the general trend of the development of various industries in 5G era [1].

2. Traditional and digital building management
The traditional building operation and maintenance management is the property management, which is carried out by many people on duty and regular maintenance. Once there are users to report for repair, personnel need to be assigned to carry out on-site maintenance.

Modern intelligent building operation and maintenance management, combined with digital information and digital technology to achieve efficient management. Intelligent operation and maintenance management can realize self-management, self-optimized operation and self-maintenance of the operation, and with the help of artificial intelligence under big data, and meet the personalized needs of building users.

Therefore, compared with traditional operation and maintenance management, digital operation and maintenance management has obvious advantages in terms of personnel use, response speed, work efficiency and management mode, but it is much higher in terms of investment, as shown in Table 1.
3. Digital operation and maintenance system

The digitalization of operation and maintenance management is inseparable from all kinds of advanced science and technology, such as BIM technology, big data, cloud computing, GIS technology and so on.

3.1. BIM technology

BIM technology (Building Information Modeling) originated in the United States and has been gradually extended to Europe, Japan, Singapore and other regions. BIM started early in these countries, and its development level, system and application are relatively perfect [2]. Compared with the previous management technology, BIM technology has the following advantages:

1. Realize the integration and sharing of building equipment information. The whole life cycle of a building [3] can be roughly divided into four stages: planning stage, design stage, construction stage and operation and maintenance stage, as shown in Figure 1. Each stage covers a variety of architectural information, and some seemingly unimportant information in the early stage may play a very important role in the operation and maintenance management of future buildings. Such as the service life of the fan-coil unit in air conditioning system, maybe we won't care about the service life of a specific device, but the information is able to provide accurate and useful information for us, if we mark this information in BIM, when the service life of the equipment will due soon, we can in advance to be replaced. Therefore, BIM is not only the carrier of architectural information, but also the importance to call the key information.

2. Implementation of 3D modeling data monitoring and management of building equipment. Three-dimensional modeling of architectural equipment [4] plays an important role in digital operation and maintenance management, which is more convenient and intuitive than traditional equipment management. We can clearly see the information and operation status of construction equipment. Taking water chiller and water pump as an example, we can intuitively see the flow direction of cooling water circulation loop and frozen water circulation loop, and know the temperature and pressure of water supply and return at different locations in real time. In case of equipment failure, the 3D model of BIM can be used to quickly locate and view the equipment information, so as to facilitate the operation and maintenance personnel to carry out further maintenance work.

![Figure 1. Full life cycle of a building](image-url)
3.2. Big data and cloud computing

Big data refers to the data set captured, managed and processed by conventional software tools within a certain period of time. By installing sensors on a variety of building equipment, a large number of big data of the operation process of equipment can be obtained, and the data of each equipment can be centralized into a large public platform and utilized through calculation and analysis.

Cloud computing is a kind of distributed computing technology, in which the most basic concept is to automatically divide the huge computing processing program into countless smaller subroutines through the network, and then send the processing results back to the users after searching, computing and analyzing by the huge system composed of multiple servers.

However, the big data and cloud computing platforms in China are still in the exploratory stage. It is believed that the big data and cloud computing platforms will bring us better information interaction experience in the future.

4. The working process of digital operation and maintenance

The working process of digital operation and maintenance can be roughly divided into five parts: Three dimensional modeling, data acquisition, dynamic display, data processing and operation optimization:

1) Three dimensional modeling. 3D modeling of BIM in building and equipment system is important in digital operation and maintenance. It is the base of digital operation and maintenance, because the operation and monitoring data need to be displayed in the system.

2) Data collection. Through real-time monitoring of construction equipment, equipment information is collected. For example, to building water chillers, we need to collect data, including instantaneous power, total power consumption, operation time, supply water temperature and return water temperature. The equipment to be monitored for the air-conditioning system of the whole building also includes the chilled water circulation pump, cooling water circulation pump, supplementary water pump and Cooling tower etc. For specific data to be monitored for refrigeration machine room equipment, see Table 2.

Table 2. Equipment data monitoring table of refrigeration machine room of an office building

| Device name                  | Monitored data                                                                 |
|------------------------------|-------------------------------------------------------------------------------|
| 1 Water chiller              | Instantaneous power, total power consumption, operating time, equipment pressure, water supply and return temperature Chilled water flow rate, pump head, operating time, equipment pressure, total power consumption, supply and return water temperature Cooling water flow rate, pump head, operating time, equipment pressure, total power consumption, supply and return water temperature                     |
| 2 Chilled water circulating pump | Water flow, pump head, running time, equipment pressure, total power consumption Water flow, running time, equipment pressure, total power consumption |
| 3 Cooling water circulating pump                  |                                                                                   |
| 4 Supply water pump                      |                                                                                   |
| 5 Cooling tower                 |                                                                                   |

3) Dynamic display. Through BIM model and real-time updated equipment information, the running process of the equipment can be displayed dynamically, so that the real-time changes of data is can be seen. Once the operation data of a certain equipment is abnormal, the problem can be found through the dynamic display of equipment information in the first time, so that the problem can be solved quickly.
(4) Data processing. Operation and maintenance information includes all the static and dynamic data of the building, they can be compared with the historical data of equipment and the green building energy saving operation standard for analysis and comparison. These historical data can be put into a public platform, which is the government's energy saving monitoring platform. The government will can reward and punish individual building according to its energy consumption data.

(5) Operation optimization. Through the real-time observation of building equipment data and the prediction of outdoor meteorological parameters and indoor air-conditioning load, operator can adjust the water chiller operation and optimize air-conditioning system operation, which can meet the needs of office staff on the working environment and reduce energy consumption to the maximum extent.

Figure 2 shows the operation interface of digital operation and maintenance management system in an office building.

![Figure 2. Digital operation and maintenance system display](image-url)

5. Conclusion
Digital operations based on BIM technology is a new operational management mode, with its convenient and efficient advantages have been around the world has caused wide public concern, Nowadays, the digital operation and maintenance system is not perfect, but with the secondary development and expansion of BIM Technology and other technologies, I believe that the future development prospects of digital operation and maintenance will be better and better.

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