

Research on the Application of BIM in the Operation and Maintenance Management of University Libraries

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Abstract: With the rapid development of information technology, university libraries, as important carriers and service providers of academic resources, are facing more and more challenges in the digital age. The traditional library operation and maintenance management model can no longer meet the growing demand. However, there is currently relatively little research on BIM based operation and maintenance management of university libraries. Although BIM technology has achieved significant results in the construction industry, its application in the library field has not yet been fully developed and explored. Therefore, this study aims to fill this knowledge gap by utilizing the advantages and characteristics of BIM technology to propose an operation and maintenance management model suitable for university libraries, in order to achieve more efficient, intelligent, and sustainable operation and maintenance management.

Keywords: BIM Technology; IT Operation Management; University Library.

1. Introduction

In the construction of universities, libraries play an important role. Students spend about one-third of their time in the library [1]. Libraries play a role in value orientation, educational promotion, and spiritual cultivation for students. However, university libraries have also exposed an increasing number of operational maintenance and management issues. Based on BIM technology, two-dimensional data on building drawings can be converted into three-dimensional models, and the constructed models can be used as carriers in the operation and maintenance phase, greatly improving management efficiency. Therefore, we can apply BIM technology to the operation and maintenance stage to solve the operation and maintenance management problems of university libraries.

2. Research Status of Operation and Maintenance Management based on BIM Library

At present, libraries in China face problems such as insufficient personnel skills, a wide variety of equipment, and a lack of management systems. To address these issues, we should increase technological development, cultivate technical talents, and formulate management measures to ensure the effective operation and maintenance management work.

Gao Xinao et al. applied BIM technology to the operation and maintenance management of libraries, changing the problems of low efficiency and high difficulty in traditional library operation and maintenance management models [2]. Based on the current situation of equipment operation and maintenance management in university libraries, Liu Baiping et al. analyzed the existing problems and shortcomings, and proposed methods and strategies to improve the efficiency of equipment operation and maintenance management in university libraries from different perspectives[3]. Lin Ping et al. analyzed and designed a library information operation and maintenance management system using a three-layer B/S structure, which standardized the operational process of

library operation and maintenance work and greatly improved the efficiency of existing library information operation and maintenance work [4]. Zhang Jun et al. elaborated on the characteristics of self-service in university libraries, analyzed the current situation of self-service operation and maintenance management in vocational college libraries, explored the content and mode of self-service operation and maintenance in vocational college libraries, and proposed measures to achieve self-service operation and maintenance management in vocational college libraries [5].

From the current research status, the operation and maintenance management based on BIM technology has broken the traditional management mode and actively combined with new technologies and methods, solving the problems of slow information transmission and high equipment management and maintenance costs in operation and maintenance management to a certain extent. However, there are still some problems in the research and application of operation and maintenance management based on BIM technology at present:

(1) Although the research on the combination of BIM technology and operation and maintenance management is relatively common, the existing research and application mainly focus on the design and construction stages of building engineering.

(2) There is not much in-depth research on characteristic buildings such as university libraries. Both domestically and internationally, there have been explorations in both theoretical and practical applications of BIM based operation and maintenance management. The theoretical exploration involves data exchange and information integration, while the application exploration involves the system architecture construction and software development required by actual engineering projects, which is a common research. There is relatively little targeted research on specific purpose buildings during the operation and maintenance phase.

(3) There is relatively little research on the relationship between BIM, operation and maintenance management, and university libraries both domestically and internationally.

3. Application Framework of BIM Technology in the Operation and Maintenance Management of College Books

3.1. Basic Requirements for Library Operation and Maintenance Management System

3.1.1. Data Integration and Standardization Requirements

Data integration: The library operation and maintenance management system needs to be able to integrate data from different sources, including equipment, resources, environment, and other aspects. Data integration requires the system to achieve seamless connection and sharing of data, ensuring data consistency and accuracy.

Data standardization: In order to achieve unified management and analysis of data, the library operation and maintenance management system needs to establish unified data standards, clarify data formats, naming rules, etc., to ensure the interoperability and consistency of data between different systems.

3.1.2. Equipment and Facility Modeling Requirements

Modeling accuracy: The modeling of equipment and facilities in the library operation and maintenance management system requires high precision, including accurate modeling of the geometric shape, position, attributes, and other information of the equipment. Modeling requires the system to be able to describe the characteristics of the equipment in detail and match them with the actual equipment.

Device correlation: The system should support modeling the correlation between devices, that is, the physical or logical relationships between devices. For example, the relationship between bookshelves and books, lighting and switches. This can better analyze the mutual influence between devices and optimize resource utilization efficiency.

3.1.3. Requirements for Intelligent Operation and Maintenance Management

Anomaly detection and warning: The system should have anomaly detection and warning functions, which can monitor the operating status of equipment in real time and give timely alarms when abnormalities occur. For example, when high temperature or low humidity is detected, an alarm can be automatically issued and corresponding measures can be taken.

Fault diagnosis and maintenance: The system should be able to accurately diagnose equipment faults and provide corresponding maintenance plans by analyzing equipment data. At the same time, the system should also support the management of maintenance records, including the recording and statistics of maintenance time, costs, and other information.

3.1.4. Requirements for Improving Reader Service Quality

Personalized services: The library operation and maintenance management system should be able to accurately analyze the needs of readers, and provide personalized services to readers through technologies such as data mining and machine learning. For example, recommend relevant books based on the reader's borrowing history and interest preferences.

Self service: The system should support functions such as self borrowing and returning books, querying library

collections, and providing a convenient service experience. At the same time, the system should also have a friendly user interface and operation guidance, making it convenient for readers to operate independently.

3.1.5. System Integration and Compatibility Requirements

Compatibility: The library operation and maintenance management system should have good compatibility and be able to seamlessly integrate with existing library management systems. This can avoid data redundancy and duplicate system construction, and improve the overall efficiency of the system.

Data sharing: The system should support data sharing and interoperability, ensuring that data between different systems can be updated and synchronized in real time. For example, data sharing between library management systems and human resources systems can make personnel scheduling more efficient.

3.1.6. Data Security and Privacy Protection Requirements

Data security: The system should have comprehensive data security measures, including data encryption, firewall, access control, etc., to ensure the security of data during transmission and storage.

Privacy protection: The system should comply with privacy protection laws and regulations to protect the personal privacy information of readers. For example, desensitizing the personal information of readers and allowing only authorized personnel to access it.

In summary, research on the application of BIM technology in library management systems has put forward requirements for data integration and standardization, equipment and facility modeling, intelligent operation and maintenance management, improvement of reader service quality, system integration and compatibility, data security and privacy protection. By meeting these requirements, efficient, intelligent, and secure library operation and maintenance management can be achieved.

3.2. Overall Architecture Design of Operation and Maintenance Management System

The overall architecture design of the book management system application research based on BIM technology includes the following components:

Data management module: responsible for managing basic data such as book information, user information, borrowing and returning records in the library. This module can use a database to store and manage data, and provide corresponding data access interfaces.

BIM Technology Application Module: Utilizing BIM technology to manage and display spatial information in libraries. This module can use BIM software for modeling and design, presenting the layout, floors, rooms, and other information of the library in three-dimensional form, and providing a visual interface for users to browse and query.

Borrowing and returning management module: handles the borrowing and returning operations of books. When users borrow books, this module will update borrowing records and inventory information; When the user returns the book, the module updates the return record and inventory information, and performs overdue processing.

User Management Module: Manage functions such as user registration, login, and permission control. This module is

responsible for verifying user identity, maintaining user information, and restricting user access and operations to the system based on their permissions.

Search and Recommendation Module: Provides book search and recommendation functions. Users can search for books through keywords and recommend relevant books based on personal interests and borrowing records.

Data analysis module: Analyze and statistically analyze data such as book borrowing and returning records and user behavior. This module can provide various reports and charts to help library managers understand information such as library usage, popular books, borrowing trends, etc., in order to optimize library resources and services.

Interface module: Data exchange and integration with external systems. For example, it can interface with the book supplier system to achieve automatic ordering and updating of book information.

In addition, the overall architecture design of the system also needs to consider requirements for system security,

scalability, performance, and other aspects

4. Case Analysis

4.1. Project Overview

The research object of this project is a university library with a total construction area of approximately 2000 square meters and two floors. Among them, the first floor has a construction area of approximately 1000 square meters, and the second floor has a construction area of approximately 1000 square meters. The building height of this project is 8 meters, with a total of 2 floors. Among them, the first floor is 4 meters high, and the second floor is 4 meters high. The library has the following functional areas: reading area, self-study room, and conference room. The internal facilities of the library include: air conditioning system, power system, and fire protection system.



Fig 1. Library model

4.2. Basic Library Management Module

The basic management module of a book management system based on BIM technology includes the following aspects:

Book Information Management: This module is used to manage the basic information of books, including book titles, authors, publishers, ISBN numbers, classification numbers, etc. Through BIM technology, the information of books can be associated with building information models, allowing readers to search for the location and availability of specific books through a query system.

Borrowing and Returning Management: This module is used to handle the borrowing and returning process of books, including borrowing, returning, renewing, and making appointments. The borrowing and returning management module will record the borrowing history, overdue situations, and fines of readers, ensuring the reasonable utilization and order of library resources.

Reader Management: This module is used to manage the information of readers, including their personal information, borrowing records, arrears, etc. Through BIM technology, reader information can be associated with building information models, achieving reader positioning and navigation functions, and providing more convenient services.

Book procurement and cataloging: This module is used to manage the procurement and cataloging process of books. Administrators can add new books to the system and perform cataloging, classification, and other operations on them. Through BIM technology, relevant information of books can be associated with building information models, making it convenient for readers to query and locate book locations.

Statistical Analysis and Reporting: This module is used for statistical analysis of library data, including book borrowing,

reader usage, library resource utilization, etc. Administrators can make decisions and manage based on statistical results. Through BIM technology, statistical analysis results can be correlated with building information models, providing more comprehensive data analysis.

These basic management modules can effectively manage library resources and provide services, improving the operational efficiency and reader experience of the library.

4.2.1. Library Space Management Module

Space layout design: Through BIM technology, the building information model of the library can be associated with the spatial management module to achieve spatial planning and design. Administrators can design spatial layouts based on the needs and usage of the library, improving space utilization and user experience.

Space usage monitoring: Through BIM technology, it is possible to monitor the real-time usage of library space, such as seat occupancy and bookshelf storage. Administrators can adjust spatial layout and service strategies in a timely manner based on monitoring results, providing better services for readers.

Space maintenance: Through BIM technology, it is possible to inspect and maintain library spaces. Administrators can use BIM technology to record and manage information such as maintenance plans, records, and costs, ensuring the safety and sustainable development of the library.

Spatial navigation and positioning: Through BIM technology, the building information model of the library can be associated with the spatial management module, achieving spatial navigation and positioning for readers. Readers can quickly find the location of the books they need through the query system, improving usage efficiency and convenience.

Space security monitoring: Through BIM technology, it is possible to achieve security monitoring of library spaces. For

example, using BIM technology to manage facilities such as video surveillance and access control systems in the library, ensuring the safety of readers and the library.

In summary, the spatial management module of a book management system based on BIM technology can

effectively manage and optimize the library's spatial resources, improve the reader's experience and utilization efficiency. At the same time, it can also provide more convenient and accurate management tools for library administrators.



Fig 2. Example of Library Space Management

4.2.2. Library Security Management Module

In the book management system based on BIM technology, the security management module is an important component to ensure library security. This module is mainly used for monitoring and managing the security facilities, fire prevention systems, video surveillance, etc. of the library, as well as handling emergency situations and security incidents.

Security Facility Management: Through BIM technology, the building information model of the library can be associated with the security management module to monitor and manage the operational status of security facilities in real time. Administrators can ensure the normal operation of safety facilities through system detection, maintenance records, and other functions.

Video surveillance system: Through BIM technology, it is possible to manage the video surveillance system of the library. Administrators can view the monitoring footage through the system and perform operations such as deployment, recording, and playback of the monitoring area to ensure the safety of the library.

Fire protection system management: Through BIM technology, it is possible to manage the fire protection system

of the library. Administrators can monitor the status of fire alarm equipment through the system, conduct regular testing and maintenance, and ensure the reliability of the fire protection system.

Emergency plan management: Through BIM technology, it is possible to manage the emergency plan of the library. Administrators can associate emergency plans with building information models for easy access and updating of plan content. In case of emergency, administrators can quickly obtain emergency plans through the system and take corresponding measures.

Security incident management: Through BIM technology, it is possible to manage library security incidents. Administrators can record and handle security incidents, including theft, disputes, accidents, etc., through the system. The system can automatically generate security incident reports and provide relevant data analysis to provide decision-making basis for administrators.

In summary, the security management module of a book management system based on BIM technology can help library managers effectively monitor and manage library security facilities and incidents, improve library security and emergency response capabilities.



Fig 3. Example of Library Security Management

4.2.3. Library Asset Management Module

In a book management system based on BIM technology, the asset management module is an important component. This module is mainly used to manage and maintain various assets of the library, including books, equipment, furniture, equipment, etc.

Asset registration and identification: Through BIM technology, various assets of the library can be registered and identified. Administrators can enter basic information about assets in the system, such as name, specifications, quantity, purchase date, etc., and generate unique identification codes for each asset for easy management and traceability.

Asset inventory and positioning: Through BIM technology, it is possible to achieve inventory and positioning of library assets. Administrators can conduct asset inventory through the system, timely verify and update asset information, and avoid asset loss and loss. Meanwhile, the spatial positioning function provided by BIM technology can be utilized to facilitate the search and location of specific assets.

Asset maintenance and repair: Through BIM technology, maintenance and repair management of library assets can be

achieved. Administrators can record maintenance plans, repair records, and repair costs of assets in the system, timely maintain and repair assets, and extend their service life.

Asset borrowing and returning: Through BIM technology, it is possible to manage the borrowing, returning, and returning of library assets. Administrators can record the lending and return status of assets in the system, including borrowers, borrowing dates, return dates, etc., to facilitate tracking of asset flow and usage.

Asset scrapping and updating: Through BIM technology, library assets can be managed for scrapping and updating. Administrators can mark the scrapped status of assets in the system and take corresponding measures, such as disposal, updates, etc., to ensure the effective utilization and management of assets.

In summary, the asset management module of a book management system based on BIM technology can help library managers effectively manage and maintain various assets of the library, improve asset utilization and management efficiency. At the same time, it also provides convenient query and statistical functions, providing decision-making basis for administrators.

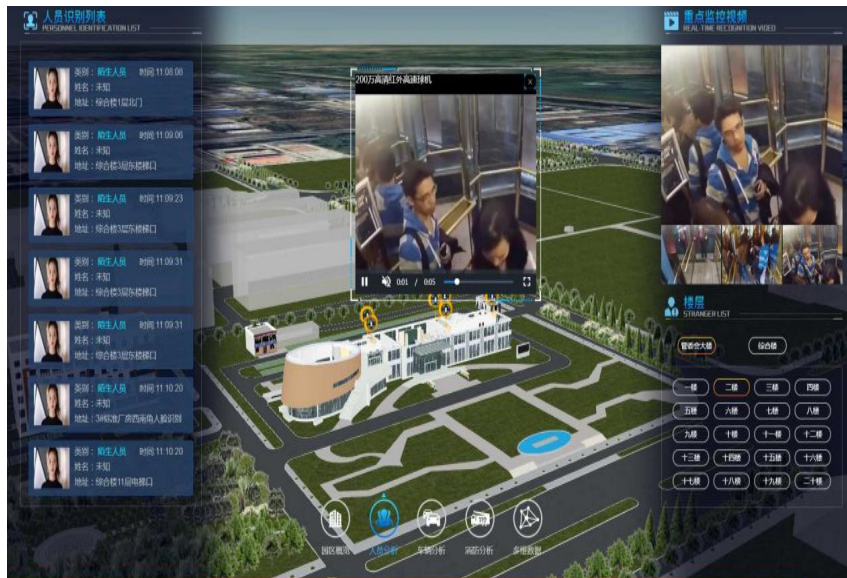


Fig 4. Example of Library Asset Management

5. Summary

Based on the above, a book management system based on BIM technology is a new type of management tool that can achieve comprehensive management of library building information models, security management, asset management, and other aspects. This system has diverse functional modules that can help library managers manage and maintain various library affairs more conveniently.

Among them, the security management module can ensure the normal operation of the library's security facilities and fire prevention system, handle emergency situations and security incidents; The asset management module can achieve operations such as registration, inventory, maintenance, borrowing and returning, and scrapping of library assets, improving asset utilization and management efficiency; The building information model management module can achieve the management and analysis of library building information, providing decision-making basis.

The book management system based on BIM technology has the characteristics of informatization, refinement, and intelligence, which can effectively improve the efficiency of library management, reduce costs, and provide readers with a better service experience. Therefore, the system has broad application prospects and market demand.

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