Research on Strategies for Improving Construction Project Archive Management in the Context of Digital Transformation

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Abstract: As a true record of project implementation, construction project archives contain important information from all stages of a project, including initiation, planning, implementation, and completion acceptance, and are of great reference value for post-project maintenance and renovation. However, with the significant increase in the scale and complexity of construction projects, traditional management models have increasingly struggled to meet actual needs, making digital transformation urgent. This paper uses methods such as literature research and case analysis to comprehensively and deeply analyze the development dilemmas of digital transformation in construction project archive management, aiming to provide new ideas for the digital transformation of construction project archive management.

Keywords: Construction Project Archives; Digitization; Transformation; Management Improvement; Digital Translation of Archives

1. Introduction

Construction project archives are one of the important components of engineering construction and play a significant role in the smooth progress of projects and post-project maintenance. However, traditional construction project archives have many drawbacks in terms of management efficiency, information utilization, and storage security. The digital transformation of construction project archives has brought new development opportunities to their management, which is of great significance for improving project management efficiency and promoting sustainable project development.

2. Overview of Construction Project Archives

2.1 Construction Project Archives

Construction project archives refer to documents and materials in various forms and carriers with preservation value formed during the entire work cycle of a construction project, from initiation, planning, design, and construction to completion and acceptance [1]. These project materials detail the entire process of project construction, carry all the construction information of the project, and serve as a microcosm of project construction achievements. They are also important references for subsequent project maintenance, renovation, and decision-making.

2.2 Research Status at Home and Abroad

Overseas research on the digital transformation of construction project archive management started early and has achieved rich results. The National Institute of Standards and Technology (NIST) has developed a series of electronic document management standards and specifications, clarifying the format, metadata requirements, and storage periods of electronic documents, providing theoretical guidance for the digitization of construction project archives; the United Kingdom has conducted in-depth research on the integration of Building Information Modeling (BIM) technology and archive management, combining information in BIM models with construction project archives to enable real-time access to project design, construction, and operation information, which is integrated into the archive management system to achieve full lifecycle management of project information [2].

In China, scholars have discussed the digital transformation of construction project archives from different perspectives. In

terms of standard formulation, the National Archives Administration issued the Specifications for Construction Project Archive Management (DA/T28-2018) in 2018, which regulates the collection, organization, archiving, and preservation of construction project archives; in terms of technology application, research mainly focuses on how to use emerging technologies such as big data, cloud computing, and artificial intelligence to improve archive management levels; in terms of management model innovation, scholars have explored how to build archive management models adapted to the digital era [3].

Overall, current researchers at home and abroad have achieved good research results in the digital transformation of construction project archive management, but there are still some deficiencies and gaps that urgently need further improvement.

3. Necessity of Digital Transformation and Reference to Successful Cases

3.1 Necessity of Digital Transformation in Construction Project Archives Management

3.1.1 Challenges faced by traditional management models

(1) High Space Occupancy. Under traditional management models, construction project archives are mostly paper-based, requiring significant physical storage space. With the continuous expansion of construction project scales and the increasing number of projects, the volume of archives has exploded, leading to a sharp rise in storage space requirements[4].

(2) Low Efficiency in Archive Retrieval. In traditional models, archive retrieval relies heavily on manual searches, with retrieval tools mainly being paper-based catalogs or electronic directory indexes[5]. Staff need to sift through vast amounts of archives based on query results, a process that is cumbersome, highly dependent on the accuracy of index catalogs, time-consuming, and prone to omissions, making it difficult to meet the demand for rapid and precise archive queries.

(3) Difficulty in Archive Filing. Construction project archives encompass various documents generated throughout the entire lifecycle, from planning and project establishment, survey and design, construction, to completion and acceptance, including construction drawings, project proposals, contract documents, acceptance reports, and other materials in different forms and formats[6]. Affected by factors such as the lack of synchronization between archive work and project construction and delays in archive collection and filing, the filing process is challenging, resulting in poor integrity and standardization of archives.

3.1.2 Urgent need for digital transformation

The "14th Five-Year Plan for the Development of the National Archives Undertaking" clearly states the need to "further strengthen the informatization of archives" and "promote the digital transformation of archive management." From a project management perspective, as the scale and complexity of construction projects increase, so do the requirements for project archive management. Different entities involved in projects, such as developers, contractors, and supervisors, generate a large amount of documentation during project execution. These materials need to be collected, organized, and stored promptly and accurately to support the smooth progress of projects, a requirement that traditional management models cannot meet[7]. Digital transformation can fully integrate emerging information tools such as big data and blockchain to establish interconnected management platforms, promote intelligent management of construction project archives, and improve the efficiency and quality of project management.

3.2 Reference to Successful Cases

The National Archives of the United Kingdom introduced advanced digital technologies to digitize and store a vast number of historical documents, maps, and images, established a comprehensive database system, realized intelligent management and retrieval of archives, and provided archive query services to the public through an online platform. Domestically, the Second Jiaozhou Bay Tunnel Project in Qingdao conducted an overall plan at the initial construction stage, setting the goal of

building China's first digital tunnel based on BIM technology. By establishing a digital construction platform, real-time collection, storage, and management of archive information were achieved during the project, ensuring the integrity and accuracy of archive information. These cases have successfully demonstrated the digital transformation of construction project archive management and provided positive references for the in-depth integration of archive management and project construction.

4. Challenges Faced by the Digital Transformation of Construction Project Archive Management

4.1 Non-Unified Technical Standards

The problem of inconsistent technical standards in the digital transformation of project archives in different regions and of different types is relatively prominent, mainly in the following aspects:

(1) Non-unified storage formats. Some projects store archive files in PDF format, while others use image formats such as JPEG and TIFF, and still others use structured data formats such as XML and JSON. Different storage formats vary in data compatibility, file size, and image quality, which brings difficulties to the sharing and exchange of archive data.

(2) Non-unified metadata standards. Metadata is the basic unit for describing data, including data names, definitions, data types, value ranges, etc. [8]. Different projects may have different metadata definitions for the same type of archive data, making it difficult to accurately understand and use archive data during data integration and analysis.

(3) Inconsistent interface standards for digital devices and software. Different digital devices and software cannot be seamlessly connected, and scanned files cannot be directly imported into the archive management system. The method of conversion and transmission through third-party software increases work links and error risks while limiting the collaboration and efficiency of archive digitization; additionally, during the upgrade and expansion of the archive management system, the lack of unified interface standards makes it difficult to integrate with new digital devices or software, greatly affecting the functional expansion and performance improvement of the system [9].

4.2 Data Security Risks

In the digital context, the data security of construction project archives also faces certain risks. For example, in the storage link, digital archives are mainly stored in storage devices such as hard disks, magnetic disks, and optical disc libraries, which have certain physical security risks; during transmission, digital archives are transmitted via the network, making network security another risk affecting data security; in addition, if the operations of access, copying, etc., during data utilization are not well managed, there may be risks of data leakage, loss, or abuse.

4.3 Shortage of Composite Talents

The digital transformation of construction project archive management requires composite talents who understand both archive theory and information service technology. However, the training of traditional archivists has relatively focused more on archive theory and business practice, with less understanding of information technology; while information technology personnel are more familiar with information technology services, they lack knowledge of the basic logic, business processes, and specifications of archive management. Overall, composite talents are relatively scarce.

4.4 Pressure of Capital Investment

The digital transformation of construction project archive management involves significant capital investment in hardware and software infrastructure (such as databases, servers, storage devices, network equipment, computer devices, etc.), software system development and maintenance, and business personnel training. However, for most enterprises, the reserve funds for project construction archive management are very limited, and the pressure of construction funds has become one of the main factors restricting the digital transformation of construction project archive management.

5. Strategies for the Digital

Transformation of Construction Project Archive Management

5.1 Formulating a Digital Transformation Plan

(1) Clarifying the goals and principles of digital transformation. The goal of digital transformation is to use advanced digital technologies to build an efficient and secure archive management system, achieve full lifecycle digital management of archive information, improve management efficiency, and provide strong support for the decision-making, management, and operation of construction projects[7]. During the transformation process, the principles of practicality and security must be strictly followed to ensure that the actual needs of construction project archive management are met, work efficiency and quality are improved, and archive data is protected from leakage, tampering, and loss.

(2) Planning the implementation steps of digital transformation. In the early stage of digital transformation, a digital transformation work team should be established to coordinate the specific matters of the transformation. First, a thorough investigation and analysis are needed to deeply understand the current status of construction project archives, including quantity, type, storage method, and management process, and to formulate detailed digital transformation plans and management measures [10]; archive digitization is a key link in the transformation, requiring systematic digital scanning of paper archives and conversion into electronic archive databases; the construction of an archive management system and integration with business systems are important guarantees for achieving digital transformation, requiring the development of an archive management system that meets management needs and its integration with other business systems to achieve the sharing and exchange of construction project archive data; after the system is launched, continuous maintenance and upgrades are required to ensure the stable availability of the system[11].

5.2 Strengthening Technological Innovation and Application

The digital transformation of construction project archive management first requires building a secure and stable digital management platform with functional modules such as archive collection, organization, storage, retrieval, utilization, and authority settings to meet the diverse needs of construction project archive management[9]. In addition, advanced digital technologies can be fully utilized. For example, big data technology can be used to deeply analyze and mine massive project archive data to provide data support for project management; the unique characteristics of blockchain technology, such as decentralization, non-tampering, and strong traceability, can be used to provide a solid guarantee for the authenticity and integrity of archive data [12].

5.3 Improving the Data Security Assurance System

While the digital management platform for construction project archives improves the efficiency of archive work, archive information security faces more severe challenges. To comprehensively enhance archive data security, the data security assurance system needs to be further improved [11]. For example, data encryption and backup can be used to protect archive data from the data side; user identity verification can be carried out through identity authentication technology, and strict user access authority management systems can be formulated to clarify the access levels and operation authorities of different personnel to archive data [13]; and security detection mechanisms and emergency response plans can be established to achieve security detection and emergency response for archive management systems, ensuring archive data security from multiple dimensions.

5.4 Strengthening the Construction of Composite Talent Teams

Building an excellent construction project archive management team is the cornerstone of doing a good job in the digitalization of construction project archive management [7]. On the one hand, we can strive to attract composite talents who are familiar with both archive management theory and information

technology through talent recruitment to inject new ideas and vitality into the digital transformation of construction project archive management; on the other hand, we can carry out regular business training to help archive management personnel more comprehensively and systematically understand the management content and work processes of construction project archives, comprehensively improve the professional quality of archive business personnel, and ensure the smooth progress of the digitalization of construction project archive management[14].

5.5 Increasing Capital Investment and Rational Allocation

The digital transformation of construction project archive management is a long-term, arduous, and complex task that cannot be achieved without substantial project funding support. Therefore, it is essential to actively secure and rationally allocate every fund. On the one hand, detailed project application reports should be developed to illustrate the necessity of digital transformation, expected outcomes, and funding requirements, thereby seeking special fund support from multiple sources[15]. On the other hand, a detailed fund utilization plan is required to clarify the purpose and allocation ratio of each fund according to the goals and tasks of digital transformation, ensuring the reasonable use of every sum of money.

6. Conclusion

This study mainly employs methods such as literature research and case analysis. Through in-depth exploration of the digital transformation of construction project archive management, it comprehensively analyzes the theoretical foundation, research status, and current problems and challenges faced by the transformation. Targeted at these issues, practical transformation strategies are proposed, with the aim of providing some references for the digital transformation of construction project archives. Overall, the digital transformation of construction project archive management remains a long-term and arduous task, requiring the joint efforts of multiple stakeholders, including government agencies, enterprises, public institutions, and relevant research institutions. It is essential to continuously improve the relevant standard system, jointly promote technological innovation, and further strengthen talent cultivation, so as to provide more robust support for the high-quality development of construction projects.

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