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Digitalization of Engineering Archives Management Based on Building Information Modeling Technology

Wenli Qin*

School of Civil Engineering and Geomatics, Southwest Petroleum University, Nanchong, China

*Corresponding author: 202331086122@stu.swpu.edu.cn

Abstract. The large-scale development of various engineering projects in China has led to a significant increase in the workload of engineering archive management. However, traditional engineering archive management still relies on paper documents and Computer-Aided Design (CAD) drawings. Even with the beginnings of digitalization, engineering archive management is inherently fragmented and inefficient, with low utilization value. Building Information Modeling (BIM), with its advantages of visualization and coordination, can effectively integrate information within engineering archive management, improving collaborative efficiency. However, there are still many challenges that need to be solved by simply combining BIM technology with engineering archive management. Currently, scholars are actively integrating BIM with digital twins, a combination that can effectively address these challenges. Finally, this article proposes the future development direction of combining artificial intelligence technology with building information modeling (BIM). The integration of artificial intelligence and BIM models can revolutionize the technical path of engineering archive management, while achieving comprehensive upgrades in the theoretical framework, cognitive depth, and safety management.

Keywords: Engineering archive management; building information modeling; digital twin; artificial intelligence.

1. Introduction

Rapid economic development and urbanization have led to the large-scale implementation of various engineering projects in China. The construction industry has flourished, with the number of projects continuing to grow. According to data released by the National Bureau of Statistics, in the first three quarters of 2023, China's infrastructure investment maintained a steady growth trend, with a year-on-year growth rate of 6.2%, which was 2.4 percentage points higher than the same period in 2019. In the first half of 2023, China's new infrastructure construction investment increased by 16.2% year-on-year, information-related new infrastructure investment rose by 13.1%, and integrated new infrastructure investment grew even faster, reaching 34.1% [1]. Against this background, the scale of engineering construction has expanded significantly, leading to a substantial increase in the workload of managing engineering archives. Massive amounts of engineering archive information need to be recorded and managed. However, traditional engineering archive management mainly relies on paper documents and 2D-Computer-Aided Design (CAD) drawings. Although engineering archive management has begun to promote the development of digital information, such as scanned documents and CAD files, its management model is essentially fragmented, static, and unstructured [2-4]. There are also problems such as resource dispersion and inconvenience in sharing. There has been no special upgrade or optimization in managing the increasing number and variety of electronic files and archives [5]. In the context of China's active promotion of engineering digital transformation and intelligent construction, according to the "Guiding Opinions on Promoting the Coordinated Development of Intelligent Construction and Building Industrialization" issued by the People's Government of the People's Republic of China, the construction industry needs to accelerate the integration of industrialization and informatization, build a building industry Internet, etc. to achieve high-quality development [6]. In recent years, engineers have widely used Building Information Modeling (BIM) in the field of engineering construction. BIM is an application concept of building information modeling for full life cycle management of three-dimensional visualization, which

includes multiple elements such as models, related information, data, and management processes [7]. BIM technology, with its information integration and collaborative management capabilities throughout the entire life cycle of the building, can achieve seamless transmission and dynamic optimization of data at all stages of the project. This technology can also make forward-looking predictions and simulation analyses of risks that may arise throughout the entire process, thereby playing a key role in improving engineering construction quality, optimizing project progress, and controlling costs. Currently, BIM is widely used in engineering construction both in China and other countries. However, its primary use is in creating models during the design and construction phases, so BIM's application in construction records management remains quite limited.

This article first reviews existing research and briefly explains the shortcomings of traditional construction records management models. It then analyzes the potential of BIM technology in this area and describes some specific applications. Finally, it explores the practical challenges of using BIM in records management.

2. The Drawbacks of Traditional Engineering Archive Management and the Potential of BIM

2.1. Limitations of Traditional Engineering Archives Management

Engineering archives are historical records with preservation value generated during the construction process of a construction project. Construction project documents are generated throughout the entire construction process, including project preparation phase documents and supervision documents. Construction project archives contain important evidence, serve as a basis, and hold reference value. Archives management personnel should identify documents with preservation value, determine the preservation period, and organize the documents and file them for safekeeping [8]. However, its management model still generally relies on paper carriers and offline processes, resulting in inefficient information flow and difficulty in releasing its utilization value.

2.1.1. Information isolation

Throughout the entire construction cycle, design, construction, supervision, material supply, and other construction entities use independent information tools or documents to generate project information based on their respective business scenarios and management standards. This results in significant fragmentation of information at the source level. In communication transmission projects, design units mainly output CAD format line construction drawings [9]. For the quality inspection of construction projects, classify and compile construction sub-project reports according to standard requirements and actual needs [10]. During the supervision process, supervisors focus on preparing supervision and management documents such as supervision notices and parallel inspection reports. Supervision notices and work contact forms are two standard document forms [11]. The lack of unified coordination among the information generation paths, carrier formats, and data standards of various entities directly results in data barriers at the source stage of project information, making efficient circulation and sharing impossible.

2.1.2. Low value

There is a severe lack of relevance in information management. For example, there is a lack of effective connection between construction photos, acceptance records, and other materials, and the corresponding drawings and components. Paper documents rely on manual browsing and catalog indexing, which is time-consuming and labor-intensive. If electronic files are not named or stored in a standardized manner, their actual use efficiency is extremely low. Engineers spend an average of 30% of their working time on file retrieval, which seriously restricts production efficiency. To achieve efficient development, it is necessary to optimize the management and access mechanisms of massive engineering documents [12, 13]. Due to limited visualization, reading traditional 2D drawings requires a high level of expertise and spatial imagination. However, traditional manual extraction methods are not only inefficient and error-prone, but existing optical character recognition (OCR)

technology also lacks decision support capabilities when faced with complex drawing layouts and dense text, making it inefficient for operations such as spatial analysis and quantity counting. It is also difficult to extract deep value from archival data. This leads to the output results often being unstructured and chaotic [14].

2.2. Advantages of BIM

BIM is a digital model based on three-dimensional technology that brings together various information about a building project and covers the entire life cycle of the project from design, construction to operation. Compared with traditional two-dimensional drawings and documents, the advantage of BIM is that it supports visualization, coordination, simulation, optimization, and output. BIM can greatly improve the way information is shared and people collaborate, and help different professional teams collaborate [15]. Therefore, BIM technology can collect and organize project information throughout the process, link data and models in real time, and thus create a complete digital asset library. The complete digital asset library provides a single, reliable source of data for project decisions and later operation and maintenance. J.P. Zhang et al. proposed a distributed BIM service framework that uses a private cloud. This framework lets each participant store data on their own server. These separate models then form one unified BIM model through virtual integration on the cloud platform [16]. Walid Thalet's team developed a Revit and Dynamo collaborative workflow that automatically extracts asset management data from the model and exports it to a specialized table format that meets the facility owner's requirements. Facility owners can use this form to connect directly to their facility management system, saving time on manual input and avoiding delays in equipment maintenance due to missing information [17]. Yan Peng pointed out that the BIM information management platform of the Shenzhen-Zhongshan Link project uses a unified coding system to link engineering information such as design, progress, safety hazards, quality hazards, quality inspection, drawings, and lists, realizing the comprehensive management and control of the project and the integrated loading and sharing of multi-source business data [18]. Incorporating BIM into project archive management elevates it from document management to data management, thereby releasing the vast potential of information throughout the entire project life cycle.

3. Multi-dimensional Challenges of BIM Models as Statutory Archive

3.1. Technical Barriers

BIM models are usually created based on multiple software platforms, but the data formats and storage standards of each platform are different. For example, mainstream tools such as Autodesk Revit and Bentley have their own unique data structures and storage methods, which leads to the diversity of data sources and non-standardization of formats, making project file management very complicated. This challenge is further exacerbated by the wide variety of modeling software being developed and the lack of standardized information formats [16]. Suppose these archives need to be accessed or reused in the future. In that case, the model may not be readable, usually due to software version iteration, format compatibility, and other factors, which will seriously affect the preservation of the archives' long-term availability and value.

3.2. Management Barriers

BIM technology is gradually becoming a core tool for project archive management. However, incorporating the generated BIM model into the statutory archive management system faces practical challenges at the management level. At present, many archive management agencies still face significant obstacles regarding personnel awareness, process adaptation, and long-term maintenance. The existing archive management process is complicated to be directly compatible with the characteristics and requirements of the BIM model and is in urgent need of redesign and integration. Because the BIM model archiving management system involves the participation of multiple parties, the data involved is enormous, and the business is complex, the closed loop of its management logic

needs to cover all aspects of the construction project and be closely linked to various departments, positions, and roles. Due to the different roles of the participants, there are differences in the data used and the data provided, so effective collaboration must be achieved by relying on unified standards that are commonly followed by all parties [3]. In addition, as a dynamic and structured digital asset, the long-term preservation, updating, and authenticity assurance of BIM models also put forward unprecedented technical and management requirements.

3.3. Theoretical Barriers

Although BIM technology has shown significant advantages in improving project quality and efficiency, it still faces many challenges at the legal level as a statutory archive, mainly in key issues such as legal validity recognition, copyright and ownership definition, and compliance and standard unification. Existing contract templates may not be able to fully adapt to the requirements of BIM projects [19,20]. At present, no effective and mature contract model can fully deal with various professional liability issues in BIM implementation. The existing standard contract texts have been weak in promoting the application of BIM technology in the construction industry and have failed to effectively encourage its widespread adoption [21]. The widespread application of new technologies such as BIM has become an irreversible trend. It is necessary to deeply integrate archive management with BIM and other emerging technologies to build a new archive management model, and in this process, continue to maintain the core advantages of archive management in terms of credibility, authority, political nature, and legal and historical attributes, to further improve the efficiency and level of archive management work with the help of technical means [22].

4. Towards Intelligent Engineering Archives Powered by Digital Twins

4.1. Current Status and Consensus Basis of Intelligent Engineering Archive Research

In the construction of the engineering archive management platform, an integrated management system is built based on BIM technology to achieve the deep integration of BIM with cutting-edge technologies such as the Internet of Things, big data, and artificial intelligence, which can effectively support the automatic collection, intelligent identification, associated retrieval, and integrated application of engineering information [23]. Dai Yang pointed out that artificial intelligence has not only had a profound impact on society as a whole, but also brought important inspiration to the field of archival cultural heritage. Many key technologies in artificial intelligence, such as machine learning, deep learning, big data analysis, natural language processing, and computer vision, have shown high applicability and broad application prospects in information resource management and archival research [24]. Yan Peng proposed that under the "Internet + Smart Construction" concept, engineering projects should comprehensively promote smart construction. Leveraging information technologies such as BIM, mobile internet, cloud computing, and big data, this will enable the deep integration of engineering construction and infrastructure management. By implementing parallel management of electronic documents—including program management forms, quality inspection records, measurement and payment files, and routine official documents—alongside electronic archive management, the digitization of archives for large-scale construction projects can be effectively promoted. Such an approach enables the realization of a new model characterized by synchronous application of archival information and collaborative management of electronic archives, thereby driving the evolution of China's electronic archive management toward greater intelligence [18]. In terms of archive management mechanism, explore the new "BIM+" archive management model, establish a dynamic archiving mechanism covering the entire life cycle of the project, improve the incentive and constraint mechanism of multi-party participation, and create a suitable environment for the promotion and application of BIM in the field of engineering archives. Based on the actual problems of highway engineering project management and combined with their own research directions, Zhao Shunqing and others systematically integrated the BIM three-dimensional visualization information model, drone three-dimensional terrain modeling technology, and WBS

document control technology to build a highway engineering management information system integrating "BIM+Geographic Information System (GIS)+ Work Breakdown Structure (WBS)" [25]. This platform is based on the integration of "GIS+BIM+ Internet of Thing (IoT)" and is combined with strategic needs. They ultimately completed the design of an integrated and intelligent levee project safety management platform [26].

4.2. Possible Future Research Directions for Intelligent Engineering Archives

Combining artificial intelligence (AI) with building information modeling (BIM) and applying them to project archive management can effectively address the current prominent challenges in this field, as previously mentioned. AI's ability to autonomously learn across diverse fields can promote the deep integration of computer science, data intelligence, management, and architecture. This builds a collaborative interdisciplinary methodology and enhances the theoretical integrity and methodological innovation of project archive management. Second, in terms of cognitive level, AI technology can intelligently identify, classify and extract recorded information, and then construct knowledge charts. It is helpful for risk assessment, decision support and trend prediction. Therefore, throughout the entire project life cycle, the use of data has become more intelligent and high-end. The BIM management platform that utilizes ai will also leverage machine learning, enabling dynamic allocation of permissions, detection of abnormal tasks, and adjustment of risk control. By adding technologies such as blockchain, they can track all behaviors and encrypt data. This has greatly enhanced the security of the project archive and the protection of personal information. The use of AI in BIM models can improve the management approach of project archives. It will greatly enhance theory, understanding and safety management.

5. Conclusion

This article first describes the current state of the construction industry. The ever-expanding scale of projects has led to a corresponding increase in the workload of project archive management. Currently, the construction industry is in a critical period of advancing digital transformation, and BIM is being widely adopted in engineering projects. By comparing it with traditional project archive management, this article highlights the limitations of traditional project archive management and the advantages of BIM in visualization, collaboration, and simulation. These capabilities demonstrate its enormous potential for application in project archive management. This article then summarizes and elaborates on BIM's applications in this field, identifying challenges and areas for improvement in actual project archive management. Finally, this article explores the application of BIM in project archive management through the deep integration of digital twin technologies, such as the Internet of Things and big data, and proposes a future direction for integrating artificial intelligence with BIM. Applying both approaches to project archive management can not only effectively address current challenges in project archive management but also innovate its technical approach, achieving a comprehensive upgrade in theoretical framework, cognitive depth, and safety management.

References

[1] Yan H. Research on information management and construction of infrastructure engineering archive. Digital Communication World, 2025, (1): 220-222.

[2] Mao R Z. A brief discussion on archiving management of CAD electronic files. China Water Resources, 2003, (12): 77-78.

[3] Liu X D. Research on the characteristics and digitalization of engineering design drawing archives. Theory Observe, 2020, (7): 150-152.

[4] Research on unstructured electronic archives query based on visual retrieval technology. SpringerLink, 2025.

[5] Qiang D M, Jing H, Wang J T, et al. Current status survey and improvement strategies for the construction of archive management standards for urban rail transit projects in my country. Archives of Shanxi, 2023, (3): 176-181.

[6] Ministry of Housing and Urban-Rural Development, National Development and Reform Commission, Ministry of Science and Technology, et al. Guiding opinions on promoting the coordinated development of intelligent construction and building industrialization. 2020.

[7] Hu Y J. Research on archiving management of BIM models. Beijing University of Civil Engineering and Architecture, 2020.

[8] Chang L. On the management methods of engineering archives. Journal of Shanxi Normal University (Natural Science Edition), 2010, 24(S1): 90-91.

[9] Huang Z X, Huang S X. Automatic division method and implementation of communication line construction drawings. Computer Applications and Software, 2018, 35(9): 323-326, 333.

[10] Niu Q L. Division and reporting of inspection lots for construction projects. Construction Materials & Decoration, 2020, (5): 186-187.

[11] Yuan Y M. The difference between construction project supervision notices and work contact forms in my country. Project Management, 2025, (4): 23-25.

[12] Design engineers and technical professionals at work: observing information usage in the workplace. Journal of the American Society for Information Science and Technology, 2009.

[13] Li Z, Raskin V, Ramani K. Developing engineering ontology for information retrieval.

[14] Khan M T, Yong Z, Chen L, et al. Automated parsing of engineering drawings for structured information extraction using a fine-tuned document understanding transformer. arXiv, 2025.

[15] Liu L. BIM-based construction project archive management informatization and project life cycle management integration. Archives of Shanxi, 2025, (5): 172-174.

[16] Li Q, Deng Y H. Research on multi-source heterogeneous building information model data interaction technology. Construction Materials & Decoration, 2022, 18(26): 42-45.

[17] Ivanova I, Kiesel K, Mahdavi A. BIM-generated data models for EnergyPlus: a comparison of gbXML and IFC formats. Building Simulation Applications 2015 - 2nd IBPSA-Italy Conference, 2015.

[18] Yan P, Shu Z M. Collaborative management of electronic archives of large-scale construction projects based on BIM technology. Beijing Archives, 2021, (7): 31-33.

[19] Contractual risks of BIM implementation and the proposed contract form for DBB and DB projects. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 2025.

[20] Nilchian S, Majrouhi Sardroud J, Darabpour M, et al. Features and conditions of building information modeling contracts. Buildings, 2022, 12(11): 1839.

[21] Building information modelling- the legal frontier: overcoming legal and contractual obstacles. 2025.

[22] Li H, Huang Y L, Wang C, et al. Rail transit project archive management under the BIM situation. Future City Studies, 2020, (11): 74-77.

[23] Zhao X. Application of modern information technology in water conservancy project archive management. Archives of Shanxi, 2024, (11): 186-188.

[24] Dai Y, Chen Y, Li M Y, et al. Archival interdisciplinary and interdisciplinary cooperation from multiple perspectives. Archives & Construction, 2024, (8): 11-18.

[25] Zhao S Q, Sun H. Research on the application of BIM+ in highway engineering project management. Highway, 2020, 65(9): 231-236.

[26] Rao X K, Ma R, Zhang L, et al. Research on embankment engineering safety management platform based on GIS+BIM+IoT digital twin. China Rural Water and Hydropower, 2022, (1): 1-7.