Proceedings of the 4th International Conference on Functional Materials and Civil Engineering
DOI: 10.54254/2755-2721/2026.38425

BIM-Supported Management Processes in Building Renovation Projects

Yueying Wang

School of Construction Management and Engineering, University of Reading, Reading, UK
wt026403@student.reading.ac.uk

Abstract. With the aging of existing buildings and the increasing demand for urban renewal and energy-saving renovations, the number of building renovation projects is constantly rising. The renovation project is constrained by the original building conditions and faces problems such as incomplete data, on-site information deviation, difficulty in detecting concealed components, and numerous design changes, which place higher demands on project collaborative management. This paper employs literature review and case analysis methods to explore the application of Building Information Modeling (BIM) in the existing-condition investigation of building renovation, model reconstruction, design collaboration, cost and schedule management, and elaborates on its practical approaches drawing on cases reported in the literature. The results show that BIM can build a unified digital information foundation, serving multi-disciplinary collaboration and quantity take-off and schedule management. However, it is restricted by data quality, model updates, software compatibility, and the technical proficiency of personnel. Therefore, the efficiency of information collection should be optimized, BIM data standards improved, and cross-disciplinary collaboration throughout the entire process strengthened.

Keywords: building renovation, BIM, existing buildings, project management, multi-disciplinary collaboration

1. Introduction

With the continuous renewal of urban stock, many existing buildings built earlier are facing problems such as ageing facilities, inability to meet current use requirements, and insufficient energy-saving performance. As a result, the number of building renovation and adaptive reuse projects is constantly increasing. There is an essential difference between building renovation projects and new construction projects. All design and construction activities are based on the already completed building entity, often resulting in the absence of original completion drawings, inconsistency between archived drawings and the actual situation on site, and difficulty in obtaining information on concealed works such as walls and pipelines. At the same time, due to the limitations of the existing structure and space, design changes occur frequently during the renovation stage. The above-mentioned problems are prone to causing deviations in the calculation of engineering quantities and delays in the construction period, and increase the difficulty of coordination and collaboration among multiple specialties. Against this backdrop, Building Information Modeling

© 2026 The Authors. This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (https://creativecommons.org/licenses/by/4.0/).

DOI: 10.54254/2755-2721/2026.38425

(BIM) technology can integrate multi-dimensional information such as building geometry, component attributes, and materials through digital models, providing a feasible technical path for the full-cycle information management of building renovation projects.

Studies have explored the application path of BIM in the transformation of existing buildings from multiple dimensions. The research scope covers various directions such as the collection of current information of existing buildings, reverse model reconstruction, multi-disciplinary design coordination during the renovation stage, extraction and calculation of engineering quantities, four-dimensional (4D) construction progress simulation, and on-site construction management [1, 2]. By leveraging multi-source data fusion methods, BIM can build a digital information carrier to assist renovation projects in completing scheme comparison, conflict detection, and construction control. Existing engineering cases have also confirmed that BIM can alleviate various problems caused by information asymmetry in the traditional mode. However, the current practice still has several prominent limitations: reverse modeling of existing buildings generally requires a relatively high time and human resource cost; the problem of incomplete basic data caused by the absence of original archives is difficult to eliminate; there are obstacles to data exchange between different software platforms; the application of BIM varies greatly among different projects, and some projects only achieve visual display of models and fail to deeply integrate into the project management process [1].

This study mainly adopts the research methods of literature review and case analysis. It explains the underlying logic of BIM serving the management of building renovation projects, sorts out the specific application scenarios of BIM in current situation investigation and model reconstruction, transformation design coordination, cost and progress management, etc., and analyses the application mode of BIM in combination with real cases recorded in the literature. At the same time, it summarises the practical obstacles in the current practice and sorts out the future development direction.

2. The BIM foundation in building renovation project management

2.1. Information and management requirements of building renovation projects

Building renovation projects are different from new construction projects because most design and construction activities must be carried out under the constraints of existing buildings. After years of use, the actual condition of the building may no longer match the original drawings. Changes may be due to ageing, previous repairs, later additions or unrecorded modifications. Over time, mechanical and electrical systems may also be replaced or changed, and hidden components and pipes are often difficult to identify before construction.

These conditions increase uncertainty during renovation [1]. Incomplete or outdated information can affect the development of renovation schemes and may lead to repeated design changes when unexpected site conditions are found [3]. Coordination among architectural, structural, mechanical, and electrical systems has also become more difficult because new components must be installed within limited existing spaces. The inaccuracy of hidden element information may further affect quantity take-off, cost estimate and construction planning [1].

Therefore, the transformation project management requires an information database that can be checked and updated as the project progresses. Existing drawings, site surveys, component information, and records of previous alterations need to be organized and linked so that the design, cost, schedule and construction teams can work according to more consistent information. This

DOI: 10.54254/2755-2721/2026.38425

information demand also provides a basis for the introduction of BIM in subsequent transformation management.

2.2. Information integration and synergy of BIM

BIM provides a general information model for organising project data such as architectural geometry, component attributes, material information and engineering quantities. This is especially useful in renovation projects, because the information usually comes from different sources and may not fully match the current condition of the building. Original drawings, on-site measurements, laser scanning data, photographic measurement results and historical records can be checked and combined to update the model as more reliable information becomes available [1].

After organising the existing building information, the BIM model can support communication between designers, contractors, owners and other project participants [3]. Architectural, structural and electromechanical information can be viewed in the same model, which makes it easier to identify spatial conflicts and compare remodelling schemes. The model can also provide component and quantity information for cost estimation, and can be associated with the construction plan to support the progress planning [4]. These functions are particularly relevant to the remodelling project, because design changes and on-site adjustments are relatively common.

However, the usefulness of BIM depends on the quality and integrity of the information entered into the input model. Lack of drawings, inaccurate field data, or delayed model updates may reduce the reliability of post-design and management. The exchange of information between different software platforms will also affect the collaboration between project participants [1, 2]. Therefore, BIM should be regarded as an information and coordination tool, not a complete replacement for on-site investigation and professional judgement.

3. Typical management applications and case analyses

3.1. Existing condition investigation and model reconstruction

The current situation information is an important basis for building renovation. In practice, original drawings may be incomplete or different from the actual building. Previous repairs and later modifications may also have changed the original layout. In addition, concealed components and embedded pipelines are often difficult to identify before construction. These problems will affect the renovation design and later project management [1, 2].

The remodelling of the historic buildings of Odd Fellows in Atlanta is a typical example. The building was constructed in 1912 and had experienced several additions and repairs. It was also damaged by a tornado in 2008. Due to the lack of some historical records and the lack of complete documents for subsequent modifications, the project needs to rebuild the existing building before further renovation. A heritage building information model (HBIM) is built by combining historical drawings, field survey records and photographic survey data. The model included the main walls, structural components, façades, and interior spaces of the building [2].

The reconstructed model provided a clearer record of the existing building condition and helped the project team understand the current spatial layout. It also provided basic information for later renovation design. However, the accuracy of the model still depended on the quality of the available data. Field surveys and photogrammetric data collection required additional time and labour, while some concealed components inside walls could not be directly captured [2, 5].

DOI: 10.54254/2755-2721/2026.38425

For historic buildings, previous repairs and alterations also need to be recorded. Such information is not always easy to represent through geometric models alone [6]. Therefore, HBIM can help organize existing building information, but field investigation and historical records are still necessary when the model is incomplete [7].

3.2. Renovation design and collaborative management

Building renovation often involves architecture, structure, mechanical systems, and electrical systems within an existing spatial framework. Compared with new construction, the available space is more limited and the original structural conditions cannot be changed freely. In the traditional two-dimensional design process, information from different disciplines may be updated separately, which may lead to spatial conflicts, repeated design changes and communication delays [4, 8].

The Odd Fellows historic building project also involved multi-disciplinary renovation design. Based on the HBIM model established during the existing-condition investigation, the project team coordinated structural repair, internal space adjustment, mechanical and electrical upgrades, and façade conservation within the same digital environment. The model was used to compare renovation schemes and check spatial conflicts between new mechanical and electrical systems and existing structural components [2]. When conflicts were identified, pipeline layouts and equipment positions could be adjusted before construction. The same model also provided a common visual reference for the owner, designers, conservation specialists, and construction teams during design discussions [2].

This form of coordination can reduce the uncertainty caused by some separate drawings and make it easier to identify design conflicts before the on-site work begins. This type of coordination is particularly useful in renovation projects, where new systems must often be installed within limited existing spaces. However, the case also showed that collaboration still depends on data exchange and model maintenance. Information may be lost when models are transferred between different software platforms, and project participants may have different levels of BIM experience [2].

Another problem is the update of the model after design changes. If changes made during the renovation process are not reflected in the BIM model in time, the model may no longer match the current project information. Therefore, BIM can support design collaboration, but the practical value depends on the consistency of model updates, the compatibility of data formats, and the effective use of different project participants.

3.3. Cost and schedule management

In building renovation projects, cost and schedule control may be difficult because the existing conditions are not always fully understood before construction. After the discovery of hidden components or unexpected site conditions, design changes may occur, affecting the engineering quantity calculation, cost estimation and construction planning [1, 4].

The renovation of H. M. Comer Hall at the University of Alabama provides an example of cost and schedule management based on BIM. The project included partial demolition, structural renovation, mechanical and electrical upgrades, and interior space reconstruction. BIM models were used to extract component quantities for cost estimation. The model was also linked with the construction schedule to create a 4D simulation of the renovation process [4, 9].

4D models were used to review the order of disassembly, structural work and mechanical and electrical installation. When the design changes, the relevant quantity information can also be

DOI: 10.54254/2755-2721/2026.38425

updated through the model, which provides additional information for cost adjustment and schedule planning [4]. This method reduces some of the duplicate work in the calculation of labour quantities and makes it easier to review the construction sequence before the on-site work begins.

The project also reports some limitations. Data exchange between BIM software and cost calculation software was not fully consistent, and exported quantity information still required manual checking [4]. Frequent design changes also increased the workload of keeping the model and schedule up to date. In addition, unexpected site conditions, such as damage to existing components or delays in material delivery, could not always be reflected in the model in advance. Therefore, 4D simulation can support cost and schedule management, but it cannot completely replace on-site adjustment and professional judgement.

4. Existing problems and development directions

The lack of original drawings of existing buildings is a common reality problem faced by renovation projects. Many historical restoration activities lack written archives, resulting in the innate deficiency of the basic information of the project. Status research and reverse modelling work consume a lot of manpower, equipment and time resources. The accuracy of the model largely depends on the quality of the data collected on the spot. Measurement deviations and information defects will be directly passed to the subsequent design stage. During the implementation stage of renovation, demolition, maintenance and various design changes, the physical state of the building will be constantly changed. However, BIM models are often difficult to update synchronously, which may cause the model to be inconsistent with the physical state of the building.

From the perspective of project implementation, the data interoperability between various BIM software and cost management software is limited [10]. During the cross-platform transmission of the model, data information is easily lost, which affects the efficiency of multidisciplinary collaboration. The application level of BIM in the project team is uneven, and some construction units and owner units lack practical experience, making it difficult to give full play to its collaborative value. Frequent design changes in the transformation project add to the heavy update work, which can easily lead to a disconnect between the model version and the actual design. In addition, most of the existing relevant case studies focus on showing the operation process of BIM. There is still a relative lack of quantitative empirical data on the improvement effect of BIM on the cost and construction period of the renovation project.

In view of the above practical difficulties, in the future architectural transformation, the development of BIM should not only pursue the detail level of the model, but also pay attention to the matching degree of information quality and management. Relevant policies should standardise the acquisition of building information, considering not only the collection cost, but also the actual accuracy of the model. At the same time, it is necessary to improve the data standards and model delivery specifications of BIM in the transformation scenario, enhance the data interoperability between different software, open the data links between design, cost and progress modules, and reduce the workload of manual repeated proofreading. A dynamic model operation and maintenance mechanism suitable for building renovation projects should also be established. The responsibilities and workflows for model updates after design changes should be clearly defined to ensure that the model can be updated along with changes in the physical building, thereby improving the implementation of BIM technology in renovation projects.

DOI: 10.54254/2755-2721/2026.38425

5. Conclusion

Building renovation projects generally encounter inherent problems such as incomplete basic information of existing buildings, frequent adjustments to the scheme design, and great difficulty in multi-disciplinary collaboration and coordination. BIM technology can support renovation projects on three levels: First, by integrating multi-source information of existing buildings to complete reverse model reconstruction, it builds a relatively complete and unified digital information foundation for subsequent renovation design; Second, relying on a single integrated model, multi-disciplinary design collaboration is achieved, spatial conflict checks are carried out, and errors caused by information fragmentation among different disciplines are reduced. Third, by integrating the component engineering quantity information and the construction schedule plan, it can assist the project in conducting cost estimation and construction progress simulation.

However, the actual application effect of BIM in building renovation projects is still restricted by multiple factors, such as the quality of the original basic data, on-site information collection conditions, the dynamic update mechanism of the model, the compatibility of the software platform, and the BIM technical capabilities of all participants. In the future, efforts should be made to enhance the efficiency of information collection and model update for existing buildings, establish data connection links among different software and specialties, and improve the integrated collaborative management model of design, cost and schedule. BIM is essentially an information collaboration tool for building renovation projects. Its application effectiveness does not depend on the model itself but is jointly determined by the quality of the underlying data and the overall project management process. Future studies are expected to provide more quantitative empirical evidence to verify and continuously improve the application of BIM in building renovation projects.

References

[1] Volk, R., Stengel, J., & Schultmann, F. (2014). Building information modeling (BIM) for existing buildings — Literature review and future needs. *Automation in Construction, 38*, 109-127. https://doi.org/10.1016/j.autcon.2013.10.023

[2] Li, B., & Willkens, D. S. (2025). Digital transformation through multidevice HBIM workflow: A case study on supporting the adaptive reuse of the Odd Fellows Building in Atlanta, Georgia. *Frontiers in Built Environment, 11*, 1720481. https://doi.org/10.3389/fbuil.2025.1720481

[3] Ochoa, A., & Froese, T. (2023). Exploring BIM implementation challenges in complex renovation projects: A case study of UBC's BRDF expansion. *Applied Sciences, 13*(23), 12563. https://doi.org/10.3390/app132312563

[4] Alzarrad, M. A., Moynihan, G. P., Parajuli, A., & Mehra, M. (2021). 4D BIM simulation guideline for construction visualization and analysis of renovation projects: A case study. *Frontiers in Built Environment, 7*, 617031. https://doi.org/10.3389/fbuil.2021.617031

[5] Schönfelder, P., Aziz, A., Faltin, B., & König, M. (2023). Automating the retrospective generation of as-is BIM models using machine learning. *Automation in Construction, 152*, 104937. https://doi.org/10.1016/j.autcon.2023.104937

[6] Arayici, Y. (2008). Towards building information modeling for existing structures. *Structural Survey, 26*(3), 210-222. https://doi.org/10.1108/02630800810887108

[7] Nguyen, T. A., Do, S. T., Le-Hoai, L., Nguyen, V. T., & Pham, T. A. (2023). Practical workflow for cultural heritage digitalization and management: A case study in Vietnam. *International Journal of Construction Management, 23*(13), 2305-2319. https://doi.org/10.1080/15623599.2022.2054268

[8] Paik, S. M., Leviakangas, P., & Choi, J. (2022). Making most of BIM in design: Analysis of the importance of design coordination. *International Journal of Construction Management, 22*(12), 2225-2233. https://doi.org/10.1080/15623599.2020.1774837

[9] Doukari, O., Seck, B., & Greenwood, D. (2022). The creation of construction schedules in 4D BIM: A comparison of conventional and automated approaches. *Buildings, 12*(8), 1145. https://doi.org/10.3390/buildings12081145

DOI: 10.54254/2755-2721/2026.38425

[10] Gerbino, S., Cieri, L., Rainieri, C., & Fabbrocino, G. (2021). On BIM interoperability via the IFC standard: An assessment from the structural engineering and design viewpoint. *Applied Sciences, 11*(23), 11430. https://doi.org/10.3390/app112311430