Received: 10 Jan. 2025 | Revised: 14 Feb. 2025 | Accepted: 17 Feb. 2025 | Published online: 25 Feb. 2025
RESEARCH ARTICLE

Journal of Global Humanities and Social Sciences
2025,Vol. 6(2)40-45
DOI: 10.61360/BoniGHSS252017660201

Study on the Application of BIM Technology and Optimisation of Construction Management in Urban Renewal Projects

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Abstract: With the acceleration of urbanisation, the scale and complexity of urban regeneration projects are increasing, and traditional construction management methods are gradually showing inadequacies in the face of increasingly complex demands. Building Information Modelling (BIM) technology, as a revolutionary digital technology, has gradually become a core tool to promote the optimal management of urban renewal projects due to its efficient information integration and visualisation capabilities in all phases of design, construction, operation and maintenance. Therefore, studying the application of BIM technology in urban renewal projects and analysing its optimisation in construction management has become an urgent issue in the current construction industry. This paper will focus on the application of BIM technology in urban renewal projects and its optimisation role in construction management, and put forward corresponding implementation strategies and suggestions for construction management optimisation.

Keywords: urban renewal project; BIM technology; construction management optimisation

Introduction

With the rapid advancement of global urbanisation, many cities are faced with great demands for renewal and renovation. Traditional construction management models are often constrained by problems such as lagging information, misallocation of resources and insufficient project coordination, which makes it difficult to guarantee the quality and efficiency of urban renewal projects. Therefore, Building Information Modelling (BIM) technology, as a new information management tool, has gradually become a key technology to optimise the management and improve the efficiency of the construction industry with its accurate management and collaborative sharing of information during the whole process of design, construction and operation. Efficient management of the whole life cycle of the building.

1. The Role of BIM Technology in Construction Management Optimisation

First of all, BIM technology achieves the centralised management of project information, breaking the dilemma of scattered and poor communication of information exchange in the traditional construction process. Through the BIM platform, all project-related information can be stored centrally, facilitating collaboration and communication between departments, greatly improving the efficiency of project management. Secondly, BIM technology can achieve accurate control of project progress. With the dynamic simulation function of BIM, the construction plan can be adjusted according to the actual situation, and potential problems can be found and solved in time, effectively avoiding project delays and cost overruns. In addition, BIM technology can also help optimise project costs. Through the automatic identification of construction materials and equipment, BIM technology can carry out cost estimation and optimisation, reduce the cost of building construction, and improve the profitability of enterprises (Wei, 2024). Finally, BIM technology has been deeply applied in all stages of urban renewal projects, such as survey, design and construction, and can achieve comprehensive monitoring and management of the entire construction process. This not only improves the construction efficiency, but also ensures the quality and safety of the project.

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2. Application of BIM Technology in Urban Renewal Projects

2.1. Design optimisation

2.1.1. Virtual modelling and visualization design

In urban renewal projects, BIM technology greatly improves the efficiency and accuracy of the design phase through the application of virtual modelling and visualization design. Virtual modelling is one of the core applications of BIM technology, and through the construction of 3D digital model, it can comprehensively and accurately display the various components of the building project, including the structure of the building, mechanical and electrical equipment, pipeline system, etc.. This model not only has a high degree of spatial visualisation, but also realistically reproduces the physical and functional characteristics of the project, providing an intuitive working platform for designers. Through virtual modelling, designers can simulate the project in the computer environment, predict and adjust the feasibility of different design options, so as to avoid problems in the actual construction process (Ma et al., 2025). In addition, virtual modelling is also able to centralize the data of various aspects of the project on a single platform, which facilitates collaboration and information sharing among different teams and professions, improves the efficiency of multi-party communication, and reduces errors and misunderstandings in information transfer. Visual design, as an extension of virtual modelling, further strengthens the intuitiveness and interactivity of the design scheme. Traditional two-dimensional drawings are difficult to clearly show the details of complex designs, and through the three-dimensional modelling of BIM, the design drawings not only become more intuitive, but also able to be displayed in different perspectives, helping all parties to the project to quickly understand the design intent and construction difficulties.

2.1.2. Design conflict detection and coordination

Design conflict detection and coordination is an indispensable application of BIM technology in urban renewal projects, which is mainly through the integrated 3D modeling platform, timely detection and resolution of multi-disciplinary conflicts and inconsistencies in the design phase, thus effectively reducing rework and waste of resources in the construction phase. Urban renewal projects usually involve cross-disciplinary and multi-professional cooperation, such as architecture, structure, mechanical and electrical, HVAC and other fields, the design of these professions is interdependent and complex, the traditional two-dimensional design drawings are difficult to effectively identify potential conflicts between the professions, which can easily lead to omissions in the design scheme and errors during the construction.BIM technology, through the establishment of an integrated 3D model, will be all the design information and data integrated on the same platform, making it possible for all the design information and data to be integrated on the same platform, thus effectively reducing rework and waste of resources during the construction phase. integrated on the same platform, which enables all professional designs to be displayed and analysed in the same virtual space, thus improving the predictability and controllability of conflicts in the design stage (Wang, Mao, & Liu, 2024). Specifically, the design clash detection function of BIM technology can automatically identify and locate collisions and inconsistencies among the various disciplines in building design. For example, the arrangement of electromechanical pipelines may clash spatially with structural beams, walls, or other equipment, and traditional design methods can often only identify these problems at the construction site, leading to increased project costs and delays in the construction period. Through the collision detection function in the BIM model, designers can instantly discover these problems in the virtual modelling stage, and make timely adjustments and optimisation, thus avoiding repeated modifications and construction stagnation due to design conflicts in the construction process.

2.2. Construction management

2.2.1. Project progress and cost control

In the construction management of urban renewal projects, the application of BIM technology provides strong support for project progress and cost control.BIM enables project managers to carry out comprehensive planning and simulation of all aspects of the project prior to construction, foresee potential problems and take measures in advance through three-dimensional modelling and information integration, so as to effectively control the progress of the project. Through accurate modelling, the constructor is able to track the execution status of each project in real time, identify progress deviations automatically, and then take corrective measures to avoid schedule delays (Chen, 2024). In addition, BIM technology also helps to reduce the waste

phenomenon in construction and reduce the material procurement and labour costs through the optimal allocation of resources, the reasonable arrangement of the construction sequence and the refined design of the construction plan. Project cost control through the dynamic data monitoring and analysis of BIM technology can provide real-time cost prediction and early warning for project managers, discover the risk of project cost overruns in a timely manner, and ensure that the project is completed within the budget.

2.2.2. project quality management and risk identification

The application of BIM technology in engineering quality management and risk identification provides a technical guarantee for the smooth progress of urban renewal projects. In traditional construction management, quality problems and safety hazards are often not detected in time due to poor information communication and management omissions, and BIM technology realises digital tracking and monitoring of the whole process of construction by integrating design information and construction process data, which greatly improves the accuracy and efficiency of quality management. For example, through the 3D modelling of the building structure, BIM technology is able to detect possible structural conflicts, construction difficulties and safety hazards in the design stage in advance, and make optimization adjustments before construction, thus avoiding the occurrence of quality problems from the source. In addition, BIM technology, combined with modern equipment such as sensors and drones, can monitor the environment of the construction site and the operating conditions of the workers in real time, and timely identify possible safety risks, such as improper operation of the construction personnel or equipment failure, to avoid the occurrence of safety accidents. In terms of project quality management, the BIM model can be docked with the construction quality standards in real time to ensure that each stage of construction meets the predetermined quality requirements.

2.3. Operation and maintenance management

2.3.1. Facility management and information transfer

In the operation and maintenance management of urban renewal projects, the application of BIM technology in facility management and information transfer plays a crucial role. With the continuation of the building life cycle, facility management becomes an important link to ensure the normal operation of building functions, while BIM technology provides comprehensive information support for facility management. Through BIM technology, all kinds of facilities of a building, including structures, equipment, pipelines, power systems, etc., can be accurately represented and managed in digital models (Li, 2024). Facility managers are able to obtain detailed information about each part of the building in real time through the BIM model, and realise the whole life cycle management of building facilities. This process not only improves the diagnostic efficiency of equipment failures, but also quickly locates the source of the problem when a failure occurs, reducing maintenance time and cost. At the same time, BIM technology provides a reliable way for information transfer. In traditional facilities management, the transmission of information often relies on paper documents or a single management system, there are problems of information lag and communication barriers. BIM technology, however, ensures real-time updating and sharing of various types of information through a centralised data platform, thus enhancing information communication and collaboration between different departments and personnel.

2.3.2. Data sharing and updating

Data sharing and updating is a key link in the operation and maintenance management of urban renewal projects. Traditional operation and maintenance management often faces the problem of information silos, which makes it difficult for different systems and departments to share and update data in real time, leading to lagging or inaccurate decision-making basis, and the introduction of BIM technology has effectively solved this problem. Through the BIM platform, all kinds of data related to the project can be centrally managed and shared, including design data, construction data, equipment operation data, maintenance history and so on. These data are continuously updated and expanded during the building operation process, providing continuous support for operation and maintenance decisions. For example, during the use of a building, as equipment is replaced, functions change and maintenance records increase, the BIM system is able to automatically update the relevant data and share it with all parties via the cloud platform, ensuring that all participants have access to the latest, comprehensive facility information. Especially when

carrying out equipment maintenance or troubleshooting, O&M personnel can use the BIM system to query the historical maintenance records, service life, maintenance status and other information of the relevant facilities, so as to make scientific maintenance decisions.

3. Construction Management Optimisation Implementation Strategies for BIM Technology in Urban Renewal Projects

3.1. Key success factors for implementation

3.1.1. Government and industry support

The successful implementation of BIM technology in urban renewal projects cannot be separated from the strong support of the government and the industry. First of all, the government's policy guidance and regulation construction provide the necessary framework guarantee for the popularisation of BIM technology. In the construction industry, especially in the field of urban renewal, the application of BIM technology is still in the stage of gradual advancement, and many enterprises and projects may be resistant to or concerned about the implementation of BIM technology due to the lack of clear legal norms and policy support. Therefore, the government should clarify the legal status and application standards of BIM technology through the introduction of relevant regulations and policies to provide protection for its full implementation in construction projects. For example, the government can formulate mandatory standards to require the use of BIM technology in large-scale urban renewal projects, or give certain financial subsidies and tax breaks to enterprises adopting BIM technology to reduce their initial investment burden. Secondly, industry associations and related organisations should also play an active role in promoting the standardisation of BIM technology and organising related industry seminars and technical exchange activities to enhance the overall technical level and awareness of the industry (Zhang, 2024). Industry support can not only provide more technical resources for BIM technology, but also promote its wide application in different regions and different types of projects.

3.1.2. BIM technology training and talent cultivation

The key to the effective implementation and operation of BIM technology lies in the cultivation of talents and technical training. Although BIM technology is gradually being applied in the construction industry, many construction industry practitioners still have insufficient mastery of BIM technology due to its complexity and technicality. To ensure that BIM technology can be maximised in urban regeneration projects, it is first necessary to provide systematic technical training to all parties involved before project implementation. This includes training for designers, constructors, project managers and other types of positions, so that they can master the BIM software tools and operating procedures, thus reducing errors and rework due to improper operation. Secondly, BIM technology training should not be limited to a single field of knowledge transfer, and should pay more attention to the cross-border integration of multiple disciplines and the cultivation of practical operation ability. The training of talents needs to be based on actual projects, combined with specific cases for teaching, so as to ensure that the students can flexibly apply what they have learnt in the actual work.

3.1.3. Cross-industry, cross-professional synergy mechanism

One of the advantages of BIM technology lies in its interdisciplinary and inter-industry synergy, however, inter-industry and inter-professional collaboration is also a key factor for its successful implementation. Urban regeneration projects usually involve multiple parties, such as architectural design, structural engineering, mechanical and electrical installation, landscape design, and other multi-disciplinary and inter-disciplinary collaboration. In the traditional project management model, the professional teams often have information silos and poor data exchange and communication, leading to design conflicts, resource wastage, schedule delays, etc. BIM technology, by providing an integrated platform, can share the design solutions and construction progress of all parties in real time, thus realising seamless data matching and collaborative work. In this process, a cross-discipline and cross-industry collaboration mechanism is crucial. All project parties must establish an effective information sharing and feedback mechanism on the BIM platform to ensure that every aspect of the project can be adjusted and optimised in a timely manner. In order to achieve this goal, project management parties should establish a clear collaboration process and division of responsibilities to ensure a smooth flow of information (Tang, 2024). In addition, cross-industry collaboration is not only limited to building design and construction, but

should also include the participation of government departments, environmental protection organisations, and urban planning departments to form an all-encompassing, multi-level collaborative network. Under this collaborative framework, all parties are able to focus on common goals and achieve optimal allocation of resources, minimisation of risks and maximisation of benefits through BIM technology.

3.2. Implementation steps and recommendations

3.2.1. Gradual implementation from design to construction

The implementation of BIM technology should start from the initial design stage of the project, throughout the construction process, and continue to the later operation and management. In order to ensure that BIM technology can maximise its effectiveness, it is recommended to take a step-by-step approach, from design to construction step by step. In the design phase, BIM technology helps designers optimise and visualise the building scheme through 3D modelling and virtual simulation, identifying potential problems in the design in advance, such as structural conflicts and irrational equipment layouts, so as to avoid design modifications and rework during the construction phase. Then, in the construction phase, BIM technology can provide real-time construction progress and resource scheduling information to ensure that construction personnel can accurately perform construction tasks according to the model. In addition, during the construction process, BIM technology can be interfaced with the on-site construction management system to track construction quality and progress in real time, identify and solve construction problems, further optimise the construction process, and reduce construction costs and duration. The gradual implementation of the process can ensure that BIM technology and the needs of each project phase to match, to avoid blind promotion or over-reliance, to ensure that its application effect is maximised.

3.2.2. Data management and post-maintenance

BIM technology not only plays an important role in the design and construction stage, its value in the later maintenance and management should not be ignored. After the completion of the project, the operation and maintenance of the building also need to rely on the accurate data support of BIM technology. Therefore, establishing a scientific and reasonable data management mechanism to ensure the data circulation and update of BIM model in the whole process of the project is the key to realise the whole life cycle management of the building. During the construction phase, all construction data should be entered into the BIM system in a timely manner to ensure that all design changes, construction progress, quality inspections and other information during the construction process are accurately recorded and form a complete digital file. This data will provide valuable reference and basis for later facility management (Luo, 2024). After the building is put into use, BIM technology can help managers monitor the use status of the building in real time by integrating building operation and facility management information, such as energy consumption, equipment operation and other indicators, so that potential problems can be detected and dealt with in a timely manner. For example, through the BIM model, facility managers can quickly access the maintenance records and historical data of various facilities in the building, and pinpoint the location and requirements of repairs and maintenance, which greatly improves the efficiency and accuracy of maintenance work.

Conclusion

To sum up, through an in-depth analysis of the application of BIM technology in urban renewal projects, this paper shows that BIM technology can effectively optimise the construction management and enhance the overall benefits of urban renewal projects by improving the efficiency of information sharing and collaboration, reducing the project costs and risks, as well as refined quality management. To this end, the government, industry and enterprises should work together to promote the standardisation of BIM technology, provide corresponding policy support and technical training, and ensure its smooth implementation in urban renewal projects. In the future, with the continuous maturity and application of BIM technology, the management mode of the construction industry will be more intelligent and digital, thus providing more reliable technical support and practical experience for sustainable urban development.

Conflict of Interest

The authors declare that they have no conflicts of interest to this work.

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How to Cite: Chen, K. S., Chen, K. Y., Liu, K., Ma, J. & Li, W. (2025). Study on the Application of BIM Technology and Optimisation of Construction Management in Urban Renewal Projects. *Journal of Global Humanities and Social Sciences*, *6*(2), 40-45.
https://doi.org/ 10.61360/BoniGHSS252017660201