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Research on Collaborative Management of BIM (Building Information Modeling) in Engineering Projects

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Abstract: The research on collaborative management of Building Information Modeling (BIM) in engineering projects aims to explore the application of BIM technology in construction engineering and its impact on collaborative management. BIM technology creates digital 3D models, centrally manages project information, promotes information sharing and collaboration, and improves project management efficiency. In construction projects, BIM technology can effectively solve the problems of difficult information sharing and poor information transmission, thereby making collaborative management more efficient. In addition, the application of BIM technology in the design, bidding, and construction stages can ensure the smooth transmission of information and improve the efficiency of collaborative management. Research has shown that the application of BIM technology in structural design significantly improves design quality and demonstrates its wide applicability. However, despite the significant advantages of BIM technology in collaborative management, there are still some challenges, such as trust issues and technical operational difficulties. Through in-depth research and application of BIM technology, more efficient collaborative management models can be provided for future engineering projects, promoting the development of the construction industry.

Keywords: BIM, engineering project, collaborative management.

1. Introduction

The rise and development of Building Information Modeling (BIM) technology is a significant transformation in the construction industry. BIM technology simulates multiple tasks of a project through digital information modeling, providing an integrated 3D modeling platform that greatly improves the efficiency of design, construction, and management of construction projects [1]. In recent years, with the rapid development of information and communication technology (ICT), BIM technology has received widespread attention and application worldwide, becoming one of the core technologies in the construction industry [2].

The application of BIM technology in collaborative management of engineering projects can significantly improve the smoothness and accuracy of information flow. Traditional project management methods often face communication barriers, while BIM creates a shared communication platform that enables real-time collaboration and information exchange among all parties on the same platform, thereby improving the overall efficiency of the project [3]. In addition, BIM technology can also help project teams better communicate design and construction plans through its powerful

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visualization capabilities, thereby reducing construction accidents caused by communication errors [4]. On the other hand, BIM can improve the transparency and retention of project content and information in collaborative management. All information changes and construction progress can be recorded on a shared platform, which not only helps project managers make decisions, but also enables them to quickly identify the cause and take corresponding measures when problems arise in the project [5].

Currently, the application of BIM technology in engineering projects has achieved significant results. Through BIM technology, project teams can achieve high integration and sharing of information, promote collaborative work among stakeholders at all stages, and improve overall work efficiency [6]. For example, in the field of structural design, BIM technology promotes data access and exchange by creating digital 3D models, centralizing information management, and significantly improving project quality and construction efficiency [4]. In addition, BIM technology has played an important role in project management, cost control, quality management, and has become a core force for the transformation and upgrading of construction enterprises [7].

However, despite the broad application prospects of BIM technology in engineering projects, it still faces difficulties in information sharing and poor information transmission in practical applications, which affects the efficiency of collaborative management [1]. However, through collaborative management, information sharing and collaborative work among all parties in the project can be achieved, improving the overall efficiency and quality of project management [8].

In conclusion, studying the role of BIM in collaborative management of engineering projects is of great significance for improving project efficiency. By achieving high integration and sharing of information, BIM technology can significantly improve the collaboration efficiency, transparency, and construction quality level of projects, thereby promoting the modernization and sustainable development of the construction industry [9].

Studying the collaborative management of BIM technology in engineering projects is of great significance. The research topic of this article is to deeply explore the application of BIM technology in collaborative management of engineering projects, and discuss its advantages and disadvantages. Using a case analysis research method, the aim is to provide theoretical support and practical guidance for efficient management of engineering projects, thereby promoting the collaborative management process of BIM technology in the construction industry and improving the economic and social benefits of projects.

2. Definition and Current Development of Collaborative Management

The application of collaborative management in Building Information Modeling (BIM) is an important research field. The basic concept of collaborative management refers to promoting information sharing and cooperation among project participants through effective communication and coordination. However, the introduction of BIM technology provides new tools and methods for collaborative management, making information transmission and sharing smoother and more efficient.

In today's era, there are still some problems in the development of collaborative management of BIM in construction projects. Firstly, the difficulty of information sharing and the blockage of information transmission are one of the main challenges [1]. Although BIM technology can smoothly transmit information during the design, bidding, and construction phases, the high integration and sharing of information still face significant challenges in practical applications [1]. Secondly, users have different opinions on the functionality, effectiveness, and usability of web-based collaboration tools. Although 70% of user reviews are positive, there is still a significant portion of users who hold negative attitudes towards the user experience of these tools, indicating that there is still a lot of room for improvement in the practical application of these platforms [3]. In addition, the operational issues

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of BIM in structural design cannot be ignored. Despite the excellent performance of BIM models in data management and information exchange, system operability remains a major obstacle in practical operations, especially in the field of structural design, limiting the comprehensive application of BIM [4].

Overall, although the application of BIM in collaborative management has shown significant advantages, its comprehensive promotion and application still face challenges in terms of information sharing, actual user experience, and system completeness.

3. Case Analysis

This study selects a specific engineering project as the case study object, conducts in-depth research on the selected case, compares and analyzes the application of BIM technology in different engineering projects, explores the advantages and disadvantages of BIM technology in engineering project collaboration management, as well as possible problems and challenges. At the same time, this study will propose targeted suggestions and improvement measures to provide reference for the improvement of BIM technology in engineering project management. In order to further explore the application of BIM in collaborative management of engineering projects, this study selected multiple specific project cases for analysis. Through qualitative and quantitative analysis of these cases, the actual effects and existing problems of BIM technology in different stages have been revealed.

3.1. TL331 Project

The TL331 project is a mid to late stage project implemented in the first phase of a theme park in the United States. It is a flexible exhibition space, with a main body of a 3-story building covering an area of approximately 1720 square meters and a total construction area of approximately 3229 square meters. The total planned construction period is 371 calendar days, and the project scope is full professional general contracting. The project faces several main issues that need to be addressed, including deviations in collaboration and information transmission during construction, resulting in delayed progress and increased costs. The differences in architectural concepts among different stakeholders, especially in terms of quality standards. The design standards and detailed design of theme parks are different from the conventional practices in China. Sample construction and material selection must be strictly carried out in accordance with the owner's requirements [10].

To address these issues, the project adopted the IPD (Project Integrated Delivery) model and applied BIM technology. The application of BIM technology is mainly reflected in the use of a full process building information model, from design to construction, as well as the use of 3D model drawings and 4D schedule for communication and problem solving. At the same time, all parties involved achieve data collaboration and transmission through the BIM platform. It can be seen that the advantages of BIM technology in collaborative management of this engineering project are reflected in the following aspects. Maximizing information sharing and professional collaboration in collaborative management. Effectively promote the progress and cost control of engineering projects. Improve the work efficiency of Party B and all participating parties, and accelerate the construction progress [10].

But at the same time, the application of BIM technology also has the following problems. The application of BIM technology in collaborative management requires all parties to have BIM technology capabilities, which increases training costs. The initial investment is relatively large, which may not be economical enough for small-scale projects. The application of BIM technology requires close cooperation from all parties and demands high collaboration skills from management personnel [10].

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3.2. BIM Information Retrieval Research Project

This study is a research project on BIM (Building Information Modeling) information retrieval. This project aims to address the challenges in BIM information retrieval and communication, mainly due to the lack of relevant BIM technology knowledge among many project participants, making it difficult to efficiently retrieve the required information from complex BIM and communicate and collaborate with other participants. To address this issue, the study proposed a framework called BIM-GPT, which combines BIM with GPT technology to develop an artificial intelligence based virtual assistant system. This system allows operators to retrieve information from BIM using everyday language without the need to master complex BIM techniques and operating languages. And with the help of the virtual assistant system, operators can collaborate with participants in various engineering stages online to achieve real-time cooperation and communication of various projects, ensuring the efficiency and quality of project progress [11].

BIM technology is widely used in collaborative management in this study. BIM technology can provide rich sources of building information data, integrate BIM technology with GPT models, achieve interaction of resource information, and support 3D visualization of engineering projects, helping participants communicate intuitively with the construction site and greatly increasing the efficiency of collaboration and management. At the same time, the BIM-GPT framework proposed in this study greatly leverages the advantages of BIM technology. GPT technology not only improves the accessibility of BIM, making it easy for non-technical personnel to use, but also reduces the tedious work required for developing natural language processing functions, allowing staff to achieve high-precision query results without the need for a large amount of training data [11].

However, the method proposed in this study may also have some limitations. Research overly relies on the performance and usability of GPT models, which may require some degree of modification and customization based on the actual situation of the project in practical applications. Moreover, for querying or collaborative communication of very professional or complex information, BIM expertise may still be needed to collaborate with professionals [11].

3.3. Group C Project of Zibo Cultural Center

This study takes the C group project of Zibo Cultural Center as an example to explore the refined management of engineering projects based on BIM technology. By analyzing various construction difficulties and using BIM technology to solve collaborative management problems encountered on construction sites, such as collision detection and material optimization. This project is a large-scale construction project, and the main collaborative management issues that need to be addressed include the following parts. The management of construction sites is complex and requires three-dimensional planning. The construction technology difficulties such as large steel sleeve inclined column embedded parts and the collision problems between multiple construction teams require communication and cooperation among all parties involved [12].

The application of BIM technology in collaborative management of this project is mainly reflected in the following aspects. Conduct collision detection through 3D visualization models, communicate with various responsible parties in a timely manner, discover and solve related structural problems. Using BIM models for construction simulation, optimizing construction management and organization. BIM based drawing review meetings, timely communication and problem-solving with all parties involved. Utilizing the BIM cloud platform to share construction drawings, facilitating on-site collaboration and communication between management and construction personnel. Utilize BIM+VR to provide safety education and training to relevant personnel, enabling them to stay in touch anytime, anywhere. The construction progress and quality management are visualized and

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simulated through BIM technology, adjusting the enterprise's construction plan to ensure the reasonable utilization of project funds and time [12].

However, there are also several issues with the application of BIM technology in this project. When applying BIM technology comprehensively in the construction process, it is necessary to cultivate a new generation of building technicians to adapt to the new collaborative and communication environment. This plan has high requirements for information technology of equipment and environment. In the early stages of the project, the investment cost was relatively high due to the construction of an information collaboration system [12].

3.4. Analysis and Summary

Through the analysis of these cases, it can be seen that BIM technology is widely applied and has significant effects in collaborative management of engineering projects. However, there are still some challenges, such as the difficulty of information sharing and the complexity of technical operations, which need to be further explored in future research [13]. The maturity and operational difficulty of BIM technology itself are also important factors affecting its application effectiveness. Despite the rapid development of BIM technology in recent years, there are still significant challenges for some small and medium-sized enterprises and project teams in practical applications. The high operational complexity and learning costs of BIM software may affect its widespread use in projects [13].

In summary, although BIM has significant advantages in collaborative management of engineering projects, the limitations of case studies and potential shortcomings in research methods still need further research and improvement to enhance the application effectiveness and popularity of BIM technology [12].

4. Advantages and Disadvantages of BIM Technology Applied in the Collaborative Management of Engineering Projects

Through in-depth analysis of multiple engineering project cases, this study reveals the advantages and disadvantages of BIM technology in collaborative management of engineering projects, providing valuable references and suggestions.

BIM technology has demonstrated unique technical advantages in engineering collaboration management. BIM technology achieves efficient sharing and professional collaboration of information among all parties by establishing a full process building information model. Whether in the design, construction, or operation stages, all parties can achieve seamless integration through the BIM platform, greatly improving work efficiency [1]. BIM technology effectively promotes the progress and cost control of engineering projects. Through the 4D schedule and 3D model drawings, all parties involved can promptly identify and resolve potential issues, avoiding construction delays and budget overruns. BIM technology has significantly improved the work efficiency of all parties involved. Through the collaboration and transmission of data on the BIM platform, all parties can quickly obtain the required information, reduce communication barriers, and accelerate construction progress [3]. BIM technology supports 3D visualization and virtual simulation, helping participants communicate intuitively with the construction site and solving many complex construction problems, such as collision detection, material optimization, etc., increasing the efficiency of collaboration and management. BIM technology provides a rich source of building information data. By combining with artificial intelligence technologies such as BIM-GPT framework, it can achieve resource information interaction and high-precision query understanding, supporting more intelligent data-driven decision-making [11].

At the same time, there are still some problems and shortcomings in the application of BIM technology in collaborative management. The application of BIM technology requires all parties to

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have certain technical capabilities, which increases training costs and learning burden. Especially for non-technical personnel, mastering the operation and application of BIM still poses significant challenges [3]. The initial investment in BIM technology is relatively large, especially for small and medium-sized projects and enterprises, which face significant economic pressure. This includes the costs of purchasing software and hardware equipment, technical training, and system construction. The application of BIM technology requires close cooperation from all parties and demands high collaboration skills from management personnel. If collaboration is not smooth, it may lead to delayed information transmission, affecting project progress and quality [14]. In practical applications, BIM technology may require a certain degree of modification and customization based on the specific situation of the project. For very professional or complex information queries and collaborative communication, professional knowledge is still needed to handle them.

The future development direction and improvement suggestions mainly focus on the following aspects. Firstly, enhancing the interoperability and data management capabilities of BIM technology is the key to future development. Currently, the application of BIM in structural design and construction has shown wide applicability, and in the future, the operability of BIM platforms should be further optimized to improve project collaboration efficiency [4]. Secondly, the integration and application of BIM technology with other advanced technologies will be an important development trend. Combined with Internet, AI technology, big data analysis and other technologies, real-time monitoring and intelligent management of the construction site can be realized [13]. In addition, in the future, training and education for project members should be strengthened to improve their proficiency and mastery of BIM technology [5].

5. Conclusion

This study analyzed multiple studies on collaborative management of Building Information Modeling (BIM) in engineering projects and summarized the significant advantages of BIM in improving project collaboration efficiency, information sharing, and management quality. Firstly, the application of BIM technology in the design and construction stages can effectively promote the smooth transmission of information and the efficiency of collaborative management. Secondly, the application of BIM based collaborative management platforms in actual projects has significantly improved the quality of project planning, understanding, and execution. In addition, the application of BIM technology in structural design promotes data sharing and exchange by creating and managing digital 3D models, enhancing the overall quality of the project.

This study has made significant contributions to the collaborative management of BIM in engineering projects in both theory and practice. Firstly, this article analyzes the application of BIM technology in different engineering projects, revealing its significant advantages in improving project management efficiency, information sharing, and collaborative work. It explores the advantages and disadvantages of BIM technology in today's context and proposes corresponding improvement methods for existing problems. However, this study also has some shortcomings and limiting factors. Firstly, due to limitations in data sources and the randomness of case analysis, this study mainly focuses on specific types of engineering projects, which may not fully reflect the application effects of BIM technology in all engineering projects.

The research and development direction of collaborative management of BIM technology in the future should focus on the following aspects. Firstly, it is important to strengthen the exploration of the integration of BIM technology with other emerging technologies, such as blockchain technology and AI technology, to further enhance data management and information security levels. Secondly, research on the application of BIM technology in more types of engineering projects, especially those with complexity and high risk, should be strengthened to verify its applicability and effectiveness in different environments. Finally, attention should be paid to the research of BIM technology in

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education and training, to enhance the technical level and collaboration ability of relevant practitioners, and thus promote the digital transformation of the entire industry.

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