Analyzing the Application of BIM Technology in Construction Project Management

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Abstract: Against the backdrop of the booming economic development in China, the construction industry has also witnessed rapid growth. The overall construction process of building projects is no longer a simple "drawing-construction" model, but has become more complex. This study aims to fully utilize BIM technology and apply it throughout the entire construction management process, with the goal of enhancing the quality of construction management, streamlining operational workflows, and improving efficiency. This paper analyzes the current research status both domestically and internationally, and identifies several implementable strategies to enhance the application efficiency of BIM technology in construction project management, considering its use in the planning, design, and construction stages. The research findings presented will greatly assist project management in the field of construction.

Keywords: BIM Technology; Construction Project Management; Application; Efficiency

1. Introduction

In the early stages, BIM technology primarily found its applications in architectural design and research institutions in our country. However, in recent years, the Chinese government has increasingly emphasized the importance of BIM technology, with research institutions attaching great importance to it and continuously conducting related studies. The government has also introduced corresponding policies and standards to better apply BIM technology in the construction industry [1]. Presently, BIM technology has been widely utilized throughout various stages of engineering implementation, greatly enhancing the systematized operation of construction projects. This can be mainly attributed to the high efficiency of BIM technology in data processing, which enables precise control over project data and facilitates cost control and energy conservation. BIM technology holds significant application value in the field of construction project management. It can improve management levels and effectively oversee elements such as materials, machinery, and personnel to ensure smooth construction and achieve desired objectives [2].

This study aims to deepen the application of BIM technology in construction project management. Through strengthening the training and recruitment efforts for BIM technology management personnel within enterprises, as well as enhancing the promotion and application of BIM technology, we can effectively improve management efficiency and quality.

2. An Overview and Development of BIM Technology

2.1. Overview of BIM Technology

BIM, known as Building Information Modeling, has emerged in the field of construction as digital technology rapidly advances across various industries. Through the utilization of BIM technology, three-dimensional models are created for construction projects, enabling relevant personnel to accurately grasp blueprint information. This not only effectively prevents unexpected issues during the construction process but also facilitates cost control, accelerates construction progress, and ensures construction safety [3]. The application of BIM technology throughout the lifecycle of a building is depicted in Figure 1. Particularly in recent years, the continuous improvement of BIM technology has propelled the development of the construction industry, meeting the needs of modern households.

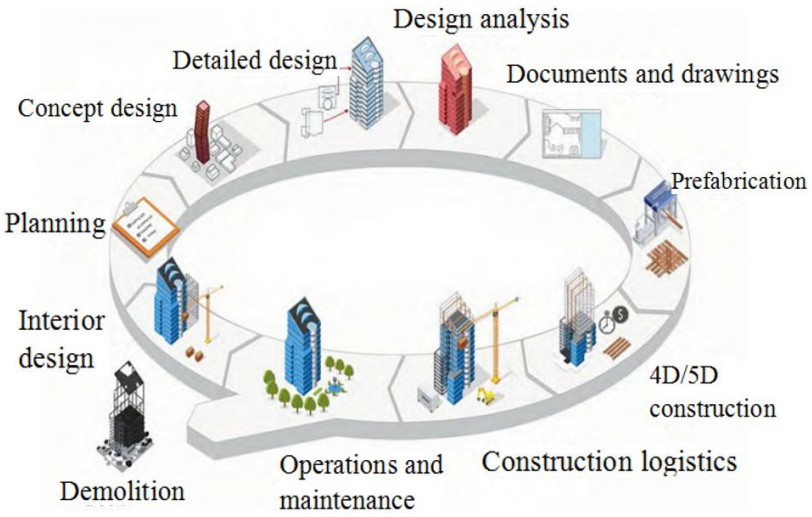

Figure 1. Application of BIM technology throughout the building lifecycle

2.2. Development of BIM Technology

2.2.1. Research status abroad

BIM technology was adopted earlier in the United States, with the GSA launching the National 3D-4D-BIM Program as early as 2003, clearly stating that BIM technology would serve public buildings. The goals of the 3D-4D-BIM program were twofold: first, to innovate technology and provide society with efficient, aesthetically pleasing, and economically secure federal buildings; second, to promote the use of open standards [4]. In 2011, the "Government Construction Industry Strategy" was issued by the British government, aiming to achieve a 20% reduction in procurement costs. To accomplish this goal, the government established regulations, requiring the use and attainment of Level 2 BIM technology for all projects starting in April 2016. The report indicates that the application of BIM technology in the UK has saved the government a significant amount of funds, which can be further invested in new initiatives.

2.2.2. Research status in China

BIM technology entered China relatively early, with its research being strongly supported by the "10th Five-Year Plan" Science and Technology Support Program in 2004. In 2008, relevant specifications were formulated by Chinese architectural research institutions, with the technical and content requirements of these specifications largely meeting the standards of the IFC data model [5]. In 2011, the Ministry of Housing and Urban-Rural Development of China issued the *Outline of Informationization Development in the Construction Industry (2011-2015)* which included BIM technology for the first time in its informationization standard construction [6]. In 2018, during the National People's Congress and Chinese People's Political Consultative Conference, it was proposed to incorporate BIM technology courses into the architectural curriculum.

In the construction process of architectural projects in China, both design firms and construction companies are utilizing BIM technology, with its usage rate being significantly higher than other involved parties. This signifies that the main purpose of BIM technology in the construction field of China is to facilitate the implementation of design during the construction process. The proportion of BIM usage among project stakeholders is illustrated in Figure 2.

3. Characteristics of BIM Technology

BIM technology possesses the characteristics of visibility, coordination, and simulation [7]. Its advantages in engineering management process are evident, and the key analysis will be focused on these characteristics.

3.1. Visualization

Taking construction project management as an example, visualization is a prominent feature of BIM technology. By employing BIM technology effectively, various project information can be intuitively presented, and the information can be represented in a model format within the computer, further advancing the development of architectural project management. Particularly for large-scale

construction projects, the advantages of BIM technology become even more prominent.

3.2. Simulation

Another notable characteristic of BIM technology in construction project management is simulation. Through the implementation of BIM technology, architectural projects can be simulated and examined for clashes using software. Design flaws can be detected within the model, and potential issues during the construction process can be predicted. By taking reasonable measures to mitigate these problems, the construction can proceed safely and efficiently, enhancing the quality and safety of the project.

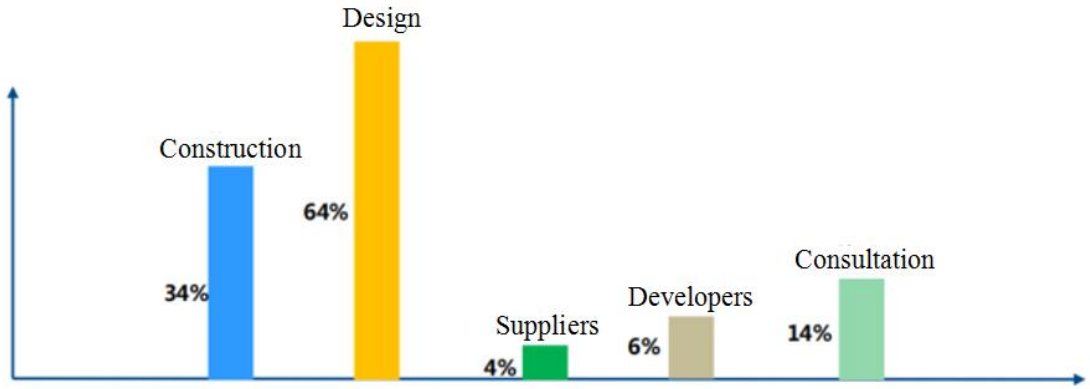

Figure 2. Proportion of BIM usage among project stakeholders

3.3. Coordination

Technical coordination refers to BIM's ability to coordinate the construction process of a project in advance. By utilizing BIM technology to monitor the project, various scenarios that may arise during construction can be simulated in advance, ultimately determining the project model. In order to promote close collaboration among all departments and relevant personnel, fully leveraging their respective roles, it is necessary to utilize BIM technology for coordinating project management. By proactively addressing potential issues that may arise during the project management process, coordination and cooperation can be ensured among relevant departments and personnel, thereby guaranteeing the quality of the project [8].

4. The Practical Application of BIM Technology in Construction Project Management

4.1. Project Planning Phase Management

Placing macro analysis of a project before its initiation in the field of construction engineering projects enables a comprehensive understanding of the project's essential information and complete data. By integrating BIM technology in a rational manner during the project initiation and construction stages, scientific planning can be achieved, ensuring maximum economic benefits for clients. Furthermore, the utilization of BIM technology can facilitate the overall economic development and guarantee the comprehensive effect of technical application and economic construction. Through the application of BIM technology, a thorough analysis of all data can be conducted, leading to the establishment of a three-dimensional model. By utilizing this three-dimensional model, project decision-makers can grasp various factors such as the surrounding geographical environment, providing a more direct visual experience and avoiding the influence of subjective factors during the decision-making process. Consequently, the efficiency of decision-makers is greatly enhanced [9]. The controllability and visuality inherent in BIM technology can be harnessed to improve information retrieval capabilities during the planning process, with relevant indicators being set for verification. Additionally, incorporating GIS technology and RS technology into the information database of BIM allows relevant departments to showcase the value of information from multiple dimensions, ensuring the rigor of preliminary planning.

4.2. Project Design Phase Management

With the development of the construction

industry, contemporary construction projects have transitioned from simple engineering endeavors to intricate and comprehensive processes. These projects involve an increasing number of stages and specialized content, requiring extensive collaboration among various stakeholders. In this regard, BIM technology has emerged as a pivotal platform for communication and exchange among these key individuals.

Through the utilization of BIM technology, traditional CAD two-dimensional data can be transformed into three-dimensional models, effectively presenting information in a visual and immersive manner. Design professionals can directly communicate and collaborate with construction teams and stakeholders by utilizing the model database, gaining valuable insights into their needs. This enables timely modifications to designs and plans, ultimately minimizing the need for costly rework down the line.

4.3. Project Construction Phase Management

BIM technology greatly aids in the control of construction quality. With the use of BIM, personnel can detect and assess the quality of buildings more effectively. By promptly identifying quality issues and evaluating their impact on various aspects, critical control points for construction quality can be identified during the project implementation process[10]. Additionally, BIM technology enables the optimization of quality objectives for projects. Through the establishment of models and the early extraction of detailed schedules to determine the quantity and specifications of components required for construction, overall quality control goals and individual project objectives can be defined in a scientifically sound manner. By aligning these objectives with actual project aims, the overall construction level of the project can be enhanced. The primary processes involved in the application of BIM technology are illustrated in Figure 3.

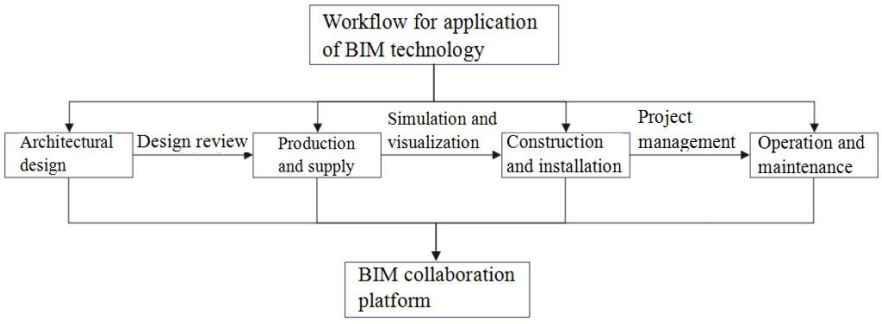

Figure 3. Workflow for application of BIM technology

5. Recommendations for the Application of BIM Technology

5.1. Strengthening the Cultivation and Recruitment of BIM Technology Management Personnel

The successful implementation of BIM technology in construction project management heavily relies on the capabilities and proficiency of the operational staff, which directly impacts the effectiveness of BIM technology. In practice, there is a high demand for BIM technology professionals in the industry, but the existing supply of talent falls short, posing a significant challenge to the comprehensive adoption of BIM technology in construction enterprises. Therefore, we propose the following solutions: Firstly, internal talent cultivation within enterprises can be conducted through specialized training programs to develop existing personnel. Secondly, attracting BIM technology professionals from the market by offering competitive salaries. Thirdly, leveraging the collaborative partnership between academia and industry to directly cultivate and nurture BIM talents from universities, a practice that many educational institutions are open to. These approaches effectively address the shortage of BIM technology professionals, promoting the application and widespread adoption of BIM technology in the construction industry.

5.2. Enhancing the Promotion and Application of BIM Technology

While BIM technology has demonstrated promising application effects in current

construction project management, the pace of promoting and applying BIM technology has not been as sustained as expected. There are still many individuals in relevant fields who do not fully recognize the potential of BIM technology and maintain a cautious attitude towards its adoption. This situation has led to certain limitations of BIM technology in the field of construction management. Therefore, it is crucial for us to further strengthen the promotion and application of BIM technology and extensively expand its scope of application.

6. Conclusion

To conclude, in order to continuously enhance the application of BIM technology in construction project management, it is crucial to strengthen the competency of management personnel and promote the widespread adoption of BIM technology. In the current interconnected world, where information exchange drives societal development, the integration of material resources and digital information has greatly improved social productivity and fulfilled diverse human needs. The extensive application of BIM technology in the construction industry follows this trend. Therefore, it is imperative for management personnel to elevate their proficiency in BIM-related knowledge and actively utilize BIM technology in their managerial practices. By doing so, construction projects can improve their quality, reduce costs, shorten timelines, minimize errors, and decrease the likelihood of rework. Construction companies should strengthen the application of BIM technology, promote high-quality management practices, enhance the overall construction quality of projects, and contribute to the sustained development of the construction industry.

Acknowledgments

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