

Digital Transformation of Construction Management Industry in China: A Review of Literature

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Abstract

Through the rapid growth of the construction market in past decades, the construction management industry in China is now facing the challenges of digital transformation with the extensive development and application of information technologies in construction engineering and management. This literature review explores the digital transformation of the construction management industry in China, focusing on its drivers, technological advancements, challenges, and implications. It highlights the role of government initiatives, labour shortages, and the demand for sustainable practices as key drivers of this transformation. The review discusses the impact of technological advancements such as Building Information Modelling (BIM), Internet of Things (IoT), and virtual reality (VR) on construction management practices. Furthermore, it explores the impact of digital transformation on project management and performance, emphasizing improvements in construction supervision, quality management, cost management, and schedule planning.

Keywords: Digital Transformation, Construction Management, Project Management

1. BACKGROUND OF TRADITIONAL CONSTRUCTION MANAGEMENT IN CHINA

The initial construction management responsibilities reflected the characteristics of project management, intending to perform the "owner's self-management" function to a certain extent. During the subsequent implementation, the internationally accepted design-led approach was not adhered to, resulting in a lack of technical content and authority among the construction management companies. Moreover, the later implementation of cost consulting and bidding agency systems overshadowed the investment control and project management functions of supervision. Supervision gradually became ineffective, evolving into the owner's "quality officer" and "safety officer," while the design institute became merely a "draftsman," resulting in an institutional fragmentation of engineering consulting services. This literature review aims to provide an overview of the existing research and knowledge on the digital transformation of construction management in China, covering its drivers, challenges, technological advancements, and implications for the industry.

1.1. Drivers of Digital Transformation

The digital transformation of the construction management industry in China is driven by various factors, including the government's push for innovation and efficiency, the need to address labour shortages, the demand for sustainable construction practices, and the increasing complexity of construction projects. These drivers have led to a growing emphasis on the adoption of digital technologies and data-driven decision-making processes.

1.2. Government Initiatives

The Chinese government has been instrumental in driving digital transformation in the construction industry. Policies such as the "Internet Plus Construction" strategy and the development of national BIM standards have provided a framework for the industry to follow (Chen, 2023). The construction industry in China faces significant labour shortages, driving the need for automation and digital tools to enhance productivity. The aging workforce and the reluctance of younger generations to enter the construction industry have exacerbated this issue, making digital transformation essential to maintain productivity levels (Hilali et al., 2020). Sustainable construction practices are becoming increasingly important, driven by both government regulations and market demand. Digital technologies enable better resource management, waste reduction, and energy efficiency, aligning with the goals of sustainable development (You, 2024). The growing complexity of construction projects necessitates more sophisticated management tools. Digital technologies such as BIM and Internet of Things (IoT) provide the means to manage complex project data, improving coordination and decision-making. Advancements in digital technologies such as BIM, IoT, drones, and VR have revolutionized various aspects of construction management in China. BIM has gained widespread acceptance for its ability to facilitate collaborative design, clash detection, and project visualization, thereby improving project coordination and reducing errors (Chen, 2023).

BIM has become a cornerstone of digital transformation in construction management. It provides a platform for integrating various aspects of the construction process, from design to operation, enabling better collaboration and decision-making. BIM's capabilities in visualization, simulation, and analysis help in identifying potential issues early in the project lifecycle, reducing costs and delays (You, 2024). IoT technologies are being increasingly used in construction management to monitor and control various aspects of the construction process. Sensors and devices collect real-time data on environmental conditions, equipment performance, and worker safety, enabling more efficient and safer construction practices. And the virtual reality (VR) technologies are being used to create immersive environments for design visualization, training, and safety simulations. VR allows stakeholders to experience the construction project virtually, providing a better understanding of the design and potential issues before actual construction begins (Hilali et al., 2020).

Integrating digital tools with traditional construction practices can be challenging. Many construction firms are accustomed to traditional methods and may resist adopting new technologies. Bridging the gap between traditional and digital practices requires a change in mindset and organizational culture (Cao & Wang, 2021). The Chinese government has been proactive in promoting the digital transformation of the construction industry. Initiatives such as the "Internet Plus Construction" strategy and the development of national BIM standards have provided a framework for the industry to follow. Industry players, including construction firms, developers, and technology providers, have also embraced digital transformation to gain competitive advantage and meet the evolving demands of the market. The "Internet Plus Construction" strategy aims to integrate internet technologies with the construction industry to enhance efficiency and innovation. This strategy encourages the use of digital tools such as BIM, IoT, and cloud computing in construction projects (Chen, 2023). Construction firms in China are increasingly adopting digital technologies to improve project management and performance. The adoption of BIM, IoT, and other digital tools has become a competitive necessity, enabling firms to deliver projects more efficiently and meet client expectations (You, 2024).

2. CHALLENGES AND OPPORTUNITIES

The digital transformation of the construction management industry in China is not without its challenges. These include issues related to data security, interoperability of digital platforms, the need for upskilling the workforce, and the integration of digital tools with traditional construction practices. With the increasing use of digital technologies, data security has become a critical concern. The construction industry deals with sensitive data related to project designs, financial information, and personal data of workers. Ensuring the security of this data is essential to prevent breaches and maintain

trust (Cao & Wang, 2021). The lack of interoperability between different digital platforms is a significant challenge. Construction projects involve multiple stakeholders using various software tools, and the inability to integrate these tools can lead to inefficiencies and errors. Developing standards and protocols for data exchange is essential to overcome this challenge (Hilali et al., 2020). The adoption of digital technologies requires a workforce skilled in using these tools. The construction industry in China faces a significant challenge in upskilling its workforce to keep pace with technological advancements.

3. IMPACT ON PROJECT MANAGEMENT AND PERFORMANCE

Research indicates that the digital transformation of construction management in China has led to improvements in project planning, scheduling, and resource allocation. The use of digital tools has also enhanced project monitoring and control, leading to better cost management and reduced project delays. Furthermore, the integration of digital technologies has the potential to optimize the entire project lifecycle, from design and construction to operation and maintenance. Digital tools such as BIM and project management software enable better planning and scheduling of construction projects. These tools provide real-time data and analytics, helping project managers to make informed decisions and optimize resource allocation (Hilali et al., 2020). Digital technologies have improved cost management by providing accurate and timely data on project expenses. BIM, for example, allows for detailed cost estimation and tracking, reducing the risk of budget overruns (You, 2024). The use of IoT and other monitoring technologies has enhanced on-site project monitoring and control. Real-time data on site conditions, equipment performance, and worker safety enable proactive management and quick response to issues. Digital transformation enables the optimization of the entire project lifecycle. From design and construction to operation and maintenance, digital tools provide valuable data and insights that help in improving efficiency and reducing costs throughout the project lifecycle (Chen et al., 2021; Hilali et al., 2020; You, 2024).

4. FUTURE DIRECTIONS AND RESEARCH TRENDS

Future research in the digital transformation of construction management in China is likely to focus on areas such as artificial intelligence (AI) applications, advanced robotics, and the use of big data analytics for predictive modelling. Additionally, the implications of digital transformation on sustainability, resilience, and smart city development are emerging topics that warrant further exploration (Mergel et al., 2018).

Artificial Intelligence (AI) has the potential to revolutionize construction management by automating tasks, predicting project outcomes, and optimizing resource allocation. Research in AI applications in construction is likely to focus on developing intelligent systems for project management, risk assessment, and quality control (Mergel et al., 2018). Advanced robotics can enhance productivity and safety in construction projects. Robots can perform repetitive and hazardous tasks, reducing the risk to human workers and increasing efficiency. Research in this area will explore the integration of robotics with other digital technologies for optimal performance (Li et al., 2018). The construction industry generates vast amounts of data that can be harnessed for predictive modelling and decision-making. Big data analytics can provide insights into project performance, identify trends, and predict potential issues. Research in this area will focus on developing tools and methodologies for effective data analysis and utilization. Digital transformation can contribute to sustainable and resilient construction practices. Research will explore how digital technologies can enhance resource management, reduce waste, and improve the resilience of construction projects to environmental and social challenges (You, 2024).

5. CONCLUSION

In conclusion, the digital transformation of the construction management industry in China represents a paradigm shift that is reshaping the way construction projects are conceived, executed, and managed. While challenges exist, the potential benefits of digital transformation are substantial, and ongoing research and innovation are essential to fully realize the opportunities presented by this transformation. The government's proactive initiatives and the industry's increasing adoption of digital technologies are driving this transformation, leading to improvements in project management and performance. Future research will continue to explore the potential of digital technologies to enhance sustainability, resilience, and smart city development, ensuring that the construction industry in China remains at the forefront of innovation and efficiency.

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