Chapter 7
Application of Virtual Design and Construction for Construction Waste Management in China

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ABSTRACT

Construction waste management is a major challenge in China amid rapid urbanization and environmental concerns. This study examines the role of Virtual Design and Construction (VDC) technologies in enhancing waste management across planning, segregation, reuse & recycling, and disposal. A mixed-methods approach was used, incorporating qualitative and quantitative analysis, with 30 industry professionals completing an AHP-based questionnaire. Findings highlight Building Information Modelling (BIM) as the most impactful technology for material tracking, waste reduction, and project coordination, while Robotics has the least influence. However, financial constraints, interoperability issues, and resistance to digital adoption hinder implementation. This study offers a framework for prioritizing digital technologies,

guiding industry decision-making and policy recommendations. Future research should focus on real-world implementation challenges and longitudinal case studies to further validate the effectiveness of VDC in construction waste management.

INTRODUCTION

China's rapid urbanization and large-scale regeneration projects generate substantial construction waste annually. It is estimated that approximately 600 tons of construction waste are produced for every 10,000 square meters of construction (Lu et al., 2017). Without effective waste management strategies, the country is expected to produce over one billion tons of construction waste each year, given its annual construction output of approximately two billion square meters—accounting for nearly half of the global total (Hong et al., 2019). Despite considerable research efforts on construction waste management and reduction strategies, significant gaps remain, necessitating further exploration.

As the construction industry undergoes digital transformation, technologies such as Building Information Modelling (BIM), Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) are increasingly integrated into design and construction processes (Elshafey et al., 2020). VDC, in particular, is recognized as a key enabler of efficient waste management (Liu et al., 2015). This study investigates the potential of VDC in mitigating construction waste by enhancing planning, coordination, and execution in construction projects.

Virtual Design and Construction (VDC) offers an innovative approach to enhancing construction waste management efficiency. By integrating digital tools into building design and project management, VDC facilitates collaboration among stakeholders, minimizes design errors, and reduces the need for modifications that often result in material wastage (Kang et al., 2022). Additionally, VDC enables optimized construction planning, reducing rework, streamlining material handling, and ensuring precise ordering, layout, and cutting of materials, all contributing to waste minimization. While VDC has been increasingly incorporated into architectural and construction practices, the progress in its application for waste reduction remains limited. Although construction firms recognize the necessity of waste reduction, achieving substantial improvements requires targeted strategies (Liu et al., 2022).

The adoption of VDC in waste management is hindered by social, policy, and financial barriers (Huang et al., 2018). Social challenges include limited public awareness, lack of standardized technological guidelines, and operational complexities. Policy-related constraints stem from inadequate government initiatives, regulatory gaps, and insufficient training programs. On the other hand, financial barriers involve high investment costs, tax structures, and the expenses associated with workforce

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