Opportunities and Challenges of Generative AI (GenAI) Applications in the Construction Industry

Zhu Hanjing[a], **Shi Maruoyan**[a], **Liang Mingxuan**[a], **Hwang Bon-Gang**[a]

[a] *Department of the Built Environment, National University of Singapore, Singapore* hanjingz@nus.edu.sg, e1168824@u.nus.edu, Mingxuanliang@u.nus.edu, bdghbg@nus.edu.sg

1. Introduction

The rapid advancement of Generative AI (GenAI) has transformed workflows across various industries, offering unprecedented opportunities for innovation. However, its potential applications and the challenges of adoption in the construction industry remain underexplored. This study aims to: (1) identify the opportunities for applying GenAI throughout the construction project lifecycle, and (2) examine the challenges associated with GenAI adoption in the construction industry. A critical review was conducted to investigate the potential applications and challenges, followed by expert panel interviews to validate the findings. This research identifies a comprehensive range of GenAI applications across key project phases: feasibility and planning, design, procurement, construction, and operation and maintenance. To fully harness GenAI's potential, several challenges must be addressed, including ethical and privacy concerns, technical limitations, resource and financial constraints, as well as skill and psychological barriers. This study makes contributions to academia by laying the groundwork for future research on GenAI applications in construction projects. Additionally, the findings provide practical guidance for the industry by highlighting GenAI's potential applications and equipping stakeholders to anticipate and mitigate challenges.

2. Results

2.1 Opportunities of GenAI in Construction Project Lifecycle

Generative AI has shown potential applications across construction project life cycle, including feasibility and planning, design, procurement, construction, and operation and maintenance phases. These applications leverage GenAI's ability to process vast amounts of data and provide optimized solutions tailored to project-specific needs.

Table 1: Opportunities of GenAI Across Phases

Phase	Applications
Feasibility and Planning Phase	Automate feasibility reports, generate project initiation documents, contracts, and schedules; provide expert guidance.
Design Phase	Enhance architectural design, image restoration, and structural optimization.
Procurement Phase	Assist in supplier selection, decision-making, order tracking, and inventory management.
Construction Phase	Assist in construction tasks，enhance site safety management and risk management
Operation and Maintenance Phase	Enable proactive maintenance and enhance energy efficiency

Reference: (Fei et al., 2024; Fitriawijaya & Jeng, 2024; Ghimire et al., 2024; Godahewa et al., 2022; Nyqvist et al., 2024b; Prieto et al., 2023; Saka et al., 2024a; Uddin et al., 2023; Zheng & Fischer, 2023).

2.2 Challenges to Generative AI Adoption

Despite its potential, several barriers impede the widespread adoption of Generative AI in construction. These challenges span ethic and privacy, technical, resource, financial, skill and knowledge, and psychological aspects.

Table 2: Challenges to GenAI Adoption in Construction

Category	Subcategories
Ethic and Privacy	Data security
	Intellectual property
	Low fault tolerance
	Liability
Technical	Hallucination
	Lack of accuracy
	Lack of precision
	Limited learning capabilities
	Interoperability
	Scalability
	Model Updates
Resource	Limited training data;
	High hardware requirements;
	Limited open-source algorithms;
	Specialized knowledge and regulatory adherence;
Financial	High cost
	Unpredictable Return on Investment (ROI)
Skill and Knowledge	Limited Knowledge on Generative AI
	Insufficient Workforce Skills
	Limited Access to Training Resources
Psychological	Resistance to change;
	Fear of displacement due to automation;
	Expectation of mature technologies

Reference: (Chen et al., 2023; Fitriawijaya & Jeng, 2024; Ghimire et al., 2024; Klepo et al., 2023; Liao et

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al., 2024; Nyqvist et al., 2024a; Saka et al., 2024b; Zhao et al., 2021).

3. Conclusion

This study highlights both the transformative potential of GenAI in the construction industry and the significant challenges to its adoption. While GenAI offers opportunities to enhance efficiency, design optimization, and decision-making across all project lifecycle phases, addressing technical, ethical, financial, and workforce challenges is crucial. By systematically exploring opportunities and challenges, this study provides actionable insights to guide practitioners and researchers in leveraging GenAI for sustainable advancements in construction.

Acknowledgments

This study was supported by the Construction Performance Analytics & Innovations Research Unit (cPAIRu) at the National University of Singapore. The authors would like to thank Prof. Hwang Bon-Gang and other contributors for their valuable insights and guidance during this research.

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