Available online at https://asric.africa/engineering-sciences
ASRIC Journal on Engineering Sciences Vol.6(1)(2025) 124-129

Unlocking Project Efficiency Through Artificial Intelligence: A Case for Transforming Construction Management in South Africa

Jojo Kayembe[1], Takalani Netshipale[2], Mondli Mthombeni[1], Nicoline De Wet[1]

[1]Faculty of Engineering and the Built Environment, University of Johannesburg, Doornfontein Campus
[2] SAICE & FAEO
220118328@student.uj.ac.za, tnetshipale@gmail.com, mondlim@uj.ac.za , nickyr@uj.ac.za

Corresponding Author: 220118328@student.uj.ac.za

Received 10 July 2025; revised 22 August 2025; accepted 23 October 2025

Abstract

South Africa's construction sector faces chronic inefficiencies, including delays, budget overruns, and low productivity. Artificial Intelligence (AI) has emerged as a transformative tool globally, demonstrating measurable improvements in project scheduling, risk management, and cost prediction. However, local adoption remains limited. This study investigates the perceptions, barriers, and readiness factors influencing AI integration in South African construction project management. A survey of twenty-two professionals across engineering, contracting, and project management was conducted. Results reveal strong recognition of AI's potential to enhance scheduling and budgeting (77.3% agreement) but limited organisational readiness: only 45.5% reported a digital strategy, 38.1% adequate IT infrastructure, and 18.2% active collaboration with external innovators. Key barriers include digital skills shortages (72.7%) and high implementation costs (54.5%). The findings align with international literature on AI adoption challenges while exposing South Africa's unique contextual constraints. Recommendations highlight skills development, pilot projects, and supportive policy frameworks to accelerate responsible AI adoption. The study contributes to the Africa Engineering Week theme by demonstrating how AI, when contextualised, can strengthen infrastructure delivery and socio-economic transformation.

Keywords: Artificial Intelligence; Construction Project Management; South Africa; Digital Transformation; 4IR; Infrastructure Efficiency

1. Introduction

The construction industry is central to South Africa's infrastructure-led development, yet it continues to struggle with inefficiencies that undermine delivery performance. Delays, cost overruns, and disputes are systemic, with more than 60% of large projects exceeding planned budgets or schedules (Ramabodu & Verster, 2013; Monyane & Emuze, 2018). Such inefficiencies weaken investor confidence, stall socio-economic progress, and exacerbate infrastructure backlogs.

Globally, Artificial Intelligence (AI) has been recognised as a game-changer in construction management. Applications range from machine learning algorithms that forecast project risks and costs (Pan & Zhang, 2021) to natural language processing (NLP) for automating documentation (Abioye et al., 2021) and computer vision systems for safety monitoring and progress tracking (Regona et al., 2022). These tools have delivered efficiency gains of 15–30% in international contexts (Callegari et al., 2018).

However, adoption in South Africa remains uneven. Organisational resistance, limited digital infrastructure, and scarce technical skills inhibit uptake (Tjebane et al., 2022). Although the country has

embraced the Fourth Industrial Revolution (4IR) agenda, translating AI's potential into measurable project outcomes requires addressing systemic readiness issues.

This paper investigates how South African construction professionals perceive AI, identifies barriers to adoption, and assesses organisational readiness. By situating findings within global literature, it seeks to propose context-specific strategies for unlocking efficiency through AI.

International scholarship highlights AI's disruptive potential in Construction Engineering and Management (CEM). Pan and Zhang (2021) emphasise AI's roles in planning, resource optimisation, and real-time monitoring. Abioye et al. (2021) argue that AI provides predictive accuracy for scheduling and cost estimation, while Regona et al. (2022) stress its benefits in risk detection and early warning systems.

In the African context, however, adoption barriers remain more pronounced. Organisational resistance to digital change, skills shortages, and weak IT infrastructure are recurrent challenges (Tjebane et al., 2022). Within South Africa, the Construction Industry Development Board (CIDB, 2023) highlights digital skills gaps as a pressing constraint. Moreover, local studies note that while interest in AI adoption is growing, firms often lack a clear return-on-investment framework (Lumisi, 2024).

Overall, the literature suggests that while AI tools are technically feasible, their success is contingent on organisational readiness, leadership support, and policy frameworks that encourage responsible adoption.

2. Methods, Techniques, Study Area Description, and Study Material

This study adopted a quantitative survey-based research design aimed at assessing the perceptions, barriers, and readiness factors influencing the adoption of Artificial Intelligence (AI) in South Africa's construction management sector. The choice of a structured questionnaire enabled the collection of measurable data suitable for statistical analysis while providing space for qualitative insights through limited open-ended items. Similar survey-driven methodologies have been used in prior studies investigating technology adoption in construction, as they allow the capture of perceptions across diverse professional groups (Pan & Zhang, 2021; Tjebane et al., 2022).

The research focused on the South African construction industry, which represents a complex value chain involving engineers, project managers, contractors, and planners. Invitations to participate were distributed through professional associations such as the South African Institution of Civil Engineering (SAICE) and the South African Council for the Project and Construction Management Professions (SACPCMP), ensuring relevance and diversity of expertise among respondents. A total of 22 valid responses were collected between July and August 2025, reflecting a modest but sufficient sample size for exploratory analysis in line with other sector-focused perception studies (Regona et al., 2022).

The survey instrument comprised 40 items, organised into thematic sections that examined awareness of AI, perceived benefits such as scheduling and risk management, barriers including skills shortages and implementation costs, organisational readiness, and strategic recommendations. Responses were recorded primarily on a five-point Likert scale (ranging from 1 = strongly disagree to 5 = strongly agree), a format widely employed in construction management research to quantify perceptions (Abioye et al., 2021). In addition, two open-ended questions were included to elicit qualitative reflections on opportunities and risks.

Data were analysed using the Statistical Package for the Social Sciences (SPSS) to generate descriptive statistics that summarised frequencies and agreement levels. Given the limited sample size (n = 22), advanced statistical techniques such as correlation, regression, and reliability testing (Cronbach's alpha) were not emphasised, as they require larger datasets to produce stable and generalisable results. Instead, simple percentages were prioritised as the most appropriate way to present clear patterns and trends. The open-ended responses were thematically coded, complementing the quantitative analysis by offering contextual insights.

As the research is ongoing, the study aims to expand the sample to at least 100 respondents. At that stage, more advanced statistical analysis, including internal consistency checks (Cronbach's alpha),

correlation tests, and regression modelling, will be employed to enrich the findings and test relationships between AI adoption factors and project outcomes.

3. Results

The findings highlight a generally positive perception of AI's potential within the South African construction sector, tempered by concerns regarding adoption readiness. A majority of respondents (77.3%) agreed that AI could significantly improve project scheduling, budgeting, and risk management. Similarly, 68.2% acknowledged AI's potential for risk detection and mitigation, suggesting that professionals recognise the technology's value for addressing long-standing inefficiencies in the sector. These findings are consistent with international evidence showing that AI enhances forecasting accuracy and improves project delivery efficiency (Pan & Zhang, 2021; Abioye et al., 2021).

Despite these perceived benefits, participants identified several persistent barriers. The most prominent was the lack of digital skills, with 72.7% of respondents viewing it as a major constraint. High costs of implementation were also widely cited, with 54.5% agreement, while 31.8% highlighted challenges related to system complexity and data incompatibility. These barriers align with broader global literature on AI adoption in construction, which emphasises capacity and resource limitations as recurring obstacles (Regona et al., 2022).

When assessing organisational readiness, results revealed significant gaps. While 63.6% of respondents agreed that their leadership supports AI-driven innovation, less than half (45.5%) reported the existence of a formal digital transformation strategy within their organisations. Only 38.1% indicated that they had adequate IT infrastructure to support AI applications, and a mere 18.2% reported active collaboration with universities, startups, or consultants to foster digital innovation. Such findings reinforce previous research that stresses the importance of institutional enablers, including infrastructure, leadership commitment, and collaborative networks for successful AI integration (Tjebane et al., 2022).

The open-ended responses further enriched these findings. Many participants expressed optimism about AI's capacity to reduce project delays, improve decision-making, and enhance cost control. However, concerns were also raised regarding potential job displacement, reliance on high-quality datasets, and uncertainty about the return on investment in AI systems. These qualitative insights underscore the dual nature of AI adoption: while recognised as a tool for improving efficiency, its integration is mediated by social, economic, and ethical considerations (Regona et al., 2022).

4. Discussion

This study contributes to the growing body of research on Artificial Intelligence in construction management by situating global technological advances within the realities of South Africa's construction sector. While international evidence consistently reports measurable improvements in scheduling, cost control, and risk management when AI is deployed (Pan & Zhang, 2021; Abioye et al., 2021), our findings demonstrate that local adoption is still constrained by organisational readiness and resource limitations. The contribution of this paper lies in bridging this gap: it provides empirical evidence of how industry professionals in South Africa perceive AI, identifies the most pressing barriers to adoption, and quantifies the extent of organisational preparedness.

Table 1: *Summary of Survey Agreement Rates*

Question	Agreement (%)
AI can improve scheduling, budgeting, and risk management	77.3%
Lack of digital skills is a major barrier	72.7%
Leadership supports AI-driven innovation	63.6%
High costs limit AI implementation	54.5%

Question	Agreement (%)
The company has a digital transformation strategy	45.5%
There is an IT infrastructure to support AI systems	38.1%
Collaboration with universities/start-ups	18.2%

***Table 2** – Barriers to AI Adoption*

Barrier	Agreement (%)
Lack of digital skills is a major barrier	72.7%
High costs limit AI implementation	54.5%
Resistance to digital change is prevalent	50.0%
Data formats incompatible with AI tools	45.5%
AI too complex for site-level use	36.4%

As shown above in Tables 1 and 2, by capturing the voices of practitioners, the study highlights the skills gap as the most significant barrier, with 72.7% of respondents identifying limited digital capabilities as a constraint. This insight adds to the literature by reinforcing that technological innovation alone cannot drive transformation; instead, it must be accompanied by human capital development. Furthermore, the finding that less than half of organisations have a digital transformation strategy (45.5%) underscores the urgency of embedding AI adoption within broader organisational and policy frameworks. These observations make a strong case for why this research is necessary: addressing inefficiencies in project delivery requires not only technical solutions but also systemic readiness across institutions. Fig. **1** clearly shows high agreement for AI benefits (77.3%) but low organisational readiness indicators (e.g., only 18.2% report collaboration with universities or start-ups).

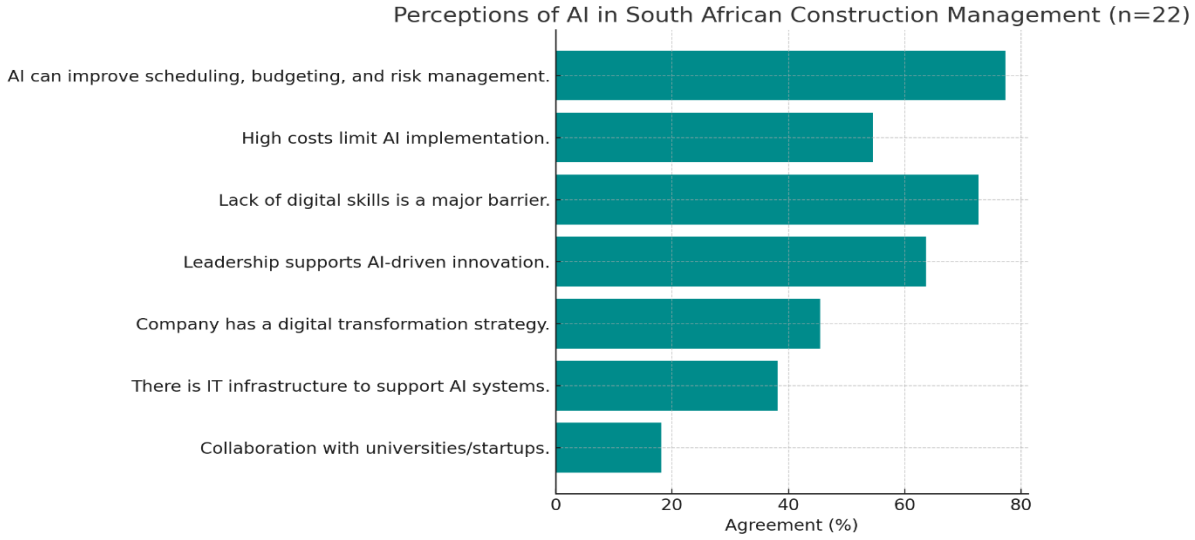

Fig. 1: Perceptions of AI in South African Construction Management (n = 22)

The topic was chosen precisely because inefficiencies in South African construction projects, manifesting in persistent cost overruns, schedule slippage, and low productivity, remain among the most critical constraints on national development (Ramabodu & Verster, 2013; Monyane & Emuze, 2018). By exploring the potential of AI to mitigate these inefficiencies, this paper provides actionable

knowledge that is both contextually relevant and aligned with the broader agenda of the Fourth Industrial Revolution. In doing so, it contributes directly to the Africa Engineering Week theme of "Accelerating Africa's Transformation through Context-Aware Engineering Innovation."

Moreover, this work brings value beyond academic contribution. For industry, the results provide an evidence-based assessment of readiness factors, offering firms a diagnostic framework for evaluating their digital maturity. For policymakers, the study identifies priority areas, particularly workforce training and IT infrastructure, where intervention is most likely to accelerate adoption. For academia, it underscores the importance of integrating AI competencies into engineering curricula to prepare the next generation of professionals. By demonstrating both the opportunities and challenges of AI in South Africa's construction sector, the study contributes to a growing call for context-aware adoption strategies that are sensitive to socio-economic realities while remaining technologically ambitious.

5. Conclusion

This study set out to examine the potential of Artificial Intelligence (AI) in transforming construction project management in South Africa. By surveying 22 industry professionals across engineering, contracting, and project management, it has provided empirical evidence of both the opportunities and barriers that shape AI adoption. The results show that while there is strong recognition of AI's benefits for project scheduling, budgeting, and risk management (77.3% agreement), adoption is held back by critical gaps in digital skills, infrastructure, and organisational readiness. Only a minority of firms reported having a digital transformation strategy or adequate IT infrastructure, and very few were engaged in collaborative innovation with universities or startups.

The contribution of this paper lies in three areas. First, it provides a contextualised account of AI adoption in South Africa's construction sector, complementing global studies by grounding the discussion in local realities of resource constraints, skills shortages, and institutional readiness. Second, it highlights the strategic levers for transformation: targeted workforce training, investment in digital infrastructure, and policy frameworks that incentivise pilot projects and collaborative innovation. Third, it aligns the discourse on AI with South Africa's national development priorities and 4IR agenda, demonstrating how AI can contribute not only to project-level efficiency but also to broader socio-economic transformation through improved infrastructure delivery.

This contribution is significant because inefficiencies in the construction sector remain a critical bottleneck to development in South Africa. Cost overruns and schedule delays not only waste financial resources but also delay the provision of essential infrastructure such as housing, transport, and energy. By showing that AI offers concrete pathways to address these inefficiencies, the study strengthens the case for integrating AI into national infrastructure strategies. In this way, the paper directly supports the Africa Engineering Week theme of leveraging engineering innovations to accelerate Africa's socio-economic transformation.

Furthermore, the study makes a practical contribution by offering firms and policymakers a diagnostic lens for assessing readiness. The findings point to clear priority areas where interventions can unlock adoption, including digital skills development, leadership commitment, and sector-wide digital strategies. For academia, the results highlight the importance of embedding AI literacy into engineering curricula, preparing graduates for an industry increasingly shaped by digital technologies.

In conclusion, while South Africa's construction sector faces structural and organisational barriers to AI adoption, the potential benefits are too significant to ignore. AI offers a pathway to reduce delays, improve cost control, and enhance decision-making, but realising this potential requires coordinated action. By combining technical innovation with institutional reform and skills development, South Africa can move from fragmented adoption to sector-wide transformation. This paper contributes to that journey by providing evidence, identifying barriers, and proposing strategic responses that can help unlock the efficiency gains promised by Artificial Intelligence in construction project management.

6. Acknowledgements

The authors would like to express their deepest gratitude to Jehovah God for granting them the strength, wisdom, and perseverance to carry out this research. We are grateful to the University of Johannesburg

for academic support and to colleagues in the Department of Civil Engineering Technology for their guidance throughout this study. Special thanks are extended to the Federation of African Engineering Organisations (FAEO) for fostering a platform that encourages research on transformative technologies across the continent. We also sincerely thank the construction professionals who participated in the survey, generously sharing their time and insights. Their contributions were invaluable in shaping the findings of this paper.

References

Abioye, S. O., Oyedele, L. O., Akanbi, L., Ajayi, A., Delgado, J. M. D., Bilal, M., Akinade, O. O., & Ahmed, A. (2021). Artificial intelligence in the construction industry: A review of present status, opportunities and future challenges. *Journal of Building Engineering, 44*, 103299. https://doi.org/10.1016/j.jobe.2021.103299

Callegari, C., Szklo, A., Schaeffer, R., & Lucena, A. F. P. (2018). Cost overruns and delays in large energy projects: An assessment of causes and impacts. *Energy Policy, 114*, 157–168. https://doi.org/10.1016/j.enpol.2017.11.059

Chen, K., Zhou, X., Bao, Z., Skibniewski, M. J., & Fang, W. (2025). *Artificial intelligence in infrastructure construction: A critical review*. Frontiers of Engineering Management, 12(1), 24–38. https://doi.org/10.1007/s42524-024-3128-5

CIDB. (2023). *Annual Report 2022/2023*. Pretoria: Construction Industry Development Board.

Monyane, T. G., & Emuze, F. (2018). Identification of lean opportunities in South African public-sector projects cost management framework. In *Proceedings of the 26th Annual Conference of the International Group for Lean Construction (IGLC)*, 18–20 July 2018, Chennai, India (pp. 1171–1180). https://doi.org/10.24928/2018/0207

Pan, Y., & Zhang, L. (2021). Roles of artificial intelligence in construction engineering and management: A critical review and future trends. *Automation in Construction, 122*, 103517. https://doi.org/10.1016/j.autcon.2020.103517

Ramabodu, M. S., & Verster, J.-P. (2013). Factors that influence cost overruns in South African public sector mega-projects. *International Journal of Project Organisation and Management, 5*(1/2), 48–56. https://doi.org/10.1504/IJPOM.2013.053153

Regona, M., Yigitcanlar, T., Xia, B., & Li, R. Y. M. (2022). Opportunities and adoption challenges of artificial intelligence in the construction industry: A PRISMA review. *Journal of Open Innovation: Technology, Market, and Complexity, 8*(1), 45. https://doi.org/10.3390/joitmc8010045

Tjebane, M. M., Musonda, I., & Okoro, C. (2022). Organisational factors of artificial intelligence adoption in the South African construction industry. *Frontiers in Built Environment, 8*, Article 823998. https://doi.org/10.3389/fbuil.2022.823998