Artificial Intelligence and the Project Management Lifecycle: Evidence from the Construction Industry in Ghana

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Abstract
The integration of artificial intelligence (AI) into project management (PM) is reshaping how projects are planned, executed, and monitored across industries. Despite increasing global adoption, empirical evidence from developing contexts, particularly within Africa's construction sector, remains limited. This study examines the influence of AI on the PM lifecycle, alongside associated challenges and sustainability outcomes, using Ghana's construction industry as a case. A quantitative approach was employed, with data collected from project managers and construction design teams within D1K1 firms. The findings reveal a positive but weak relationship between AI adoption and PM lifecycle performance ($r = 0.297$, $p < 0.01$), indicating incremental rather than transformative effects. Descriptive results show moderate agreement on AI-related challenges (composite mean = 3.741), with skill gaps emerging as the most significant constraint (mean = 3.845). In contrast, AI demonstrates a strong contribution to sustainable construction practices (composite mean = 4.005), particularly in waste reduction (mean = 4.214) and sustainability evaluation (mean = 4.095). These findings suggest that while AI enhances efficiency and sustainability, its full potential is constrained by organisational and capability-related factors. The study highlights the need for targeted skill development, strategic investment, and stronger industry–academic collaboration to support effective AI integration in emerging economies.

Keywords: Artificial intelligence, Project management, Construction industry, Sustainability, international workforce.

1.Background of the Study

Organisational effectiveness is closely tied to the ability to deliver projects efficiently and achieve predefined objectives. Project management (PM) plays a central role in coordinating resources, timelines, and stakeholder expectations to ensure successful outcomes. However, increasing project complexity driven by large datasets, uncertainty, and dynamic environments has exposed the limitations of traditional project management approaches. These challenges often result in delays, cost overruns, and inefficiencies.

Artificial intelligence (AI) has emerged as a transformative solution to these limitations. By enabling data-driven decision-making, automation of routine tasks, and predictive analytics, AI enhances the efficiency and accuracy of project processes. Historically, AI applications in PM evolved from early decision-support systems to contemporary machine learning and cloud-based solutions that optimise planning, monitoring, and risk management.

Within the context of Industry 5.0, AI adoption reflects a shift toward human-centric and technologically integrated systems. This evolution underscores the need to understand how AI reshapes project management practices, particularly in sectors such as construction, where complexity and uncertainty are prevalent.

2.Problem Statement

Although AI is increasingly adopted in project management globally, empirical evidence on its practical implementation remains limited, especially in developing economies. Existing studies predominantly focus on theoretical models or cases from industrialised countries, creating a significant gap in understanding how AI affects project management practices in developing contexts such as Ghana.

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Furthermore, current research often overlooks how AI influences different stages of the project management lifecycle, including initiation, planning, execution, monitoring, and closure. This gap restricts a comprehensive understanding of AI's impact on project outcomes. Additionally, challenges such as skill shortages, organisational resistance, and unclear return on investment hinder effective AI adoption. These gaps highlight the need for empirical investigation into how AI is applied in real-world project environments within developing economies.

In response to these gaps, this study addresses the following research questions:

1. What challenges are associated with AI integration in the project management lifecycle within the construction industry?
2. How does AI influence different stages of the project management lifecycle?

3.Literature Review

3.1Conceptual Literature Review

Artificial Intelligence

Artificial intelligence refers to systems capable of performing tasks that typically require human intelligence, including learning, reasoning, and decision-making. AI can be categorised into narrow, general, and super intelligence, with current applications largely limited to narrow AI, which focuses on specific tasks such as predictive analytics and automation.

AI approaches include symbolic AI, which relies on rule-based reasoning, and machine learning, which identifies patterns from data. In project management, AI is primarily used for task automation, decision support, and predictive modelling.

Project Management Lifecycle

The project management lifecycle provides a structured framework for managing projects from initiation to completion. It includes phases such as planning, execution, monitoring, and closure, ensuring that projects meet objectives within constraints of time, cost, and quality.

AI enhances this lifecycle by improving forecasting accuracy, enabling real-time monitoring, and supporting decision-making processes. This highlights the relevance of artificial intelligence in enhancing project management processes, particularly in improving efficiency, forecasting accuracy, and decision-making across different stages of the project lifecycle.

3.2Theoretical Framework

This study is grounded in established theories that explain how artificial intelligence (AI) supports decision-making and problem-solving within complex environments. The symbolic AI approach provides a foundational lens by emphasising rule-based reasoning, structured knowledge representation, and logical inference as mechanisms through which intelligent systems replicate aspects of human cognition (Ciatto et al., 2021; Wang et al., 2022). Within project management, this perspective is particularly relevant because it enables the automation of structured tasks such as scheduling, risk analysis, and resource allocation through predefined algorithms and decision rules.

In addition, the concept of machine intelligence is informed by the Turing Test, which evaluates a system's ability to exhibit behaviour indistinguishable from human reasoning (Hernández-Orallo, 2020). While not a direct measure of intelligence, the framework highlights the growing sophistication of AI systems in mimicking human decision-making processes. This is particularly significant in project environments where AI-driven tools increasingly support predictive analytics, stakeholder communication, and performance monitoring.

Together, these theoretical perspectives provide a basis for understanding how AI augments human capabilities in project management rather than replacing them. They also reinforce the notion that AI effectiveness depends on structured data, logical frameworks, and human oversight, especially in complex and uncertain environments. These theoretical perspectives provide a foundation for this study by explaining how artificial intelligence can support decision-making and improve processes within the project management lifecycle.

3.3.Empirical Literature Review

Benefits of AI in Project Management

Empirical evidence consistently demonstrates that AI enhances project management through improved efficiency, predictive capabilities, and decision-making accuracy. Studies show that AI-driven systems enable real-time monitoring and forecasting, allowing project

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managers to anticipate risks and adjust strategies proactively (Taheri Khosroshahi, 2024). Similarly, AI-supported resource allocation improves operational efficiency by analysing historical and real-time data to optimise deployment (Nabeel, 2024).
Research further indicates that AI contributes to enhanced collaboration and knowledge management within project teams. For instance, integrating AI with knowledge management systems improves information sharing and supports organisational learning, thereby strengthening project outcomes (Altaie & Dishar, 2024). Additionally, AI-enabled automation reduces administrative burdens, allowing project managers to focus on strategic decision-making.

Challenges of AI Integration

Despite its advantages, AI integration presents several challenges that limit its effectiveness. Empirical studies highlight high implementation costs, data quality issues, and organisational resistance as major barriers (Hashimzai & Mohammadi, 2024). The lack of skilled personnel remains a critical concern, as effective AI utilisation requires expertise in data analytics and machine learning (Lui et al., 2022).
Ethical concerns, including data privacy and algorithmic bias, further complicate AI adoption. Organisations must ensure transparency and accountability in AI systems to maintain stakeholder trust (Karamthulla et al., 2024). Additionally, uncertainty regarding return on investment creates hesitation among firms, particularly in developing economies where resources are limited.

AI and Sustainable Construction

AI plays a significant role in promoting sustainable construction practices by improving efficiency and reducing environmental impact. Empirical studies indicate that AI supports energy optimisation, waste reduction, and environmentally friendly design processes (Regona et al., 2024). Predictive modelling and smart design tools enable construction firms to minimise resource consumption and enhance sustainability outcomes (Dagadkar et al., 2024).
Furthermore, AI-driven systems contribute to sustainable development by enabling real-time monitoring of environmental indicators such as energy use and emissions (Kazeem et al., 2023). However, challenges such as high implementation costs and limited technical expertise hinder widespread adoption, particularly in developing countries. Despite the growing body of literature on artificial intelligence in project management, most studies focus on developed economies, with limited empirical evidence from developing contexts such as Ghana. Furthermore, existing research often does not examine how AI influences different stages of the project management lifecycle. This study addresses the gaps by providing empirical evidence from Ghana's construction industry.

4.Methodology

Research Design

A quantitative case study design was adopted to examine AI integration within Ghana's construction industry, as it allows for the analysis of relationships between variables using numerical data.

Population and Sampling

The target population for the study consisted of 272 project managers and design teams within D1K1 construction firms in the Greater Accra and Ashanti regions. Using Yamane's formula, a sample size of 162 firms was determined through simple random sampling. Simple random sampling was used to ensure that all members of the population had an equal chance of being selected, thereby reducing bias.

Data Collection

Data were collected through a structured questionnaire designed using five-point Likert scales, ranging from strongly disagree to strongly agree. The instrument gathered both demographic information and respondents' perceptions regarding the integration of artificial intelligence, including its associated challenges within project management practices. This method was appropriate as it allowed for the collection of standardised data from a large number of respondents efficiently.

Data Analysis

Descriptive statistics and Pearson correlation analysis were used to examine relationships between variables. Descriptive statistics were used to summarise the data, while Pearson correlation analysis was applied to determine

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the strength and direction of relationships between AI adoption and project management lifecycle performance.

Reliability and Validity

The reliability of the instrument was ensured through consistency in the questionnaire design, while validity was achieved by aligning the questions with the study objectives and existing literature.

5.Results

5.1Challenges of AI Integration

Findings indicate moderate agreement on key challenges (Composite Mean = 3.741), with the most significant issue being a lack of skilled personnel.

Statement	Mean	SD
Initial investment is high	3.655	0.898
Cultural resistance hinders adoption	3.702	0.724
Data quality issues limit effectiveness	3.750	0.929
Lack of skilled personnel	3.845	0.829
Compatibility with legacy systems	3.738	0.808
Regulatory complexity	3.786	0.879
Data security concerns	3.726	0.766
Unclear return on investment	3.726	0.827
Composite Mean	3.741	0.833

The results indicate moderate agreement on the challenges of AI integration, with the lack of skilled personnel recording the highest mean score, suggesting it is the most significant challenge. Other factors, including regulatory complexity, data quality issues, and compatibility with legacy systems, also show relatively high mean values.

5.2Sustainable Construction Practices

AI demonstrated a strong positive impact on sustainability (Composite Mean = 4.005), particularly in waste reduction and energy efficiency

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Statement	Mean	SD
Forecasting sustainability trends	3.952	0.790
Environmentally friendly design	3.940	0.910
Reduced energy consumption	3.940	0.883
Recycling and reuse of materials	3.905	0.830
Energy-efficient building design	3.988	0.814
Sustainability evaluation improvement	4.095	0.652
Waste minimisation through planning	4.214	0.793
Composite Mean	4.005	0.810

The results show a strong positive impact of AI on sustainable construction practices, with waste minimisation through planning recording the highest mean. Other variables, such as sustainability evaluation and energy-efficient building design, also show high mean score, indicating strong contributions of AI to sustainability.

5.3Correlation Analysis

A positive but weak relationship was found between AI adoption and PM lifecycle performance ($r = 0.297$, $p < 0.01$), suggesting incremental improvements rather than transformative effects.

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Variables	PM Lifecycle	AI
PM Lifecycle	1	
AI	0.297**	1

The results show a positive but weak relationship between AI adoption and project management lifecycle performance (r=0.297), indicating that while AI contributes to improvements, its overall impact is limited.

6.Discussion

The findings reveal that AI adoption has a statistically significant but relatively weak relationship with the project management lifecycle. This suggests that while AI contributes to improved efficiency, it does not independently transform project outcomes. Instead, its effectiveness depends on complementary organisational capabilities such as skilled personnel, data infrastructure, and strategic alignment. This finding is consistent with previous studies that report that AI adoption improves operational efficiency but does not independently guarantee project success without supporting organisational capabilities. Furthermore, the prominence of skill gaps as the highest-rated challenge highlights the importance of human capital in AI adoption. This aligns with existing research emphasising that technological innovation must be accompanied by workforce development to achieve meaningful impact (Jarrahi et al., 2023). Without adequate training and expertise, organisations may struggle to fully leverage AI capabilities.

Similarly, the strong positive impact of AI on sustainable construction practices indicates that AI is particularly effective in areas requiring data-driven optimisation. The high mean score for waste reduction suggests that AI enhances planning accuracy and resource efficiency, supporting sustainability goals.

However, the persistence of challenges such as high costs and data limitations underscores the uneven adoption of AI, especially in developing contexts. These barriers suggest that AI implementation is not merely a technological issue but also an organisational and institutional challenge.

7.Conclusion

This study demonstrates that AI plays a transformative yet incremental role in project management within the construction industry. While AI enhances efficiency, decision-making, and sustainability outcomes, its overall impact on the project management lifecycle remains constrained by organisational and contextual factors.

The findings align with recent studies indicating that AI adoption improves project performance but requires complementary capabilities to achieve full effectiveness (Taboada et al., 2023; Zia et al., 2024). In particular, AI's contribution to sustainability highlights its strategic importance in addressing global environmental challenges.

Overall, the study underscores that AI should be viewed as an enabling tool rather than a standalone solution, requiring integration with human expertise, organisational processes, and supportive institutional frameworks.

8.Implications

8.1Policy Implications

Governments should develop comprehensive AI strategies that support infrastructure development, data governance, and regulatory clarity. In developing contexts like Ghana, targeted investment in digital ecosystems and incentives for AI adoption can accelerate innovation within the construction sector.

8.2Institutional Implications

Educational institutions should integrate AI, data analytics, and project management into their curricula to prepare graduates for evolving industry demands. Stronger collaboration between academia and industry is essential to bridge skill gaps and foster practical, industry-relevant learning.

8.3Managerial Implications

Organisations should prioritise workforce training and capacity building to enhance AI adoption. Additionally, effective change management strategies are necessary to address cultural resistance and ensure the smooth integration of AI technologies into existing project management processes.

9.Practical Recommendations

Based on the findings of this study, the following practical recommendations are

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proposed to enhance AI adoption in the construction industry:

1. Invest in continuous training and upskilling programmes.
2. Develop clear AI implementation frameworks.
3. Strengthen data management systems.
4. Promote ethical AI practices and data security.
5. Encourage pilot projects to test AI applications before full-scale adoption.

10.Future Research

Future studies should explore the longitudinal impacts of AI on project outcomes and examine sector-specific variations in AI adoption across developing economies. Further research could also investigate how AI influences different stages of the project management lifecycle and identify strategies for improving its effectiveness in resource-constrained environments.

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