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Abstract

Purpose: Purpose: The aim of the study was to influence artificial intelligence integration on project performance in infrastructure development projects.

Methodology: This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

Findings: The findings indicate that Artificial Intelligence (AI) integration significantly enhances project performance in infrastructure development projects by improving planning accuracy, resource optimization, risk management, and real-time project monitoring. AI technologies such as predictive analytics, automated scheduling, and intelligent decision-support systems contribute to reduced project delays, better cost control, improved quality, and increased operational efficiency. The study concludes that greater adoption of AI can lead to more successful infrastructure project outcomes, provided that organizations invest in adequate digital infrastructure, technical skills, and supportive implementation frameworks.

Recommendation: The resource-based view (RBV) theory, dynamic capabilities theory & the technology-organization-environment (TOE) may be used to anchor future studies on the influence artificial intelligence integration on project performance in infrastructure development projects. The study provides practical guidance to project managers, contractors, consultants, and infrastructure agencies on how AI can be used to improve project delivery. The study informs policymakers on the need to develop AI-readiness frameworks for infrastructure development projects.

Keywords: *Artificial Intelligence Integration, Project Performance, Infrastructure Development Projects*

INTRODUCTION

Project performance refers to the extent to which infrastructure projects achieve their intended objectives regarding cost, time, quality, scope, safety, and stakeholder satisfaction. In developed economies, project performance is a critical indicator of economic efficiency and public-sector accountability. In the United Kingdom (UK), the Government Major Projects Portfolio reported 227 projects valued at approximately £834 billion in 2024, with only 11% rated as green (successful delivery), while the majority were classified as amber, indicating delivery challenges. Similarly, studies in the United States of America (USA) have shown improvements in project management practices, although major infrastructure projects continue to experience cost and schedule pressures. According to Flyvbjerg, Holm, and Buhl (2003), transportation infrastructure projects frequently experience cost escalations due to lengthy implementation periods and project complexity (Flyvbjerg, 2003).

Infrastructure project performance trends in developed economies demonstrate that even advanced nations struggle with delivering large-scale projects within planned constraints. For example, transport infrastructure studies indicate average cost overruns of 44.7% for rail projects, 33.8% for bridges and tunnels, and 20.4% for road projects, despite sophisticated planning systems (Flyvbjerg, 2003). In the USA, rail transit projects have shown improved cost-estimation accuracy over time, reflecting advances in project management methodologies and technology adoption (Odeck, Welde, and Volden, 2020). However, megaprojects continue to face challenges associated with uncertainty, stakeholder management, and changing requirements. These trends suggest that emerging technologies such as Artificial Intelligence (AI) may further enhance project performance through predictive analytics, automated monitoring, and risk management capabilities (Odeck, 2020).

Project performance in developing economies is often evaluated based on the successful completion of infrastructure projects within budget, schedule, and expected quality standards while contributing to socioeconomic development. Rapid urbanization and growing infrastructure demand have placed significant pressure on governments to deliver large-scale transportation, energy, and water projects efficiently. However, studies indicate that many developing countries experience persistent challenges related to procurement inefficiencies, funding constraints, and governance issues. For instance, infrastructure projects across several Asian developing economies have exhibited substantial cost overruns and schedule delays, particularly in rail and energy sectors. Andrić, Mahamadu, Wang, Zou, and Zhong (2019) found that infrastructure projects in Asia frequently exceeded planned budgets due to project complexity and inadequate risk management practices (Andrić, 2019).

The trend of project performance in developing economies remains mixed, with some countries demonstrating significant improvements while others continue to face implementation difficulties. Research has shown that infrastructure project cost overruns in developing countries can range from minor deviations to more than 500% of initial estimates depending on project characteristics and institutional effectiveness (Andrić, 2019). Ahsan and Gunawan (2010) observed that international development projects frequently encounter schedule delays and budget escalation resulting from weak institutional capacity and funding uncertainties (Ahsan & Gunawan, 2010). These challenges negatively affect the timely provision of public infrastructure and economic growth. Consequently, the integration of AI technologies presents an opportunity to improve

project forecasting, resource allocation, and decision-making processes in developing economies (Ahsan & Gunawan, 2010).

Project performance in Sub-Saharan Africa is commonly measured through cost efficiency, timely completion, quality standards, and the extent to which infrastructure projects achieve intended developmental outcomes. The region faces significant infrastructure deficits and increasing demand for roads, energy systems, water facilities, and public transportation networks. Despite considerable investments in infrastructure development, many projects experience cost overruns, delays, and implementation challenges. For example, studies on African road infrastructure projects found average cost overruns of approximately 35%, with some projects exceeding original budgets by more than 100%. Gbahabo and Ajuwon (2017) argue that weak institutional frameworks, procurement inefficiencies, and financial constraints significantly affect project performance across the region (Gbahabo & Ajuwon, 2017).

The trend of infrastructure project performance in Sub-Saharan Africa suggests that implementation challenges continue to undermine the effectiveness of development initiatives. In Kenya, research on rural road projects revealed that approximately 41.2% of projects experienced cost overruns, indicating persistent weaknesses in project planning and execution (Musa, Were, and Mua, 2013). Similar findings have been reported in Ghana, where infrastructure projects frequently suffer from schedule delays and budget escalations due to contractor-related, financial, and managerial factors (Frimpong, Oluwoye, & Crawford, 2003). Poor project performance in the region limits access to essential services and reduces the socioeconomic benefits expected from infrastructure investments. Therefore, AI integration offers significant potential for improving project monitoring, forecasting risks, enhancing transparency, and supporting evidence-based project management decisions in Sub-Saharan Africa (Frimpong, 2003).

Artificial Intelligence (AI) integration refers to the systematic use of intelligent digital tools to support planning, monitoring, decision-making, and control in infrastructure development projects. The four most likely AI integration dimensions are AI-based predictive analytics, AI-assisted scheduling, AI-driven resource optimization, and AI-enabled real-time monitoring. Predictive analytics improves project performance by forecasting cost overruns, delays, and risks before they occur, allowing managers to take corrective action early (Taboada, 2023). AI-assisted scheduling improves time performance by using algorithms to sequence activities, detect bottlenecks, and revise work plans when conditions change (Gao, 2026). AI-driven resource optimization improves cost and productivity performance by allocating labour, equipment, materials, and finances more efficiently (Savaş & Alptekin, 2025).

AI-enabled real-time monitoring links strongly to project performance because it uses sensors, drones, computer vision, and data dashboards to track progress, quality, safety, and contractor productivity continuously. In infrastructure projects, this can reduce delays, rework, idle resources, and poor reporting because project managers receive timely information for decision-making (Gao, 2026). When these four dimensions are combined, AI integration strengthens project performance through better cost control, schedule adherence, quality assurance, risk management, and stakeholder satisfaction. Therefore, Artificial Intelligence Integration can be conceptualized as independent variable that influences the dependent variable, Project Performance, through forecasting, automation, optimization, and real-time control. This relationship is consistent with studies showing that AI in construction project management improves efficiency, reduces uncertainty, and enhances decision quality (Taboada, 2023; Savaş & Alptekin, 2025).

Problem Statement

Infrastructure development projects play a critical role in romoting economic growth, improving public service delivery, and enhancing national competitiveness through investments in transportation, energy, water, and communication systems. Ideally, such projects should be completed within the planned budget, schedule, and quality standards while meeting stakeholder expectations and delivering intended socioeconomic benefits. However, project performance remains a major challenge globally, with infrastructure projects frequently experiencing cost overruns, schedule delays, quality deficiencies, and inefficient resource utilization. Recent studies indicate that large infrastructure projects continue to underperform despite advances in project management practices, with many projects exceeding original cost estimates and completion timelines due to poor forecasting, ineffective risk management, and inadequate decision-making processes (Abdelalim, 2024; Taboada, 2023). These performance challenges result in financial losses, delayed public benefits, reduced investor confidence, and inefficient utilization of scarce development resources (Abdelalim, 2024).

Artificial Intelligence (AI) has emerged as a transformative technology capable of enhancing project planning, predictive analytics, resource optimization, scheduling, risk management, and real-time project monitoring. Through AI-enabled systems, project managers can analyze large volumes of project data, predict potential delays, optimize resource allocation, and make informed decisions that improve project outcomes. Studies have suggested that AI integration can significantly improve efficiency, productivity, and decision quality in project environments (Savaş & Alptekin, 2025; Taboada, 2023). Despite these potential benefits, the adoption and integration of AI technologies in infrastructure development projects remain limited and uneven across many organizations. Furthermore, existing studies have largely focused on the technical capabilities of AI, with limited empirical evidence on how specific dimensions of AI integration influence project performance outcomes in infrastructure projects (Gao, 2026). Consequently, there exists a knowledge gap regarding the extent to which Artificial Intelligence Integration contributes to improved Project Performance in Infrastructure Development Projects. This study therefore seeks to examine the influence of Artificial Intelligence Integration on Project Performance in Infrastructure Development Projects by assessing how AI-based predictive analytics, AI-assisted scheduling, AI-driven resource optimization, and AI-enabled real-time monitoring affect project performance outcomes (Gao, 2026; Savaş & Alptekin, 2025).

Theoretical Review

Technology Acceptance Model (TAM)

Technology Acceptance Model (TAM) was originated by Fred Davis in 1989. Its main theme is that users adopt technology when they perceive it as useful and easy to use. In this study, Technology Acceptance Model (TAM) explains how project managers, engineers, and contractors accept Artificial Intelligence (AI) tools for scheduling, monitoring, risk prediction, and cost control. If users perceive AI as useful, it is more likely to improve project performance through better decision-making and efficiency (Na, 2023).

Diffusion of Innovation Theory

Diffusion of Innovation Theory was originated by Everett Rogers in 1962. Its main theme is that new technologies spread through organizations based on relative advantage, compatibility, complexity, trial ability, and observability. This theory is relevant because AI integration in

infrastructure projects depends on how quickly firms adopt and institutionalize AI tools. It explains why some project organizations adopt AI faster than others, depending on perceived benefits and readiness (Almaiah, 2022).

Resource-Based View (RBV)

Resource-Based View (RBV) was advanced by Jay Barney in 1991. Its main theme is that organizations achieve better performance when they possess valuable, rare, inimitable, and well-organized resources. In this study, AI systems, skilled personnel, project data, and digital infrastructure can be viewed as strategic resources that enhance project performance. Resource-Based View (RBV) therefore explains how AI capabilities may create efficiency, cost control, and competitive advantage in infrastructure development projects (Chen, 2022)

Empirical Review

Egwim and Alaka (2021) investigated the application of Machine Learning (ML) techniques in predicting delays in construction projects. The purpose of the study was to identify the most effective Artificial Intelligence (AI)-based predictive models for enhancing project performance through early detection of delay risks. The researchers recognized that delays are among the most persistent challenges affecting infrastructure development projects globally. The study adopted a quantitative research design and utilized historical construction project datasets. Twenty-seven Machine Learning (ML) algorithms were developed and tested using project performance data. The models were evaluated using accuracy, balanced accuracy, F1-score, and Receiver Operating Characteristic Area Under the Curve (ROC-AUC). The findings revealed that the Perceptron algorithm outperformed other models in predicting project delays. The study established that Artificial Intelligence (AI)-based predictive systems can significantly improve project planning and control. The researchers observed that organizations using predictive analytics were better positioned to identify emerging project risks. The study further found that AI-supported forecasting improves decision-making and reduces uncertainty in project execution. The results demonstrated the potential of Machine Learning (ML) in improving schedule performance and reducing costly project disruptions. The researchers argued that predictive models can assist project managers in proactively managing infrastructure projects. The study concluded that Artificial Intelligence (AI) integration enhances project performance by strengthening risk management capabilities. It recommended the integration of Machine Learning (ML) tools into project management information systems to improve project outcomes. The researchers further suggested future studies focusing on real-time Artificial Intelligence (AI) applications in infrastructure development projects.

Holzmann and Lechiara (2022) examined the expectations of construction professionals regarding the use of Artificial Intelligence (AI) in project management. The primary objective of the study was to understand how AI technologies can influence project performance in construction and infrastructure projects. The researchers acknowledged that Artificial Intelligence (AI) is increasingly being adopted to improve efficiency and decision-making in project environments. The study employed a mixed-method research design combining surveys and semi-structured interviews. Data were collected from construction professionals across different countries and project settings. The researchers analyzed perceptions regarding the usefulness and applicability of Artificial Intelligence (AI) tools in project management. The findings revealed that

professionals expected AI to significantly improve cost management, schedule control, risk management, and quality assurance. The study found that AI technologies are particularly useful in automating repetitive project tasks and supporting data-driven decisions. Respondents believed that AI could improve project forecasting and performance monitoring. However, the findings also showed that participants did not expect AI to replace human judgment in stakeholder engagement and leadership functions. The study established that AI is most effective when combined with human expertise. The researchers further observed that organizations with stronger digital capabilities were more likely to realize performance benefits from AI adoption. The study concluded that AI integration can contribute to better project outcomes by enhancing efficiency and reducing uncertainty. The authors recommended gradual implementation of Artificial Intelligence (AI) systems accompanied by employee training and organizational support. They also suggested further empirical studies examining the actual impact of AI adoption on project performance indicators.

Regona, Yigitcanlar, Xia, and Li (2022) examined the opportunities and challenges associated with Artificial Intelligence (AI) adoption in the construction industry. The purpose of the study was to identify how AI technologies contribute to project performance improvement in infrastructure development projects. The study was motivated by the increasing digital transformation occurring within the global construction sector. The researchers adopted the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology. A comprehensive review of peer-reviewed literature on Artificial Intelligence (AI) applications in construction was undertaken. The study examined AI technologies used in planning, design, project execution, monitoring, and project control. The findings revealed that AI significantly improves project performance through enhanced decision-making, predictive analytics, and automation. The study also found that AI improves resource allocation, cost estimation accuracy, and schedule management. The review showed that AI applications support risk identification and proactive project management. However, several barriers to adoption were identified, including limited technical skills, high implementation costs, and resistance to organizational change. The researchers observed that many construction firms remain at the early stages of AI adoption. The study concluded that AI possesses significant potential to transform infrastructure project delivery. The authors noted that successful AI integration requires investment in digital infrastructure and workforce competencies. The study recommended increasing organizational readiness and training programs to facilitate AI adoption. It further recommended future research on empirical measurement of AI's impact on project performance outcomes.

Sultan (2023) investigated the integration of Artificial Intelligence (AI) tools into construction project decision-making processes. The purpose of the study was to evaluate the effectiveness of AI technologies in improving project performance. The study recognized that infrastructure projects increasingly generate large volumes of data that require advanced analytical capabilities. A mixed-method research design involving case studies and interviews was adopted. Data were collected from construction professionals involved in AI-enabled projects. The study explored how Artificial Intelligence (AI) supported planning, monitoring, and project control activities. The findings showed that AI technologies improved project decision-making accuracy and efficiency. The study established that AI applications contributed to reduced project costs and fewer schedule delays. Participants reported improvements in risk management and resource utilization following AI implementation. The findings also indicated that AI-supported analytics improved forecasting accuracy. However, challenges such as technical complexity and employee resistance were

reported. The study revealed that organizations with stronger technological capabilities experienced greater project performance improvements. The researcher concluded that Artificial Intelligence (AI) has substantial potential to improve infrastructure project outcomes. The study recommended investing in digital skills development and organizational change management. It further recommended establishing clear AI implementation strategies to maximize project performance benefits.

Na (2023) investigated factors influencing Artificial Intelligence (AI)-based technology adoption in the construction industry. The study aimed to determine how AI acceptance affects project performance outcomes. The researchers employed the Technology Acceptance Model (TAM) as the theoretical framework. A quantitative survey design was adopted involving construction professionals from South Korea and the United States. Data were analyzed using structural equation modeling techniques. The findings indicated that perceived usefulness significantly influenced AI adoption intentions. Perceived ease of use was also found to positively affect acceptance levels. The study established that organizations with higher AI adoption levels reported better project performance outcomes. The findings showed improvements in project efficiency, monitoring, and decision-making processes. AI technologies enhanced project visibility and supported real-time management interventions. The researchers observed that organizational culture influenced the success of AI implementation. The study further found that training and awareness programs improved acceptance levels. The authors concluded that AI adoption is essential for enhancing project performance in modern construction environments. The study recommended increasing employee training and strengthening organizational support systems. It also suggested further research examining the long-term performance impacts of AI integration.

Corbin, Marqui, and Dacre (2024) explored the intersection between Artificial Intelligence (AI) and project management within the United Kingdom construction industry. The purpose of the study was to investigate how AI influences project performance and project management practices. The researchers adopted a qualitative research design. Semi-structured interviews were conducted with senior project managers from multiple construction organizations. The study examined current AI applications and barriers to adoption. Findings showed that AI technologies improved project planning, monitoring, and productivity. Participants reported enhanced decision-making and better management of project information. AI was found to support project forecasting and performance tracking. The study revealed that AI adoption contributed to improved project efficiency and reduced manual workload. However, financial constraints and technological limitations hindered widespread implementation. The researchers observed that organizational readiness played a significant role in successful adoption. The study concluded that AI has substantial potential to improve project performance in infrastructure projects. It recommended greater investment in AI technologies and digital transformation initiatives. The authors also suggested conducting longitudinal studies to evaluate long-term performance impacts. Future research was recommended to quantify the relationship between AI integration and project success metrics.

METHODOLOGY

This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low-cost advantage as compared to field research. Our current study looked into

already published studies and reports as the data was easily accessed through online journals and libraries.

FINDINGS

The results were analyzed into various research gap categories that is conceptual, contextual and methodological gaps

Conceptual Gap: Existing studies have examined Artificial Intelligence (AI) from different perspectives such as Machine Learning (ML)-based delay prediction, technology adoption, decision support systems, and project management automation. For instance, Egwim and Alaka (2021) focused on Machine Learning (ML) algorithms for predicting project delays, while Na (2023) concentrated on factors influencing Artificial Intelligence (AI) adoption in construction organizations. Similarly, Holzmann and Lechiara (2022) explored professionals' expectations regarding AI applications in project management. However, these studies do not provide a comprehensive framework that conceptualizes Artificial Intelligence Integration as a multidimensional construct comprising AI-based predictive analytics, AI-assisted scheduling, AI-driven resource optimization, and AI-enabled real-time monitoring, and how these dimensions collectively influence Project Performance. Consequently, a conceptual gap exists regarding the direct relationship between specific dimensions of Artificial Intelligence Integration and Project Performance in Infrastructure Development Projects (Egwim & Alaka, 2021; Holzmann & Lechiara, 2022; Na, 2023).

Contextual Gap: Most of the reviewed studies were conducted within the broader construction industry and focused on general project management processes rather than infrastructure development projects specifically. For example, Regona (2022) conducted a systematic review of Artificial Intelligence (AI) adoption in construction, while Sultan (2023) examined the use of AI in construction project decision-making. Although these studies demonstrated the potential of Artificial Intelligence (AI) to improve efficiency, planning, monitoring, and decision-making, they did not specifically address large-scale infrastructure development projects such as roads, bridges, railways, water systems, and energy infrastructure. Infrastructure projects differ significantly from conventional construction projects in terms of complexity, stakeholder involvement, regulatory requirements, and public accountability. Therefore, a contextual gap exists concerning the influence of Artificial Intelligence Integration on Project Performance within infrastructure development project environments (Regona, 2022; Sultan, 2023).

Geographical Gap: The majority of the reviewed studies were undertaken in developed and technologically advanced countries such as the United States, the United Kingdom, and South Korea. For instance, Na et al. (2023) collected data from construction professionals in South Korea and the United States, while Corbin, Marqui, and Dacre (2024) focused on the United Kingdom construction industry. These environments possess advanced digital infrastructure, higher Artificial Intelligence (AI) adoption rates, and greater technological readiness than many developing economies. There is limited empirical evidence on the influence of Artificial Intelligence Integration on Project Performance in infrastructure development projects within developing countries and particularly in Sub-Saharan Africa. As a result, a geographical gap exists because the findings from developed economies may not be directly applicable to countries characterized by limited technological resources, infrastructure constraints, and varying levels of digital maturity, thereby justifying further research in such contexts (Na, 2023; Corbin, 2024).

CONCLUSION AND RECOMMENDATIONS

Conclusions

In conclusion, Artificial Intelligence (AI) Integration is a critical driver of Project Performance in Infrastructure Development Projects. Through AI-based predictive analytics, AI-assisted scheduling, AI-driven resource optimization, and AI-enabled real-time monitoring, project managers can improve cost control, reduce delays, enhance quality, manage risks, and make better decisions. The reviewed studies show that AI strengthens project planning and execution by providing timely data, accurate forecasts, and automated project insights. However, successful AI integration depends on digital infrastructure, skilled personnel, organizational readiness, and management support. Therefore, infrastructure organizations should adopt AI strategically to improve project efficiency, accountability, and overall performance.

Recommendations

Theory

The study contributes to theory by conceptualizing Artificial Intelligence (AI) Integration as a multidimensional construct made up of predictive analytics, AI-assisted scheduling, AI-driven resource optimization, and AI-enabled real-time monitoring. It also extends project performance theory by showing how digital intelligence can influence traditional project outcomes such as cost, time, quality, risk management, and stakeholder satisfaction.

Practice

The study provides practical guidance to project managers, contractors, consultants, and infrastructure agencies on how AI can be used to improve project delivery. It shows that AI can support better forecasting, faster reporting, efficient resource allocation, improved supervision, and early corrective action in infrastructure projects.

Policy

The study informs policymakers on the need to develop AI-readiness frameworks for infrastructure development projects. It supports policies on digital project monitoring, AI capacity building, data-sharing standards, cybersecurity, ethical AI use, and mandatory technology-based reporting in public infrastructure projects.

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