

Artificial Intelligence Capability and Urban Infrastructure Project Performance: The Mediating Role of Logistics Management Capability

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ABSTRACT: The world is becoming increasingly technologically advanced, and the advent of artificial intelligence (AI) has transformed many aspects of modern life. There is ample literature regarding Artificial Intelligence and urban infrastructure however, a mediating role of logistics management capability has rarely been studied particularly in Saudi Arabia. The current study aimed to address this gap. For this purpose, a cross-sectional correlational design and purposive sampling technique were employed to collect data from civil engineers in Makkah, Saudi Arabia, who had at least a bachelor's degree or equivalent qualification in civil engineering, were at least 24 years old, and had a minimum of one year of work experience. The study utilized three questionnaires: Artificial Intelligence Capability Scale (AICS), Strategic Logistics Capabilities Scale and Project Implementation Profile. The correlational analysis revealed a significant positive relationship among study variables whereas, mediation analysis revealed significant full mediation of the role of logistics management capability between artificial intelligence capability and urban infrastructure performance as the direct effect was not significant but the indirect effect remained statistically positive and significant. The study provided useful implications and recommendations.

KEYWORDS: Artificial Intelligence Capability, Logistic Management Capability, Urban Infrastructure Project Performance, Civil Engineers

Introduction

Urban infrastructure plays an important role in fostering economic growth, improved quality of life, and sustainable urban development (Demir & Zakaria, 2025; Mahmood et al., 2024; Sukanya & Tantia, 2023). As cities are expanding, private and public organizations are investing immensely in transportation systems, smart cities, public cities and utilities to meet higher societal demands (Almihat et al., 2022; Carayannis et al., 2026; Madakam et al., 2026). However, these projects are often characterized by high complications like uncertain environments, schedule delays, budget constraints, and the involvement of various stakeholders, making effective project management highly challenging (Doloi, 2011; Elshamy et al., 2025; Kyeremeh, 2025). That is why organizations are looking for new technological solutions that can enhance project planning, operational efficiency, resource utilization, and overall project performance (Anantatmula, 2008; Anuar et al., 2025; Beheshti & Beheshti, 2010; Şişu et al., 2024).

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Artificial Intelligence (AI) has recently become one of the most transformative technologies in infrastructure development and project management (Adebayo et al., 2025; Ahmad, 2025; Akeiber, 2025; Al-Raeei, 2025; Kutá & Faltejsek, 2025; Salimimoghadam et al., 2025). AI capability can be defined as acquiring, integrating, and using AI technologies to support automated processes, data-driven decision-making, forecasting risk, and optimizing operational activities by the organization (Gahane et al., 2024; Islam, 2026; Kumar, 2026; Mamun, 2025). By enhancing machine learning, computer vision, predictive analytics, and intelligent automation, AI enables organizations to process high amounts of project data and generate actionable insights that can enhance planning accuracy and resource allocation (Akeiber, 2025; Shamim et al., 2025; Vergara et al., 2025; Zong & Guan, 2024). Previous studies have recommended that AI capability improves organizational efficiency, innovation, and decision quality, making it a highly strategic resource for organizations engaged in complex infrastructure projects (Abdeljaber et al., 2025; Haider et al., 2025; Neiroukh et al., 2024).

Despite the overwhelming literature on AI technologies, the literature suggests that technological capability alone does not automatically result in higher organizational outcomes. The effectiveness of AI heavily relies on an organization's capacity to integrate technological intelligence into operational processes that directly support project execution (Saurav, 2026; Trunk et al., 2020; Weber et al., 2022). Among these capabilities, logistics management capability has received substantial attention as it governs the planning, transportation, storage, coordination, and distribution of materials, equipment, and information throughout the project (Bugayko & Reznik, 2025; Ferrell et al., 2020; Kopbolsyn et al., 2025; Ramakrishnan et al., 2024). AI technologies significantly foster logistics management by enhancing demand forecasting, route optimization, real-time monitoring, supplier coordination, and inventory control, thereby improving the efficiency of logistics operations and reducing project delays (Akter et al., 2026; Khaled et al., 2026; Marisamy et al., 2026; Rachmat, 2026).

Logistics management capability is widely known as a critical predictor of project success, specifically in urban infrastructure projects where delays in material delivery, insufficient resource allocation, and supply chain disruptions can affect project cost, completion time, as well as its quality (Abbasnejad et al., 2025; Seeboo, 2025). Organizations comprising strong logistics management capability are well equipped to coordinate project activities, overcome uncertainties, optimize resource utilization, and sustain smooth operational workflows (Kovács & Paganelli, 2003; Ozpinar & Soofastaei, 2025).

Given the increasing role of AI in forecasting, resource monitoring, and supply chain coordination, AI capability may strengthen logistics management capability. Stronger logistics management capability can improve resource utilization, material delivery, and project coordination. Thus, logistics management capability may serve as a mechanism linking AI capability with urban infrastructure project performance.

Objective

To examine the mediating role of logistics management capability in the relationship between artificial intelligence capability and urban infrastructure project performance among civil engineers in Makkah, Saudi Arabia.

Hypothesis

H1: Logistics management capability significantly mediates the relationship between artificial intelligence capability and urban infrastructure project performance.

Methodology

Research Design

The study adapted a cross-sectional correlational study design to assess the relationship between variables, namely artificial intelligence capability and urban infrastructure project performance, with logistics management capability as a mediator. The reason for choosing this research design was its time efficiency in measuring variables at a single point in time.

Sampling Technique and Inclusion Criteria

A purposive sampling technique was used to recruit civil engineers working in urban infrastructure projects in Makkah, Saudi Arabia. Participants were eligible if they were at least 24 years old, held a bachelor's degree or equivalent qualification in civil engineering, and had a minimum of one year of professional work experience.

Participants

Out of 280 participants, 216 completed the questionnaire and fulfilled the inclusion criteria, while the remaining participants either withdrew from the study or did not meet the inclusion criteria, yielding a response rate of 77.14%. The participants had a mean age of 36.96 years ($SD = 10.30$). Most participants were men ($n = 147$, 68.1%), held a bachelor's degree or equivalent ($n = 122$, 56.5%), and had 1–5 years of work experience ($n = 60$, 27.8%). Regarding designation, the largest proportion were Construction Managers ($n = 48$, 22.2%), followed by Civil Engineers ($n = 47$, 21.8%), Site Engineers ($n = 43$, 19.9%), Project Managers ($n = 36$, 16.7%), Project Engineers ($n = 24$, 11.1%), and Planning Engineers ($n = 18$, 8.3%). Additionally, 117 (54.2%) participants were employed in public-sector organizations, whereas 99 (45.8%) worked in private-sector organizations.

Measure/Questionnaires

The following questionnaires were used in the study

Artificial Intelligence Capability was measured using the Artificial Intelligence Capability Scale (AICS) developed by Patrick Mikalef and Manjul Gupta (2021). The instrument consists of 44 items, and the responses are rated on a 7-point Likert scale ranging from 1 (Strongly Disagree) to 7 (Strongly Agree). The internal consistency of the scale in this study was .76, which is considered satisfactory.

Logistics management capability was measured using the Strategic Logistics Capabilities Scale developed by Morash et al. (1996). The instrument comprises 28 items and its Likert ranges from 1 (Strongly Disagree) to 5 (Strongly Agree). The internal consistency of the scale in this study was 0.92, which indicates excellent internal consistency.

Urban infrastructure project performance was measured using the Project Implementation Profile (PIP): Project Success Scale developed by Pinto and Slevin (1988). The instrument comprises 12 items and its Likert ranges from 1 (Strongly Disagree) to 7 (Strongly Agree). The internal consistency of the scale in this study was 0.81, indicating good internal consistency.

Ethical Consideration

The study adopted the APA 7th edition as well as the Helsinki Declaration of Ethical Principles. The study was approved in Makkah, Saudi Arabia, with the consent form, demographics questionnaire, and standardized questionnaires (for measuring variables). The consent form comprised the right of withdrawal, confidentiality, and the purpose of the study. Upon the written signature on the consent form, the participants were given the

demographic and study instruments for the data collection process. After the data collection process, the participants' participation was acknowledged. The data were entered into IBM SPSS Statistics version 27 for analysis.

Results

Table 1

Correlational Analysis (N = 216)

Variables	1	2	3
1.Artificial Intelligence Capability	-	.63***	.56***
2.Logistics Management Capability		-	.88***
3.Urban Infrastructure Project Performance			-

Note: *** $p < .001$

Table 1 shows that all variables were positively and significantly correlated ($p < .001$). Artificial intelligence capability was positively associated with logistics management capability ($r = .63$) and urban infrastructure project performance ($r = .56$). Logistics management capability also showed a strong positive relationship with urban infrastructure project performance ($r = .88$).

Table 2

Mediation Analysis Predicting Urban Infrastructure Project Performance from Artificial Intelligence Capability through Logistic Management Capability (N = 216)

		Consequences						
		Logistics Management Capability (M)			Urban Infrastructure Project Performance (Y)			
Antecedents		B	SE	P		B	SE	P
Artificial Intelligence Capability (X)	a	.38***	.03	<.001	c'	-.001	.01	.93
Logistics Management Capability (M)	-				b	.46***	.02	<.001
Constant	I	10.45	6.44	.10	I	.62***	2.00	.75
		$R^2 = .40, F = 142.78$				$R^2 = .79, F = 401.75$		
		*** $p < .001$				*** $p < .001$		

Note: *** $p < .001$

Table 2 shows that artificial intelligence capability significantly and positively predicted logistics management capability ($B = .38, SE = .03, p < .001$). Logistics management capability also significantly and positively predicted urban infrastructure project performance ($B = .46, SE = .02, p < .001$). However, the direct effect of artificial intelligence capability on urban infrastructure project performance was non-significant ($B = -.001, SE = .01, p = .93$). The model explained 40% of the variance in logistics management capability ($R^2 = .40, F = 142.78, p < .001$) and 79% of the variance in urban infrastructure project performance ($R^2 = .79, F = 401.75, p < .001$).

Table 3

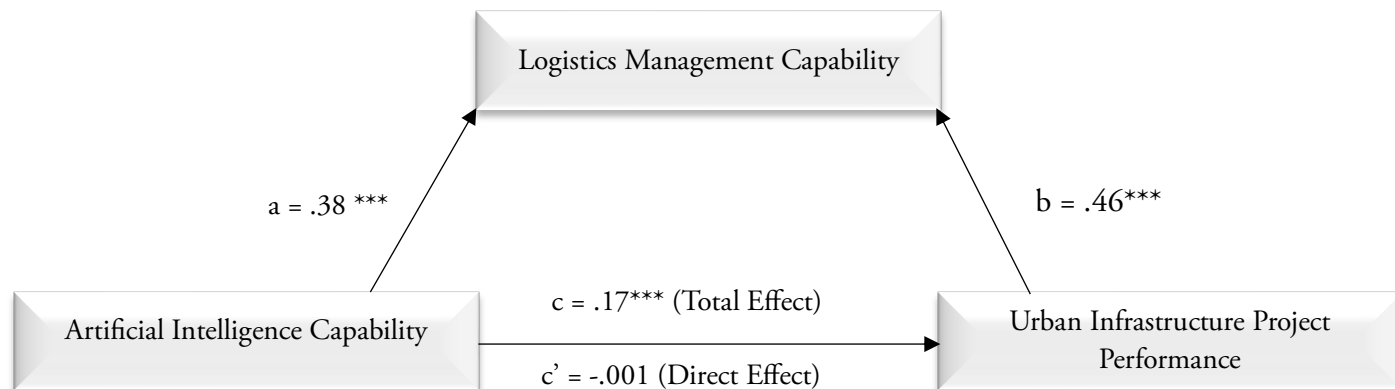
Indirect Effect

Pathways	B	β	BootSE	95% CI (BootLLCI – BootULCI)
AIC $\rightarrow$ LMC $\rightarrow$ UIPP	.17	.56	.03	(.48 - .63)

Note: N = 216, AIC = Artificial Intelligence Capability, LMC = Logistics Management Capability, UIPP = Urban Infrastructure Project Performance

Table 3 shows that the indirect effect of artificial intelligence capability on urban infrastructure project performance through logistics management capability was significant ($\beta = .56$, $B = .17$, $BootSE = .03$, 95% CI [.48, .63]).

Statistical Model



Note: $N = 216$, *** $p < .001$

The above figure illustrates that artificial intelligence capability significantly and positively predicts logistics management capability ($a = .38$, $p < .001$), which, in turn, significantly predicts urban infrastructure project performance ($b = .46$, $p < .001$). The total effect of artificial intelligence capability on urban infrastructure project performance was significant ($c = .17$, $p < .001$), whereas the direct effect became non-significant after including logistics management capability ($c' = -.001$, $p = .93$).

Discussion

The study findings demonstrated that artificial intelligence capability was significantly and positively associated with logistics management capability and urban infrastructure project performance. This means that civil engineering organizations with compatible AI capability are more prone to improve logistics operations and achieve higher organizational productivity. These findings are supported by recent research carried out in Saudi Arabia, which indicated that AI improves logistics capability and organizational performance through operational efficiency and timely, effective decision-making (Alayed & Alateeg, 2026). As per the infrastructure projects of Vision 2030 in Saudi Arabia, effective logistics management is important for completing projects on time and within specific budgets assigned (Aldossari, 2025). The significant and positive relationship between logistics management capability and project performance demonstrates that efficient planning, material coordination, and transportation are the core components for successful urban infrastructure projects. In a nutshell, the results indicate that investing in AI technologies and fostering logistics capabilities can be helpful for civil engineering organizations in Saudi Arabia to improve the performance of urban infrastructure projects.

The hypothesis of the study is supported by mediation analysis using Hayes Macro Process 4.2, Model 4, which demonstrated that logistics management capability fully mediated the relationship between artificial intelligence capability and urban infrastructure project performance. This means that AI alone does not directly influence project performance; rather, its benefits are obtained when AI strengthens logistics planning, material management, resource coordination, and scheduling. These findings are aligned with the Resource-Based View (RBV), which postulates that organizational resources create competitive advantage only when they are leveraged through effective organizational capabilities (Barney, 1991; Wernerfelt, 1984). Prior literature has also demonstrated that AI creates

organizational value by enhancing operational capabilities, supply chain processes integration, and logistics efficiency instead of generating performance directly (El Jaouhari & Driouiche, 2026; Singh et al., 2024).

In the cultural context of Saudi Arabia, these findings are particularly important as Vision 2030 promotes the adoption of digital technologies to enhance the efficiency of large-scale infrastructure and civil engineering projects. Effective logistics management enables construction organizations to avoid delays, enhance resource utilization, improve material flow, and improve project delivery, which facilitates better urban infrastructure project performance (Alqahtani et al., 2024; Alameedy et al., 2026).

Recommendations and Implications

The findings of the study suggest that organizations involved in urban infrastructure projects should focus on strengthening artificial intelligence capability and logistics management capability to improve project performance. Project managers and policymakers should consider integrating AI-driven tools into logistics planning, resource allocation, and decision-making processes to enhance operational efficiency and minimize project delays. Organizations should also invest in training and developing employees' AI-related skills to facilitate the effective integration of AI technologies into logistics and project management practices.

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