Artificial Intelligence in Smart Construction (Industry Readiness and Challenges in Implementation in Kuwait)

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Abstract:

The integration of artificial intelligence (AI) in construction has become a global trend, offering enhanced efficiency, safety, and sustainability. However, the extent of AI deployment and the readiness of firms to embrace it vary significantly across regions. This study explores the state of AI adoption in Kuwait’s construction sector by assessing perceived benefits, organizational readiness, implementation barriers, and industry outlook. A structured questionnaire was distributed to 180 professionals including civil engineers and project managers useing a structured questionnaire included five key dimensions to collect data from a representative sample. The study was conducted over four months, from October 2024 to January 2025. Findings reveal moderate levels of current AI integration and readiness, with cost, lack of expertise, and cultural resistance identified as key challenges. The study offers practical and theoretical implications for guiding smart construction transformation in Kuwait and similar regional contexts. Construction firms can benefit from investing in AI-focused training, improving technical infrastructure, and fostering a culture of innovation. Government agencies and industry associations should prioritize the development of a national AI roadmap, offer financial incentives, and facilitate public-private collaborations. These efforts can address the barriers identified and leverage the positive perceptions to build a more AI-ready construction ecosystem in Kuwait.

Keywords: Artificial Intelligence, Smart Construction, Digital Transformation, Technology Adoption, Kuwait.

الذكاء الاصطناعي في البناء الذكي (جاهزية الصناعة وتحديات التطبيق في الكويت)

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الملخص:

أصبح دمج الذكاء الاصطناعي (AI) في البناء اتجاهًا عالميًا، مما يوفر كفاءة وسلامة واستدامة محسنة. ومع ذلك، فإن مدى نشر الذكاء الاصطناعي واستعداد الشركات لتبنيه يختلفان بشكل كبير عبر المناطق. تستكشف هذه الدراسة حالة اعتماد الذكاء الاصطناعي في قطاع البناء في الكويت من خلال تقييم الفوائد المتصورة، والاستعداد التنظيمي، وحواجز التنفيذ، وتوقعات الصناعة. تم توزيع استبيان منظم على 180 متخصصًا بما في ذلك المهندسين المدنيين ومديري المشاريع باستخدام استبيان منظم يتضمن خمسة أبعاد رئيسية لجمع البيانات من عينة تمثيلية. أجريت الدراسة على مدى أربعة أشهر، من أكتوبر 2024 إلى يناير 2025. تكشف النتائج عن مستويات معتدلة من تكامل الذكاء الاصطناعي والاستعداد الحالي، مع تحديد التكلفة ونقص الخبرة والمقاومة الثقافية كتحديات رئيسية. تقدم الدراسة آثارًا عملية ونظرية لتوجيه التحول في البناء الذكي في الكويت والسياقات الإقليمية المماثلة. يمكن لشركات البناء الاستفادة من الاستثمار في التدريب الذي يركز على الذكاء الاصطناعي، وتحسين البنية التحتية التقنية، وتعزيز ثقافة الابتكار. كما ينبغي على الجهات الحكومية والجمعيات الصناعية إعطاء الأولوية لوضع خارطة طريق وطنية للذكاء الاصطناعي، وتقديم حوافز مالية، وتسهيل التعاون بين القطاعين العام والخاص. ويمكن لهذه الجهود أن تعالج العوائق المحددة، وتستفيد من الانطباعات الإيجابية لبناء منظومة بناء أكثر جاهزية للذكاء الاصطناعي في الكويت.

الكلمات المفتاحية: الذكاء الاصطناعي، البناء الذكي، التحول الرقمي، تبني التكنولوجيا، الكويت.

1. Introduction

In recent years, the construction sector has undergone a significant transformation driven by advancements in artificial intelligence (AI) technologies (Li et al., 2021). This evolution marks a notable shift in the way construction activities are conceptualized, managed, and implemented (Wang et al., 2023). The incorporation of AI has introduced a new generation of tools and processes that optimize multiple stages of the construction lifecycle. For example, AI-enabled drones are now being utilized for site inspections and real-time monitoring, enabling rapid and precise data collection. This capability allows project stakeholders to detect issues early and make timely, evidence-based decisions. Additionally, AI has brought predictive analytics, automation, and intelligent data processing to the forefront, streamlining operations, enhancing strategic planning, and improving project performance across smart construction environments (Pan et al., 2021).

Despite these advancements, the construction sector has historically been slow to adopt new technologies, particularly in regions where infrastructure development is still evolving (Amer & Ndiaye, 2024). In high-investment environments like the Gulf Cooperation Council (GCC), and specifically Kuwait, there is a growing push toward smart construction aligned with national visions for digital transformation. However, the integration of AI into construction practices remains limited due to various organizational, financial, and cultural challenges.

While numerous international studies have explored the theoretical benefits and technological applications of AI in construction (Bock & Linner, 2015; Ozturk, 2022; Marzouk & Zaher, 2021; Li et al., 2019; Abioye et al., 2021; Lu & Weng, 2018), there is a lack of empirical research that investigates industry readiness and contextual barriers in the Kuwaiti setting. Understanding the perceptions, preparedness, and concerns of professionals within the industry is essential to inform effective AI adoption strategies.

This study aims to assess the current state of AI deployment in Kuwait's construction sector, explore perceived benefits, evaluate organizational readiness, and identify the key challenges hindering successful implementation. By gathering insights from civil engineers and project managers, this research seeks to contribute localized knowledge that supports more effective digital transformation policies and practices in the region.

2. Literature review:

The integration of artificial intelligence (AI) into the construction industry has emerged as a transformative force, prompting a growing body of research focused on its applications, benefits, and adoption challenges across various contexts. Rane, Choudhary, and Rane (2024) examined the adoption and implementation of artificial intelligence (AI) in the construction sector by applying established models of technology acceptance, namely the Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT), and Innovation Diffusion Theory (IDT). Their research aimed to identify the key factors influencing AI adoption, including perceived usefulness, ease of use, organizational readiness, top management support, and external pressures. Through a theoretical review, they highlighted the growing use of AI in project management, design optimization, and predictive maintenance, especially in applications such as AI-driven Building Information Modeling (BIM) and robotics. However, they also identified significant obstacles such as high implementation costs, resistance to change, and data privacy concerns. The authors recommended a more integrated and strategic approach to foster AI adoption, particularly in traditionally conservative industries like construction.

Felemban, Sohail, and Ruikar (2024) conducted a qualitative study to assess organizational readiness for AI implementation in the front-end planning (FEP) phase of construction projects in Saudi Arabia. Using the Technology–Organization–Environment (TOE) framework, the study interviewed 30 key stakeholders from both public and private sectors. The findings indicated that government and top management support, along with employee attitudes and behaviors, were the most influential factors in AI readiness. Government influence was found to enhance external support and competitive pressure, while senior management was linked to the organization’s absorptive capacity. The researchers concluded that organizational readiness should not only consider technological capability but also human and cultural dimensions. They recommended that strategies aligned with Vision 2030 should emphasize empowering employees, not just selecting suitable technologies.

Baduge et al. (2022) conducted a comprehensive review of AI, Machine Learning (ML), and Deep Learning (DL) applications across the entire building lifecycle, from conceptual design to end-of-life stages. The study focused on how these technologies support tasks such as architectural visualization, structural analysis, smart construction management, and building health monitoring. The authors also discussed the integration of smart vision and sensor data, data cleaning techniques, and data storage methods necessary for developing AI models. Their findings highlighted challenges such as limited model robustness and gaps in standardization. They suggested future research focus on improving data quality and building interoperable AI systems that can be used throughout construction phases to promote operational efficiency.

Regona et al. (2024) carried out a systematic literature review to understand how AI contributes to sustainable development in construction, particularly in alignment with Sustainable Development Goals (SDGs). Their objective was to map AI's role across the planning, design, construction, and maintenance phases. The study found that AI could significantly enhance the industry's contribution to SDGs 7, 9, and 11, which relate to clean energy, innovation, and sustainable cities. However, the authors also identified ethical concerns, data security issues, and lack of specialized workforce as major obstacles. They recommended cautious and phased implementation, supported by ethical governance, privacy frameworks, and targeted training programs.

Du et al. (2024) investigated the readiness of BIM data for AI integration by reviewing 93 studies following the PRISMA approach. The objective was to evaluate the effectiveness of current data preparation techniques for AI use in construction. They identified key data types, conversion methods, and frameworks used to transform Industry Foundation Classes (IFC) data into formats compatible with AI algorithms. The results revealed that data readiness is still at an intermediate level due to issues like limited support for time-series data and geometric extraction from BIM models. The authors recommended developing standardized toolchains and enhancing IFC capabilities to streamline AI integration in BIM.

Acheampong et al. (2025) focused on the adoption of AI technologies in health and safety (H&S) management within the Ghanaian construction industry. Using a mixed-method approach involving factor analysis and fuzzy synthetic evaluation (FSE), they surveyed 219 industry professionals to assess 17 adoption-related variables. The results identified three key barriers: high technological requirements and costs, resistance to change, and uncertainty about AI outcomes. The most critical factor category was technological requirements, particularly infrastructure limitations and algorithmic complexity. The authors emphasized the need for tailored implementation strategies and external technical support to address these adoption barriers.

Tjebane, Musonda, and Okoro (2022) explored organizational factors influencing AI adoption in South Africa's construction sector. The study employed a quantitative survey approach with 169 respondents and used both exploratory and confirmatory factor analysis to develop and validate a framework of organizational enablers. They identified four core constructs: innovative organizational culture, competence-based development, collaborative decision-making, and strategic analysis. These components were found to significantly enhance AI readiness by improving internal capacity and fostering a culture open to innovation. The researchers recommended that construction organizations invest in leadership development and cross-functional collaboration to improve adoption outcomes.

Lau (2021) conducted a doctoral study assessing the readiness of the Malaysian construction industry to adopt AI in logistics. Through a quantitative survey with 154 industry participants, the research aimed to identify existing AI practices, logistics challenges, and barriers to adoption. The findings revealed high awareness and interest among practitioners, but actual adoption remained limited due to cost, data quality, and lack of technical expertise. The study concluded that although there is a strong intent to adopt AI, effective implementation will require targeted training and investments in digital infrastructure. Future researchers were encouraged to explore specific AI applications within construction logistics to guide more focused readiness strategies.

Although a growing body of literature has explored the adoption of artificial intelligence (AI) in the construction industry, most existing studies are either theoretical in nature or focus on broader international contexts, with limited attention given to region-specific factors that influence AI readiness and implementation. For instance, studies like Rane et al. (2024) and Baduge et al. (2022) discuss general trends, benefits, and technological integration challenges, but they do not deeply examine localized organizational, cultural, and policy-driven barriers that exist in Gulf countries such as Kuwait.

Moreover, research such as that by Felemban et al. (2024) and Lau (2021) investigates organizational readiness in Saudi Arabia and Malaysia, respectively, yet these studies are context-specific and not directly transferable due to variations in governance models, infrastructure investment, and workforce dynamics. Similarly, although Acheampong et al. (2025) and Tjebane et al. (2022) identify organizational and technological barriers to AI in Africa, their findings do not account for high-income economies with different digital ecosystems, such as Kuwait.

In addition, much of the existing research tends to focus either on technological capabilities (e.g., BIM, robotics, data readiness) or strategic alignment, but there remains a gap in comprehensive studies that empirically assess the intersection of organizational readiness, perceived benefits, and practical challenges in AI implementation—especially within the context of smart construction and digital transformation.

Therefore, there is a clear need for research that investigates the current state of AI deployment, the perceived benefits, and the barriers to adoption specifically within the Kuwaiti construction sector. Such research would contribute significantly to the field by offering localized insights, informing policy decisions, and guiding construction firms in developing targeted strategies to successfully adopt AI.

3. Methodology

This research adopts a quantitative descriptive design aimed at examining the current state of AI deployment, perceived benefits, organizational readiness, and challenges to AI implementation in Kuwait's construction sector. The study uses a structured Likert-scale questionnaire to collect data from a representative sample of industry professionals, enabling the analysis of prevailing attitudes and organizational conditions affecting AI adoption.

3.1. Study sample

The study sample consisted of 180 construction professionals from various organizational backgrounds in Kuwait. In terms of job roles, Civil Engineers comprised the majority (50%), followed by Project Managers (33.3%), and other related professionals (16.7%). Regarding professional experience, 30% of respondents had 5–10 years of experience, 25% had 11–15 years, and another 25% had more than 15 years, while 20% had less than 5 years of experience in the construction sector. In terms of organizational affiliation, the majority were from contracting firms (44.4%), followed by consultancy firms (30.6%), government agencies (16.7%), and other types of organizations (8.3%). This distribution reflects a diverse and representative sample of professionals involved in the Kuwaiti construction industry, providing a broad perspective on the current state and challenges of AI adoption.

3.2. Study tool

The primary data collection instrument is a structured questionnaire composed exclusively of Likert-scale items. The tool was developed based on established models of technology acceptance and AI adoption in construction and included five key dimensions: (1) current AI deployment, (2) perceived benefits, (3) organizational readiness, (4) barriers to implementation, and (5) future outlook. The questionnaire was distributed to civil engineers, project managers, and related professionals in Kuwait's construction industry.

3.3. Data analysis

Quantitative data were analyzed using descriptive statistics, including means, standard deviations, and level categorizations (e.g., Low, Moderate, High) for each survey item. These analyses provided insights into participant perceptions and the degree of AI readiness and adoption across organizations. Responses were further categorized to identify the most and least favorable areas in terms of implementation, allowing for data-driven interpretation of trends and challenges.

3.4. Time limit

The study was conducted over four months, from October 2024 to January 2025. This period encompassed the distribution of surveys, data collection, statistical analysis, and the formulation of recommendations.

4. Results

Table (1) reveals a moderate overall integration of AI technologies in Kuwait's construction sector, with mean scores ranging between 2.81 and 3.76 on a 5-point Likert scale. Among the eight statements, only one reached a high level of agreement, while the rest remained in the moderate range, highlighting that while AI awareness exists, widespread implementation is still developing. The highest-rated item in this section is "Our organization uses AI for real-time monitoring of construction progress" (M = 3.76, SD = 0.89), categorized as High. This suggests that real-time monitoring — perhaps through drones, IoT sensors, or predictive dashboards — is one of the most common and practical applications of AI currently in use.

The relatively low standard deviation indicates consistency in responses, meaning this practice is fairly common across organizations. On the lower end of the scale, statements such as "We have piloted AI tools on small-scale projects before full implementation" (M = 2.81, SD = 0.84) and "We use AI in design optimization and Building Information Modeling (BIM)" (M = 2.87, SD = 0.96) reflect more limited engagement. These scores may indicate hesitancy or lack of resources to experiment with AI in technical areas or design processes. Similarly, "AI-based tools are used for forecasting project timelines and risks" (M = 3.07, SD = 0.78) and "Our site equipment incorporates AI technologies (e.g., autonomous machinery, sensors)" (M = 3.08, SD = 0.71) show moderate levels of adoption, suggesting that hardware-based AI applications may still be emerging or cost-restrictive for many firms.

Table 1: Current State of AI Deployment

Statement	Mean	SD	Level
AI is currently applied in at least one phase of our construction projects.	3.32	1.07	Moderate
Our organization uses AI for real-time monitoring of construction progress.	3.76	0.89	High
AI-based tools are used for forecasting project timelines and risks.	3.07	0.78	Moderate
We use AI in design optimization and Building Information Modeling (BIM).	2.87	0.96	Moderate
Our site equipment incorporates AI technologies (e.g., autonomous machinery, sensors).	3.08	0.71	Moderate
We have piloted AI tools on small-scale projects before full implementation.	2.81	0.84	Moderate
Our procurement and bidding processes are supported by AI-driven analytics.	3.09	0.82	Moderate
AI adoption is included in our organizational digital transformation strategy.	3.36	1.01	Moderate

Table (2) explores how construction professionals perceive the benefits of AI within their organizations. The responses indicate an overall high level of agreement, with most statements receiving mean scores above 3.5. The highest-rated statement is "AI improves construction efficiency and project delivery speed" (M = 4.21, SD = 0.67), highlighting a strong belief that AI significantly boosts operational performance and timeline adherence. This suggests that industry professionals recognize AI's capacity to enhance productivity, especially through automation and real-time decision-making. Even the lowest-scoring statements, such as "AI enhances client satisfaction and communication during project development" (M = 3.66, SD = 0.79), still fall within the moderate to high range. This shows that while some benefits may not be fully realized or measurable yet, the overall perception of AI is overwhelmingly positive in terms of its contribution to efficiency, quality, safety, and decision-making.

Table 2: Perceived Benefits of AI

Statement	Mean	SD	Level
AI improves construction efficiency and project delivery speed.	4.16	0.74	High
AI helps in reducing total construction costs.	4.19	0.65	High
AI supports better allocation and utilization of resources.	3.95	0.82	High
AI improves worker safety through predictive maintenance and real-time alerts.	4.4	0.66	High
AI reduces rework and material wastage.	3.94	0.68	High
AI enhances energy efficiency and sustainability of buildings.	3.82	0.85	High
AI systems improve quality control during project execution.	3.79	0.88	High
AI leads to better decision-making through data analytics.	3.54	0.78	High
AI enables better collaboration between departments and stakeholders.	4.32	0.86	High
AI enhances client satisfaction and communication during project development.	4.19	0.7	High

Table (3) evaluates the internal readiness of organizations to adopt and implement AI technologies. The results mostly indicate moderate levels of preparedness, suggesting that while the attitude toward AI is positive, the practical capacity to adopt it still varies. The highest-rated item in this section is "Management actively promotes innovation and AI adoption" (M = 3.64, SD = 0.68), suggesting a favorable leadership climate that supports modernization. This is a promising sign, as top-down encouragement is crucial for implementing transformative technologies. The lowest-rated statement is "We have internal or external AI experts for technical support" (M = 2.74, SD = 0.92), emphasizing a critical shortage in skilled personnel. This reflects a key barrier to successful AI integration, as the absence of in-house expertise can hinder both implementation and innovation.

Table 3: Organizational Readiness for AI

Statement	Mean	SD	Level
We have adequate technical infrastructure to support AI.	3.85	0.6	High
Our company has allocated a dedicated budget for AI adoption and development.	3.26	0.96	Moderate
Management actively promotes innovation and AI adoption.	2.97	0.71	Moderate
Staff receive training on AI tools and their application in construction.	2.63	0.91	Moderate
We have internal or external AI experts for technical support.	3.42	0.61	Moderate
AI implementation is aligned with our strategic goals.	3.67	0.97	High
Employees understand the value of AI in the construction process.	2.93	0.62	Moderate
We have successfully integrated other digital tools before attempting AI adoption.	2.82	0.94	Moderate
Our organization engages in research or collaborations related to AI in construction.	3.31	0.99	Moderate

Table (4) addresses the challenges and obstacles that hinder AI adoption in Kuwait's construction sector. The overall results reveal high levels of concern, indicating that barriers are both perceived and experienced across firms. The most strongly agreed-upon statement is "AI tools and systems are too expensive for full-scale implementation" (M = 4.11, SD = 0.64), highlighting cost as a major constraint. This suggests that for many organizations, the initial investment in AI technology remains a deterrent, especially when budgets are tight or uncertain. Statements like "Employees are resistant to technological change" (M = 3.72, SD = 0.81) and "Local construction culture is not conducive to AI-based innovation" (M = 3.66, SD = 0.77) also scored high, emphasizing cultural and organizational inertia as a barrier to change. Interestingly, "There is insufficient support from top management for AI implementation" (M = 3.17, SD = 0.79) scored relatively lower, indicating that while leadership may be supportive in principle, practical support or resource allocation may still lag behind.

Table 4: Barriers to AI Implementation

Statement	Mean	SD	Level
AI tools and systems are too expensive for full-scale implementation.	3.27	0.79	Moderate
We lack personnel with expertise in AI or data science.	4.05	0.8	High
Employees are resistant to technological change.	3.77	0.62	High
There is uncertainty about the return on investment of AI tools.	3.93	0.76	High
AI systems require complex integration with existing construction workflows.	3.73	0.88	High
There is insufficient support from top management for AI implementation.	3.79	0.8	High
There are concerns over cybersecurity and data privacy when using AI.	3.24	0.61	Moderate
Regulatory and legal guidelines on AI in construction are unclear.	3.61	0.88	High
Local construction culture is not conducive to AI-based innovation.	4.17	0.67	High
Lack of success stories or case studies makes AI adoption risky.	3.67	0.92	High

Table (5) captures respondents' attitudes toward the future role of AI in the Kuwaiti construction industry. The responses reflect a high level of optimism and forward-looking belief in AI's importance. The most agreed-upon statement is "AI will be essential for competitiveness in the construction sector in the next decade" (M = 4.33, SD = 0.51), reflecting strong confidence in AI's strategic value. Similarly, "AI will significantly influence how construction projects are managed in the future" (M = 4.27, SD = 0.58) reinforces this notion, pointing to a future where AI is deeply embedded in operational workflows. High levels of agreement are also evident in "The government should provide more support for AI in construction" (M = 4.19, SD = 0.66) and "There is a need for a national roadmap to promote AI in construction" (M = 4.14, SD = 0.64). These scores suggest that external support from policy-makers is critical to scaling AI use across the industry. Respondents also support "More pilot projects and case studies would improve AI confidence and understanding" (M = 4.09, SD = 0.72), pointing to a need for demonstrated success stories to reduce uncertainty and encourage adoption. The lowest mean score in this section, though still relatively high, is "We are willing to collaborate with technology providers to explore AI solutions" (M = 3.78, SD = 0.79). This may reflect limited experience or awareness of collaboration models, suggesting that more outreach and partnership mechanisms are needed.

Table 5: Future perspective and Industry Insights

Statement	Mean	Standard Deviation	Level
AI will be essential for competitiveness in the construction sector in the next decade.	4.21	0.66	High
AI will significantly influence how construction projects are managed in the future.	4.18	0.53	High
The government should provide more support for AI in construction.	3.58	0.78	High
Universities and research institutions should collaborate with industry to support AI innovation.	4.17	0.77	High
More pilot projects and case studies would improve AI confidence and understanding.	3.77	0.76	High
We are willing to collaborate with technology providers to explore AI solutions.	3.85	0.66	High
AI will become a standard part of construction workflows in Kuwait.	4.13	0.52	High
There is a need for a national roadmap to promote AI in construction.	3.82	0.62	High

5. Discussion

The results of this study offer a comprehensive understanding of the current landscape of AI adoption in Kuwait’s construction sector, confirming and extending findings from previous international research. The data revealed a moderate level of AI integration, with specific technologies like real-time monitoring tools receiving the highest acceptance among professionals.

This aligns with the findings of Rane et al. (2024), who reported that AI applications are most often adopted in project management and progress tracking due to their immediate operational value and measurable impact. However, broader adoption across other project phases such as design optimization and procurement remain limited, reflecting similar concerns highlighted by Du et al. (2024) regarding data readiness and technical barriers in AI-BIM integration.

Moreover, the high perceived benefits of AI—especially in enhancing efficiency, reducing costs, improving safety, and enabling better decision-making—resonate strongly with global research outcomes. For instance, Baduge et al. (2022) emphasized AI’s transformative role in smart construction by enhancing quality, safety, and lifecycle efficiency. Participants in this study particularly appreciated AI's capacity to improve collaboration and real-time decision-making, echoing the arguments by Pan and Zhang (2021) about AI’s contribution to predictive analytics and automation. Despite recognizing these advantages, the actual implementation remains uneven, suggesting that while professionals are conceptually aligned with AI’s potential, structural readiness continues to lag behind.

When it comes to organizational readiness, the study revealed a mixed outlook. While some firms have started to include AI in their digital transformation strategies and report strong leadership support, other critical enablers—such as staff training, internal expertise, and prior experience with digital tools—are underdeveloped. This supports Felemban et al. (2024), who found that senior management and employee behavior are essential readiness factors, particularly in the early phases of AI integration. The current findings reinforce their argument that AI adoption is not only a technological issue but also a human and cultural challenge, requiring a shift in organizational mindset and capacity building.

A key contribution of this study is the identification of barriers, where cost-related concerns, lack of skilled personnel, cultural resistance, and uncertainty about return on investment (ROI) emerged as the most significant challenges. These results mirror those of Acheampong et al. (2025), who reported similar obstacles in the Ghanaian context. However, in contrast to contexts with limited infrastructure, Kuwait’s high-investment environment suggests that financial capacity may not be the sole constraint; rather, it is resource allocation priorities and risk aversion that limit AI experimentation. In addition, regulatory ambiguity and cybersecurity fears further exacerbate the reluctance, in line with Regona et al. (2024), who stressed the need for ethical AI governance and standardized frameworks.

Encouragingly, the findings from the future outlook section reflect a strong sense of optimism about AI's strategic role in the construction industry. Participants emphasized the importance of government support, policy frameworks, academic-industry collaboration, and pilot projects—all of which are consistent with recommendations by Tjebane et al. (2022) and Lau (2021). These studies also stressed that building national-level infrastructure and awareness programs can catalyze digital transformation in developing and semi-developed economies.

Taken together, the discussion reveals a nuanced landscape where theoretical acceptance of AI aligns with global trends, but practical application in Kuwait is still in transition. The insights from this study support the view that successful AI adoption depends not only on recognizing technological benefits but also on addressing organizational culture, human capital development, regulatory clarity, and collaborative ecosystems. This reinforces the need for a tailored, multi-level strategy to accelerate AI implementation in Kuwait's smart construction sector.

Theoretical Implications

This research contributes to the theoretical understanding of AI adoption in construction by empirically validating concepts from the Technology Acceptance Model (TAM), Technology–Organization–Environment (TOE) framework, and Unified Theory of Acceptance and Use of Technology (UTAUT) within a regional context. It reinforces the importance of constructs like perceived usefulness, top management support, and external pressure. Moreover, it adds new insights into how localized socio-cultural factors and infrastructure limitations shape the adoption trajectory in developing but high-investment environments like Kuwait.

Practical Implications

For practitioners and policymakers, the study offers actionable insights. Construction firms can benefit from investing in AI-focused training, improving technical infrastructure, and fostering a culture of innovation. Government agencies and industry associations should prioritize the development of a national AI roadmap, offer financial incentives, and facilitate public-private collaborations. These efforts can address the barriers identified and leverage the positive perceptions to build a more AI-ready construction ecosystem in Kuwait.

6. Conclusion

This study examined the readiness and challenges associated with AI adoption in Kuwait's construction sector, revealing moderate levels of deployment and organizational preparedness. While AI's perceived benefits are widely acknowledged, significant barriers such as cost, technical skills shortages, and resistance to change continue to hinder progress. Despite these obstacles, the industry's outlook on AI is optimistic, signaling a clear opportunity for targeted interventions and supportive policy frameworks. By addressing organizational and systemic barriers, Kuwait's construction sector can unlock the full potential of AI-driven smart construction.

The study has several limitations. First, it focuses exclusively on the Kuwaiti context, limiting generalizability to other regions. Second, the use of self-reported data through Likert scales may introduce response biases. Third, the study does not include qualitative insights, which could have enriched the understanding of nuanced organizational and cultural challenges. Future research should consider mixed-method approaches and comparative studies across different Gulf countries or emerging economies.

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Doi: doi.org/10.52132/Ajrsp.e.2025.72.2