A SYSTEMATIC LITERATURE REVIEW: EXPLORING THE INTEGRATION OF ARTIFICIAL INTELLIGENCE IN CONSTRUCTION MANAGEMENT

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Abstract

Artificial intelligence (AI) is progressively transforming the planning, execution, and monitoring of building projects. AI provides tangible advantages to an industry characterized by complexity and risk, ranging from the enhancement of decision-making processes to the improvement of site safety and efficiency. Notwithstanding this promise, extensive implementation remains inconsistent. Numerous companies encounter issues related to expenses, employee fear, and insufficient technological preparedness. This systematic literature review examines the integration of AI technologies—namely machine learning, predictive analytics, and AI-driven safety systems—into construction workflows. Utilizing the Technology Acceptance Model (TAM), the study examines how perceptions of utility and usability affect adoption trends. The results indicate that adoption can be facilitated through specialized training, gradual implementation tactics, and conducive policy environments. This review provides ideas that may enhance the integration of AI into construction management by addressing technological and organizational issues.

Keywords: artificial intelligence (AI), construction management, technology adoption, predictive analytics, workforce resistance

Introduction

Artificial intelligence (AI) technologies are being used to optimize operations and enhance decision-making processes, hence changing the construction industry. Historically, project management in construction has relied on human discretion and physical labor, often leading to shortcomings, budget overruns, and safety concerns. Task automation, data analysis for informed decision-making, and efficiency improvement use AI to solve these problems. Increasingly vital in construction management are technologies such as predictive analytics, which use real-time data to forecast project results, and machine learning, which can forecast delays and allocate resources more effectively (Huang & Kummert, 2020). Furthermore, solutions for AI-powered safety monitoring have been developed to improve site safety by spotting risks and alerting workers in real-time, hence possibly reducing accidents and improving compliance with safety regulations.

Still, even if artificial intelligence offers great promise, its adoption into the building industry has been slow. Insufficient knowledge of artificial intelligence's possible benefits, worries about the high implementation expenses, and resistance from workers and management concerned about job loss have all combined to impede this slow adoption (Kelly et al., 2023). Moreover, the readiness of companies to use artificial intelligence—including the availability of trained personnel and necessary technology infrastructure—varies greatly throughout the sector (Zhang & Teizer, 2021). By addressing these challenges, this paper aims to provide useful ideas on how the building industry could use artificial intelligence technologies to achieve notable improvements.

Labor shortages, complex project specifications, price overruns, and safety concerns are among the many challenges the construction industry has that hinder its ability to carry out projects swiftly and safely. Though artificial intelligence (AI) can streamline processes, enhance decision-making, and accelerate deadlines, its limited use aggravates these challenges (Regona, 2022; Abioye, 2021). Though technologies like machine learning and predictive analytics have the power to greatly improve construction processes, growing interest in artificial intelligence has not been matched by research synthesizing the existing literature to identify practical approaches for overcoming barriers to AI adoption in construction management. Still, many obstacles have limited the widespread adoption of artificial intelligence, including significant upfront costs, industry fragmentation, and challenges with data integration (Abioye, 2021; Regona, 2022).

Insufficient understanding and knowledge of the possible benefits artificial intelligence could provide for construction management is a main worry. Many managers and decision-makers are unaware of how artificial intelligence may improve their operations, which makes them reluctant to use these tools (Kelly et al., 2023). Furthermore, many construction companies, particularly smaller ones with limited resources, face financial and logistical issues from the significant upfront costs connected with artificial intelligence systems and the need for expert training. Employee and manager resistance to artificial intelligence as a threat to job security is a significant issue; this fear of job loss combined with a general industry aversion to change hinders AI adoption.

Given the significant advantages artificial intelligence presents and the continuous challenges to its application, it is crucial to understand how construction managers perceive AI technology and the factors enabling or obstructing their integration into daily operations. Examining the viewpoints of construction managers, this paper will highlight these shortcomings as well as the organizational and technological factors influencing AI adoption in construction management.

This paper intends to use a qualitative literature review to explore the integration of artificial intelligence (AI) technology into construction management. This review looks at present research to understand how artificial intelligence affects decision-making, project efficiency, and labor dynamics in the construction industry. The literature's portrayal of artificial intelligence technologies—including machine learning, predictive analytics, and AI-driven safety monitoring systems—and their perceived influence on enhancing construction workflows and results is investigated in this paper. This paper provides recommendations for improving the integration of artificial intelligence technologies into building processes by means of a synthesis of data from many sources identifying traits that either support or hinder their adoption.

This study looks at the barriers construction companies have in using artificial intelligence, including budgetary constraints, technological readiness, and worker resistance. Understanding these challenges is crucial for creating plans that help the efficient use of artificial intelligence technology all over the sector. The findings of this study will improve the larger debate on AI integration in construction by offering evidence-based advice for industry leaders, managers, and legislators to help the transition toward more advanced and efficient technological approaches. The results of the study will guide the development of policy frameworks and training programs as well as industry practices to enable artificial intelligence use. The study will cover the following questions:

RQ1: How do existing studies describe the impact of AI technologies on decision-making processes in construction management?
RQ2: What key factors, including financial constraints, technological readiness, and workforce resistance, influence AI adoption in the construction industry?
RQ3: How are AI-driven safety monitoring systems and AI-enhanced Building Information Modeling (BIM) tools reported to impact project efficiency, safety, and workforce dynamics?

This research aims to comprehensively examine the integration of artificial intelligence (AI) technologies within construction management. First, this study aims to analyze how AI tools, specifically machine learning and predictive analytics, impact decision-making processes, providing insights into how these technologies can support informed and efficient management practices. Additionally, this research seeks to identify the organizational, financial, and human factors that either facilitate or hinder AI adoption within the construction industry, recognizing that these elements play a critical role in implementing and utilizing AI technologies.

Furthermore, this study evaluates the impact of AI-driven safety monitoring tools and AI-enhanced Building Information Modeling (BIM) systems on key aspects of project performance, including efficiency, safety, and workforce dynamics. Finally, the research will provide practical recommendations designed to improve the adoption and integration of AI in construction projects, ultimately aiming to optimize project outcomes and support the industry's evolution toward advanced technological practices.

This research is structured to comprehensively analyze AI adoption in construction management through a qualitative literature review. The paper begins with a detailed review of existing research, summarizing current knowledge on integrating AI technologies in construction and identifying key gaps and challenges. The methodology section describes the qualitative literature review approach, detailing the systematic process for identifying, selecting, and analyzing relevant academic and industry sources. Finally, the paper presents the findings from the review about the research questions, offering insights into the factors influencing AI adoption and practical recommendations for enhancing its implementation in the construction industry. This structure ensures a cohesive and thorough examination of the topic, providing valuable contributions to the discourse on AI in construction.

Review of Literature

The construction industry faces persistent challenges such as project delays, cost overruns, labor shortages, and safety risks. These issues necessitate innovative solutions to enhance efficiency and safety. Artificial Intelligence (AI) technologies, including machine learning, predictive analytics, and Building Information Modeling (BIM), have emerged as transformative tools for addressing these challenges (Waqar et al., 2023). AI's ability to automate repetitive tasks, optimize resource allocation, and provide real-time insights has made it an essential area of exploration in construction management (Huang & Kummert, 2020).

AI's Impact on Decision-Making in Construction

AI technologies have significantly enhanced decision-making processes in construction by leveraging data to optimize project planning and resource allocation. Machine learning algorithms, for example, analyze historical data to forecast delays and potential risks, enabling more proactive management (Regona, 2022). Predictive analytics provides real-time insights into project timelines, allowing managers to adjust schedules dynamically (Huang & Kummert, 2020).

AI-driven tools, such as digital twins, which simulate construction processes, have improved decision-making accuracy. These tools enable managers to evaluate multiple scenarios before implementation, reducing errors and improving outcomes (Lopez & Torres, 2023). Moreover, studies highlight the ability of AI to streamline procurement processes, optimize supply chains, and enhance scheduling accuracy (Wu & Lin, 2024).

Factors Influencing AI Adoption

Financial Constraints

Financial barriers remain a critical obstacle to AI adoption. The high costs of purchasing AI systems, implementing infrastructure, and training personnel discourage many firms, particularly small to medium-sized enterprises (Regona, 2022). Additionally, ongoing expenses such as maintenance and upgrades create long-term financial commitments, further limiting adoption (Waqar et al., 2023).

Technological Readiness

Technological readiness plays a pivotal role in AI integration. Firms with outdated systems often face compatibility issues, hindering the seamless deployment of AI tools. An adequate infrastructure, such as cloud-based platforms, is essential for supporting advanced AI applications (Tjebane et al., 2022). Studies emphasize that firms investing in modern IT infrastructures are better positioned to adopt AI-driven solutions (Zhang & Teizer, 2021).

Workforce Resistance

Resistance from the workforce also impacts AI adoption. Concerns about job displacement and lack of familiarity with AI tools contribute to hesitancy among workers and managers (Khanfar, 2024). Skill gaps further exacerbate this issue, as many workers lack the technical knowledge to operate AI systems effectively. Training and awareness campaigns are crucial to addressing these barriers (Kelly et al., 2023).

The Technology Acceptance Model (TAM) provides a theoretical framework for these challenges. It suggests that perceived ease of use and usefulness influence the willingness to adopt new technologies. Construction managers who view AI as complex or unnecessary are less likely to invest in its implementation (Davis, 1989).

AI-Driven Safety Monitoring and BIM Tools

AI-Driven Safety Monitoring Systems

Khanfar (2024) highlights that AI-driven safety monitoring systems have revolutionized workplace safety in construction by using real-time data to detect hazards and alert workers, significantly reducing on-site incidents. Zhang and Huang (2023) provide an example of wearable devices integrated with AI that can monitor worker health and environmental conditions to ensure compliance with safety protocols.

AI-Enhanced BIM Tools

Lopez and Torres (2023) explain that Building Information Modeling (BIM) tools integrated with AI enhance project efficiency by creating digital twins. These digital representations of physical projects allow managers to visualize workflows, identify potential bottlenecks, and optimize resource allocation. Patel et al. (2022) add that BIM tools improve collaboration by enabling stakeholders to access real-time project updates.

Yoon and Lee (2024) further note that AI-enhanced BIM tools support sustainable construction practices by analyzing material usage and minimizing waste. These tools improve project timelines and cost efficiency while promoting environmental sustainability.

Workforce Dynamics

Chen and Luo (2021) argue that AI tools influence workforce dynamics by automating repetitive tasks, enabling workers to focus on higher-value activities. However, this shift necessitates reskilling initiatives to help workers adapt to new roles. Tjebane et al. (2022) emphasize that firms prioritizing workforce development are likelier to achieve successful AI integration.

Despite these benefits, the human element of AI adoption remains a significant challenge. Resistance from workers, uncertainty about long-term employment, and inadequate training programs contribute to slow adoption rates (Kelly et al., 2023). These factors highlight the need for further exploration into the intersection of AI, workforce dynamics, and long-term sustainability within construction management.

Theoretical Framework: Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) provides a valuable framework for understanding the factors influencing AI adoption in the construction industry. TAM suggests that perceived ease of use and usefulness are critical factors in technology adoption (Davis, 1989). In construction, managers' perceptions of AI's effectiveness in improving safety and efficiency influence their willingness to support AI initiatives. Similarly, if AI technologies are perceived as user-friendly, they are more likely to gain acceptance among managers and workers.

Recent studies (Venkatesh & Bala, 2020) have expanded TAM to emphasize the role of organizational culture, training availability, and external pressures in influencing AI adoption. By integrating this framework, this study will evaluate how perceptions, usability, and organizational readiness shape AI implementation in construction workflows.

Synthesis and Gaps

The existing literature underscores the transformative potential of AI in construction management while highlighting barriers to its adoption. Financial constraints, technological readiness, and workforce resistance remain significant challenges. Furthermore, there is limited research on the long-term impacts of AI on workforce dynamics and sustainability (Waqar et al., 2023). Future studies should explore these areas to provide a more comprehensive understanding of AI's role in construction.

Although various studies discuss AI's benefits, adoption barriers, and applications in construction, few provide a consolidated framework for evaluating AI integration comprehensively. Additionally, while some research examines workforce resistance, less attention has been given to developing targeted interventions to address these challenges effectively. Understanding how and why individuals and organizations resist new technologies is crucial for developing strategies that encourage successful adoption.

Given these research gaps, a systematic literature review must synthesize existing knowledge, identify patterns, and propose strategies for overcoming AI adoption barriers in construction management. Conducting a structured review using PRISMA guidelines ensures a comprehensive evaluation of peer-reviewed studies, allowing for a rigorous analysis of how AI is currently integrated into construction management. The following section details the systematic methodology used in this study.

Methodology

Building on these gaps, this study employs a systematic literature review approach guided by the PRISMA framework to ensure a rigorous and transparent literature evaluation. The following section details the methodology used to identify, screen, and analyze relevant studies, providing a structured synthesis of AI's role in construction management.

Research Design

This study employs a systematic literature review approach to evaluate the impact of Artificial Intelligence (AI) on construction management. A systematic review allows for a structured synthesis of existing research, ensuring comprehensive and reliable findings (Creswell & Poth, 2018). This review focuses on examining AI's influence on decision-making, identifying barriers to its adoption, and assessing the effectiveness of AI-enhanced tools such as Building Information Modeling (BIM) and safety monitoring systems.

Systematic Review Approach

The study follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure transparency and rigor in the selection and analysis of literature. PRISMA consists of four phases: identification, screening, eligibility, and inclusion, as described by Page et al. (2021). A thematic analysis was conducted to categorize findings under key research questions. The thematic coding process was facilitated using Taguette, a qualitative analysis software, which enabled the classification of key themes and patterns from the literature.

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) provides a sound theoretical framework for understanding the factors influencing AI adoption in construction management. TAM suggests that perceived ease of use and perceived usefulness are critical factors in technology adoption (Venkatesh & Bala, 2020). In the context of this review, TAM helps analyze the factors influencing AI acceptance, such as managerial perceptions, workforce adaptability, and industry readiness. Including TAM within the methodology ensures that the study systematically assesses AI adoption barriers and facilitators in construction management.

Eligibility Criteria and Study Selection
A set of predefined inclusion and exclusion criteria was applied when selecting studies to ensure the review remained focused and relevant. These criteria refine the scope of the research by filtering out studies that do not contribute meaningful insights into AI's role in construction management. The selection process prioritized high-quality, peer-reviewed literature that provides empirical or theoretical contributions aligned with the study's research questions.

Table 1: Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Publication Type	Peer-reviewed studies published between 2010 and 2025	Editorials, abstracts, and non-peer-reviewed articles
Language	English-language publications	Non-English publications
Focus Area	Studies focusing on AI in construction management, decision-making, BIM, and safety monitoring	Studies unrelated to the specified research questions
Content	Articles addressing financial, technological, and workforce-related barriers	Irrelevant topics outside construction management

Search Strategy
A comprehensive search was conducted using Boolean operators and keywords, including:
- "Artificial Intelligence" OR "AI"
- "construction management" OR "BIM" OR "safety monitoring systems"
- "decision-making" OR "adoption" OR "barriers"
- "machine learning" OR "automation" OR "predictive analytics"
- "cost optimization" OR "workflow automation"

Databases:
- Google Scholar
- IEEE Xplore
- ScienceDirect
- Semantic Scholar
- PubMed Central
- CORE

The search results were systematically filtered using Taguette, which allowed for identifying relevant excerpts and ensured consistent thematic categorization.

Data Extraction and Synthesis

Data extraction and analysis were conducted using Taguette, allowing for organizing thematic categories relevant to AI adoption in construction. This process involved identifying keywords, coding text excerpts, and categorizing them under significant themes, such as AI-driven BIM tools, financial constraints, workforce resistance, and technological readiness. The extracted data included:
- Author(s), publication year, and methodology
- Focus area (decision-making, barriers, or AI tools)
- Main findings and implications

Taguette was instrumental in recognizing patterns and aggregating insights across multiple studies. The analysis centered on three primary themes:
- AI's impact on decision-making in construction management.
- Barriers to AI adoption, including financial, technological, and workforce resistance factors.
- The effectiveness of AI-driven BIM and safety monitoring tools in construction projects.

Table 2: Authors and Annotations

Ref	Author(s)	Year	Focus Area	Key Findings	Methodology
[1]	Hu et al.	2024	Decision-making in construction	AI enhances cost optimization, predictive analytics, and real-time monitoring	Delphi-ISM-MICMAC analysis, case studies
[2]	Lin et al.	2024	AI tools and efficiency	BIM-AI integration improves project performance and operational efficiency.	Thematic analysis, systematic literature review
[3]	Khan et al.	2024	Barriers to AI adoption	Financial and organizational challenges dominate adoption resistance.	Systematic review, bibliometric analysis
[4]	Farouk et al.	2025	Barriers to AI adoption	Strategic planning and stakeholder alignment are critical to overcoming resistance	Case studies, thematic analysis
[5]	Qiao et al.	2024	Safety monitoring with AI	Building information modeling integration with AI enhances safety and material management, creating digital	Simulations, case studies, sand table experiments
[6]	Kong & Ahn	2024	AI in construction workflows	BIM and IoT create digital twins that optimize project workflows and safety.	Hybrid frameworks combining BIM, IoT, and wireless technologies
[7]	Zhang et al.	2023	Automation in safety management	AI-powered safety monitoring systems significantly reduce on-site incidents	Simulation and field studies
[8]	Patel et al.	2022	AI-driven BIM tools	AI-enhanced BIM accelerates design processes and improves collaboration among stakeholders	Case studies and industry reports
[9]	Chen et al.	2021	Workforce resistance to AI adoption	Workforce education and training mitigate resistance to AI integration.	Surveys and qualitative interviews
[10]	Lopez et al.	2023	Digital transformation in construction	Digital twins improve decision-making and efficiency in large-scale projects	Exploratory research and thematic analysis

Table 2: Authors and Annotations (Continued)

[11]	Singh et al.	2020	AI adoption barriers	High implementation costs and lack of skilled personnel hinder AI adoption.	Systematic review and expert interviews
[12]	Ahmed et al.	2025	Predictive analytics in construction	AI-driven predictive analytics optimize resource allocation and reduce delays.	Data analysis and simulations
[13]	Tran et al.	2023	Role of IoT in construction workflows	Integration of IoT with AI enhances real-time monitoring and predictive maintenance.	Case studies and experimental setups
[14]	Wu et al.	2024	Cost management using AI	AI applications significantly reduce cost overruns in large-scale projects.	Hybrid approaches, including simulations
[15]	Baker et al.	2025	AI-enhanced project management	AI-driven tools improve scheduling accuracy and resource allocation.	Literature review and field experiments
[16]	Hernandez et al.	2023	Risk assessment with AI	AI tools provide real-time risk assessment, enhancing project safety.	Quantitative analysis
[17]	Yoon et al.	2024	AI and environmental sustainability	AI supports sustainable construction practices through optimized material usage.	Mixed methods research
[18]	Gupta et al.	2025	Collaborative AI tools	AI fosters collaboration by integrating design, procurement, and execution stages.	Experimental research

Thematic Synthesis

Using Taguette, a thematic synthesis was conducted to organize findings into key research areas. The extracted data were classified based on their relevance to AI's impact on decision-making, barriers to AI adoption, and the effectiveness of AI-driven tools. This method provided a structured framework for identifying trends, similarities, and divergences across studies. The analysis identified financial constraints and technological readiness as the most cited barriers to AI adoption. At the same time, AI-driven BIM and predictive analytics were consistently recognized for enhancing efficiency in construction projects.

Risk of Bias Assessment
A risk of bias assessment was conducted to ensure the reliability of the findings. This evaluation considered selection, performance, detection, and reporting biases. Studies with high levels of bias were either excluded or critically discussed to provide a balanced interpretation of the literature. The assessment framework followed the PRISMA checklist, ensuring methodological rigor and transparency.

By integrating Taguette for qualitative coding and PRISMA for systematic review structuring, this study provides a rigorous and transparent evaluation of AI's role in construction management. This methodological approach strengthens the validity and reliability of the findings, offering valuable insights into AI adoption trends, challenges, and opportunities in the industry.

Results

The systematic analysis of the selected literature revealed key trends and challenges shaping AI adoption in construction management. The findings provide insight into the effectiveness of AI-driven tools, the obstacles to their implementation, and the industry's overall readiness for AI integration. The following section presents a thematic analysis of these findings, categorizing them into significant themes from the review.

Table 3: Results

	Theme	Key Findings	Challenges	Sources
1	AI-Driven BIM Tools	Enhances efficiency and project coordination	Interoperability issues, resistance to AI in BIM	Wei (2021), Khan et al. (2024), Lopez & Torres (2023)
2	Financial Constraints	High initial investment limits adoption	SMEs struggle with funding and AI infrastructure costs	Regona (2022), Waqar et al. (2023), Farouk et al. (2025)
3	Machine Learning in Construction	Optimizes resource allocation and predicts project risks	Lack of trust in AI-driven predictions	Hu et al. (2024), Ahmed & Zhao (2025), Singh et al. (2020)
4	Predictive Analytics	Improves decision-making through real-time monitoring	Data integration challenges	Wu et al. (2024), Gupta et al. (2025), Hernandez et al. (2023)
5	Safety Monitoring Systems	AI reduces hazards using real-time environmental monitoring	Cost of IoT integration and worker resistance	Zhang & Huang (2023), Qiao (2024), Kong & Ahn (2024)
6	Technological Readiness	Lack of digital infrastructure slows AI adoption	Industry fragmentation, outdated processes	Tjebane et al. (2022), Opoku et al. (2023), Eber (2020)
7	Workforce Resistance	Concerns over job displacement hinder adoption	Skill gaps and lack of training programs	Chen & Luo (2021), Kelly et al. (2023), Khanfar (2024)

AI-Driven BIM Tools and Decision-Making in Construction
In response to the first research question, which examines how AI impacts decision-making processes in construction management, the literature highlights the critical role of AI-driven Building Information

Modeling (BIM) tools. These tools enhance efficiency, coordination, and resource allocation, enabling real-time collaboration, reducing errors, and improving visualization in construction projects. However, significant challenges such as interoperability issues with existing systems and organizational resistance have hindered widespread adoption. Some firms struggle to integrate AI-enhanced BIM due to a lack of standardized protocols and the complexity of merging new AI-driven methodologies with traditional workflows.

Additionally, machine learning applications in construction contribute significantly to decision-making by optimizing project planning and risk mitigation. AI models analyze historical project data to predict potential delays, cost overruns, and equipment failures, allowing for proactive decision-making. However, industry-wide skepticism regarding the reliability of AI-generated predictions remains a significant obstacle. Many firms prefer to rely on traditional project management approaches, citing concerns over the accuracy and adaptability of AI models in dynamic construction environments.

Predictive analytics further supports decision-making by monitoring site activities, resource allocation, and financial expenditures. AI-powered systems enhance the ability to forecast supply chain disruptions, labor shortages, and safety hazards. Despite these benefits, data integration challenges remain, as many construction firms operate with fragmented information systems that lack compatibility with AI-driven analytics platforms.

Key Barriers to AI Adoption in Construction

Addressing the second research question, which explores AI adoption factors, the analysis identifies financial constraints, technological readiness, and workforce resistance as dominant barriers.

Financial Constraints

A significant barrier to AI adoption in construction is the high initial investment costs required for AI infrastructure, training, and software implementation. These financial burdens are particularly challenging for small and medium-sized enterprises (SMEs). While AI has the potential to reduce long-term costs by minimizing waste, optimizing schedules, and improving safety, the lack of immediate returns on investment discourages many companies from committing to these technologies. Moreover, ongoing maintenance and software upgrade costs further strain financial resources, limiting scalability across the sector.

Technological Readiness

Technological readiness also plays a critical role in determining the feasibility of AI adoption. Many construction firms rely on legacy systems and outdated software, which pose significant integration challenges. The absence of necessary cloud infrastructure, IoT connectivity, and digital platforms creates a fragmented landscape where firms vary significantly in their technological capabilities and willingness to modernize operations.

Workforce Resistance

Resistance from the workforce is another substantial barrier to AI adoption. Concerns over job displacement, lack of training in AI-related technologies, and skepticism toward automation hinder AI implementation efforts. The absence of structured AI training programs and the limited awareness of AI's potential benefits contribute to worker hesitancy. Addressing these concerns through workforce education and AI-focused upskilling initiatives is essential for increasing acceptance and ensuring a smoother integration of AI-driven solutions in the construction industry.

AI-Driven Safety Monitoring Systems and Workforce Impact

The final research question examines the impact of AI-driven safety monitoring systems and AI-enhanced BIM tools on project efficiency, safety, and workforce dynamics. The findings suggest that AI-driven safety monitoring systems have effectively reduced workplace incidents. AI-enabled wearable devices, computer vision applications, and real-time environmental monitoring tools contribute to hazard detection and compliance enforcement. These technologies enhance worker protection by providing automated alerts and predictive safety assessments. However, implementation remains costly, and resistance from on-site personnel, along with privacy concerns regarding AI surveillance technologies, creates barriers to broader acceptance.

Similarly, AI-enhanced BIM tools improve project efficiency, coordination, and workflow automation by streamlining stakeholder collaboration, minimizing rework, and reducing material waste. However, interoperability challenges and industry-wide reluctance to transition away from traditional construction practices have slowed widespread adoption.

The findings highlight key opportunities and barriers to AI adoption in construction management, emphasizing the need for strategic interventions. AI-driven BIM tools and predictive analytics enhance decision-making and efficiency, but financial constraints, technological readiness, and workforce resistance hinder widespread implementation. The following discussion examines these results about existing industry practices, focusing on practical solutions for overcoming adoption challenges and maximizing AI's potential in construction workflows.

Discussion of Findings

Having identified key trends in AI adoption and challenges in the results section, this discussion will explore their implications for construction management and provide practical solutions. The findings of this study highlight both the transformative potential and the persistent challenges associated with AI adoption in construction management. Integrating AI-driven BIM tools significantly enhances project efficiency, resource optimization, and error reduction. These findings are consistent with prior research by Wei (2021) and Khan et al. (2024), highlighting that AI-driven BIM enhances workflow efficiency and collaboration. Similarly, Lopez & Torres (2023) found that integrating AI in construction workflows significantly reduces cost overruns and delays. Digital twin technology and AI-enhanced modeling allow construction firms to streamline operations, improve coordination, and reduce waste. However, challenges like data interoperability issues and reluctance to adopt AI-driven workflows hinder widespread implementation. Many construction firms, particularly smaller enterprises, lack the technological readiness to integrate AI with existing BIM systems, resulting in fragmented adoption across the industry.

Financial constraints remain a critical barrier to AI adoption. This aligns with findings from Regona (2022) and Waqar et al. (2023), which identified that small and medium-sized enterprises struggle to allocate resources for AI implementation due to high upfront costs and uncertain returns. Prior studies by Farouk et al. (2025) also indicate that long-term cost savings do not always offset initial AI investments, leading to hesitation among firms. The construction sector traditionally operates on tight profit margins, and many firms hesitate to allocate resources for AI implementation due to high upfront costs, ongoing maintenance expenses, and uncertain return on investment. One potential solution is phased AI adoption, where companies start with low-cost AI applications (e.g., AI-enhanced scheduling or predictive analytics) before scaling up to more complex AI-driven workflows. Additionally, industry-wide initiatives such as AI-as-a-service subscription models or joint AI investment funds among small and mid-sized firms could mitigate cost burdens. This reluctance is particularly evident among small and mid-sized firms, which struggle to justify significant investments in AI infrastructure without immediate financial benefits.

Applying machine learning and predictive analytics in construction has demonstrated clear advantages in risk management, scheduling optimization, and cost estimation. These results support research by Hu et al. (2024) and Ahmed & Zhao (2025), which demonstrated that AI-enhanced predictive analytics allows for more accurate forecasting in construction projects. Additionally, Singh et al. (2020) emphasized that while AI models improve risk mitigation, skepticism regarding AI-driven decision-making remains prevalent. AI models can analyze historical project data to predict cost variations, optimize material procurement, and minimize scheduling delays. However, the industry's skepticism toward AI-driven predictions persists, with some firms questioning the reliability of AI models in complex and unpredictable construction environments. The lack of standardized AI training datasets tailored to construction projects also contributes to this uncertainty.

The findings confirm that AI-powered safety monitoring systems effectively reduce on-site hazards. Wearable devices, real-time environmental monitoring, and AI-driven surveillance systems have enhanced worker safety. However, implementation challenges such as high integration costs, worker resistance, and privacy concerns create significant barriers to adoption. Employees often view AI-driven surveillance as intrusive, and management struggles to justify the costs associated with upgrading safety protocols to include AI-driven solutions.

Technological readiness continues to be a significant determinant of AI adoption**.** The construction industry's reliance on legacy systems and traditional workflows significantly slows the transition to AI-enhanced methodologies. Governments and industry organizations should provide grants or incentives for digital transformation projects in construction firms to accelerate AI adoption. Policy frameworks should also encourage standardized AI integration protocols across construction platforms to improve interoperability and scalability. Many firms lack cloud infrastructure and digital platforms to support AI applications. Furthermore, industry fragmentation and a lack of AI integration standards contribute to slow adoption rates, particularly in developing markets.

Finally, workforce resistance remains one of the most persistent obstacles to AI adoption. Similar concerns were raised in studies by Chen & Luo (2021) and Kelly et al. (2023), which found that lack of AI literacy and fear of job displacement contribute to slow adoption rates. Khanfar (2024) further argues that skepticism will continue to be a significant roadblock in integrating AI into construction workflows without targeted AI training. Concerns about job displacement, the perceived complexity of AI tools, and a lack of AI training programs create an environment of skepticism. According to the Technology Acceptance Model (TAM) (Davis, 1989), perceived usefulness and ease of use are critical determinants of technology adoption. If construction workers and managers view AI as complicated or disruptive, resistance to its adoption increases. To address these challenges, companies must prioritize structured AI training programs tailored to different expertise levels, ensuring that employees find AI tools intuitive and beneficial to their daily tasks. Upskilling initiatives should focus on demonstrating how AI augments rather than replaces traditional roles, aligning with TAM’s emphasis on perceived usefulness. Additionally, leadership should proactively communicate AI’s role in improving efficiency rather than eliminating jobs, fostering an organizational culture of technological adaptability. Implementing AI literacy programs as part of vocational education and industry certifications can enhance perceived ease of use, improving long-term workforce readiness and acceptance of AI-driven solutions.

Implications of Findings

The findings of this study have several implications for industry practices, policy formulation, and future research directions. This study contributes to the current knowledge on AI adoption in construction management by holistically synthesizing key challenges and opportunities. Previous studies, such as those by Waqar et al. (2023) and Regona (2022), have examined financial barriers and technological readiness separately. Still, this study integrates these factors to provide a more comprehensive perspective on AI adoption challenges. Additionally, this research aligns with Zhang & Teizer (2021) and Lopez & Torres (2023), reinforcing the significance of AI-driven BIM tools and predictive analytics in enhancing construction efficiency.

However, this study differs from previous research by emphasizing workforce resistance as a significant, underexplored barrier to AI adoption. While past research has primarily focused on financial and technological factors, this study highlights the necessity of structured AI training programs for construction professionals as a key factor in successful AI implementation. This insight adds a new dimension to the discussion on AI adoption, suggesting that human factors are equally as critical as technological investments.

This study lays the foundation for future research into scalable AI adoption frameworks and long-term cost-benefit analyses by addressing these gaps. Future studies should further investigate AI training models, empirical case studies on AI's financial returns over time, and best practices for overcoming workforce skepticism. From an industry perspective, construction firms must prioritize AI integration into BIM workflows to enhance efficiency, reduce errors, and improve project outcomes. To overcome financial constraints, firms should explore phased AI implementation, cost-sharing models, and AI-as-a-service platforms as alternative strategies to make AI adoption more feasible. Addressing workforce resistance through structured AI training and skill development programs is crucial to increasing acceptance and adoption rates. Without sufficient training and awareness, construction workers and managers may view AI as disruptive rather than beneficial.

From a policy standpoint, governments and regulatory bodies must actively incentivize AI adoption through mechanisms such as tax credits, grants, and funding programs to support AI infrastructure development in the construction sector. The lack of standardized AI integration frameworks and interoperability guidelines presents a significant barrier to adoption, necessitating the development of industry-wide standards to ensure seamless AI implementation. Additionally, policies must address data privacy and ethical concerns related to AI-driven safety monitoring to increase worker confidence and acceptance of AI-based oversight systems. Ensuring ethical AI practices will promote trust in AI applications and encourage broader adoption across the industry.

In terms of research, future studies should focus on conducting long-term cost-benefit analyses of AI adoption to provide construction firms with concrete financial justifications for AI investments. While prior studies such as Wu et al. (2024) and Gupta et al. (2025) have explored cost savings associated with AI, few have conducted longitudinal studies assessing AI's financial impact over extended periods. Further research should include empirical studies that track AI adoption in real-world construction projects over time. Developing AI training datasets tailored explicitly for construction applications could improve the accuracy and reliability of AI-driven predictive analytics, making AI tools more effective and widely accepted. Further exploration into human-AI collaboration in construction is also necessary to determine how AI can be effectively integrated into existing workflows while preserving essential human expertise. Unlike past research focusing on automation replacing manual processes (Singh et al., 2020; Zhang & Huang, 2023), future studies should explore hybrid models where AI complements rather than replaces human decision-making. This aligns with findings from Yoon & Lee (2024), who suggested that AI-assisted workflows are most effective when human oversight is retained. By addressing these research gaps, future studies can contribute to AI's structured and scalable adoption in construction management, ensuring that AI technologies align with industry-specific needs and workforce capabilities.

Conclusion, Limitations of the Study, and Recommendations for Future Research

The findings of this study confirm that artificial intelligence (AI) has the potential to revolutionize construction management, safety monitoring, and project efficiency. AI-driven BIM tools, predictive analytics, and machine learning applications are crucial in optimizing workflows, reducing errors, and enhancing decision-making processes. Despite these advantages, widespread AI adoption in the construction industry remains limited due to several persistent barriers, including financial constraints, technological readiness, and workforce resistance. Overcoming these challenges requires strategic investment, policy interventions, and structured workforce training programs that facilitate a seamless transition toward AI-integrated construction management.

This research highlights that firms willing to invest in AI infrastructure and workforce development stand to gain substantial benefits, including increased efficiency, significant cost savings, and improved safety standards. However, for AI adoption to be successful, it must align with industry needs while addressing concerns regarding interoperability, data security, and trust in AI-driven decision-making. Many construction firms face difficulties integrating AI into their existing workflows, mainly due to the lack of standardized frameworks and the need for cross-platform compatibility between AI-driven systems and traditional construction methodologies.

While this study provides valuable insights into AI adoption in construction, several limitations must be acknowledged. First, much of the reviewed literature focuses on the potential of AI rather than its real-world implementation, highlighting a gap in empirical case studies that analyze AI adoption in active construction projects. Future research should prioritize assessing actual implementation scenarios to understand the practical benefits and challenges better. Additionally, AI adoption varies significantly across different economic, regulatory, and technological landscapes, so findings may not be universally applicable across all regions and construction sectors. Finally, workforce resistance remains a significant obstacle, yet this study does not explore the effectiveness of AI training programs in depth. More research is needed to evaluate how structured AI education initiatives can improve the industry's acceptance rates and skill development.

Given these limitations, several key areas warrant further investigation. Future research should focus on conducting longitudinal cost-benefit analyses to measure the financial impact of AI adoption over extended project timelines, providing firms with data-driven justifications for investment. Developing standardized AI frameworks tailored to different construction firm sizes would facilitate smoother adoption and interoperability across the sector. Further exploration is also needed into human-AI collaboration strategies to determine how AI can complement rather than replace human expertise, ensuring that automation enhances rather than disrupts the workforce. Lastly, AI-driven sustainability in construction presents an emerging research frontier, requiring studies that assess how AI can optimize material usage, reduce environmental impact, and promote eco-friendly construction practices.

By addressing these areas, future research can contribute to a more structured and scalable approach to AI adoption in the construction industry, ensuring that technological advancements align with industry-specific needs and workforce capabilities. This study underscores both the opportunities and challenges of AI integration in construction management. While AI-driven solutions offer unprecedented benefits in efficiency, risk management, and cost reduction, barriers related to financial investment, workforce training, and technological infrastructure must be proactively addressed. The construction industry must take a strategic approach to AI adoption, emphasizing collaboration among industry stakeholders, government policy support, and targeted educational initiatives. By fostering industry-wide cooperation, investing in AI training, and developing robust AI adoption frameworks, the construction sector can unlock the full potential of artificial intelligence, paving the way for long-term innovation and sustainable growth.

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