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THE ROLE OF ARTIFICIAL INTELLIGENCE IN ENGINEERING PROJECT MANAGEMENT: A SYSTEMATIC REVIEW

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Abstract

This systematic study investigates the use of Artificial Intelligence (AI) in engineering project management, with an emphasis on its applications, advantages, problems, and future directions. A detailed examination of eight peer-reviewed research published between 2016 and 2025 was carried out, including a wide range of AI approaches such as Machine Learning (ML), Deep Learning (DL), and Genetic Algorithms. The findings show significant progress in scheduling, risk management, decision support, cost estimation, resource optimization, monitoring, and performance evaluation. Despite these gains, obstacles remain, particularly in data quality, organizational readiness, and the need for standardized frameworks. The paper concludes with recommendations for future research that will improve AI use in engineering project management.

Keywords:

Engineering management, Project management, Machine learning, Risk assessment, Artificial intelligence

1. Introduction

Artificial intelligence has emerged as one of the most prominent technologies in contemporary engineering and management processes. In recent years, corporations have increasingly adopted AI powered systems to enhance decision making, automate repetitive processes, and identify potential risks within engineering and construction sectors (Matel et al., 2019; Al-Sinan et al., 2024; Adelusi et al., 2023). Within engineering project management, AI provides tools for managing complex data, estimating project costs, optimizing schedules, and monitoring performance in real time.

The rising complexity of engineering projects, as well as the need for greater efficiency, have necessitated research into how AI may help project managers. Machine learning models, data analytics platforms, and intelligent decision support systems are now being applied in both industrial and academic contexts to perform tasks traditionally managed by humans (Adelusi et al., 2023; Ekanayake et al., 2024). Despite increased interest, many organizations still struggle to incorporate AI into existing management frameworks due to issues such as poor data quality, limited expertise, and uncertainty about long-term benefits (Matel et al., 2019; Jiang et al., 2024).

Several studies have examined the impact of AI across different project management domains; however, their results remain dispersed and often focus on specific tools or case studies (Aziz et al., 2016; Peng et al., 2023; Jiang et al., 2024). An organized and systematic review of recent research is therefore necessary to understand how AI is being applied, what outcomes have been achieved, and what limitations persist.

Accordingly, this review synthesizes existing research, identifies thematic patterns, and highlights opportunities for future exploration in AI driven engineering project management.

2. Methodology

The initial literature search produced approximately 30–40 relevant papers. Abstracts and conclusions were reviewed to assess their relevance to the study's objectives. Only peer-reviewed articles published in English and directly linked to engineering management or project management were considered. Studies that focused exclusively on software development or theoretical AI models without a project management framework were excluded. The eight selected studies span applications of artificial intelligence across cost estimation, scheduling, risk management, decision support, resource allocation, monitoring, planning, and performance analysis, representing both applied case studies and methodological advancements in AI for engineering project management [1]–[8].

Each manuscript was carefully reviewed to determine its scope, methodology, and significant contributions. The review focused on identifying common patterns in AI technique application, benefits reported, and practitioner obstacles. The selected works cover a wide range of topics, including construction, risk management, cost estimation, and decision assistance. The data from these studies were synthesized to provide an integrated overview of current trends and to highlight existing research gaps.

This approach enabled a focused and balanced evaluation without relying on an excessively large dataset. The modest number of studies allowed for a thorough analysis of each, ensuring that the conclusions presented in subsequent sections are well founded and reliable.

Each study was evaluated for its methodological contribution and relevance to engineering project management. In cases where a study addressed multiple application areas, its contribution was divided proportionally among them to ensure an accurate representation in the distribution analysis.

Limitations: This review was restricted to eight peer-reviewed studies published between 2016 and 2025. While this focused scope enabled a detailed qualitative analysis, it may not reflect the full breadth of AI applications in engineering project management across all industries and regions.

Table 1. Summary of selected studies on AI applications in engineering project management

Study	Year	Focus Area	AI Technique	Key Findings
Matel et al.	2019	Cost Estimation	Artificial Neural Network	ANN models improve cost prediction accuracy in tendering and early cost estimation.
Al-Sinan et al.	2024	Scheduling	Machine Learning	ML+BIM approaches can automate schedule generation and reduce delays
Aziz et al.	2016	Risk Management	Fuzzy Logic	Fuzzy logic models assess and prioritize risks in construction projects
Adelusi et al.	2023	Decision Support	Ensemble Learning	Ensemble learning models enhance decision-making in Earned Value Management for megaprojects.
Peng et al.	2023	Resource Allocation	Genetic Algorithms	GA models optimize resource allocation and safety in construction projects.
Ekanayake et al.	2024	Monitoring	Deep Learning	Deep learning models automate as-built state recognition and progress monitoring.
Jiang et al.	2024	Planning	AI + Digital Twin	AI-integrated digital twins enable synchronized construction planning and management.
Silvestri et al.	2025	Performance Analysis	Reinforcement Learning	RL models optimize building control systems for energy efficiency and occupant comfort.

Note: Some studies address more than one application area. These overlaps were considered proportionally in the weighted distribution shown in Figure 1.

To provide a clearer overview of these focus areas, Figure 1 presents a bar chart illustrating the weighted distribution of AI application areas across the eight reviewed studies. This visualization highlights that scheduling, risk management, and decision support were the most frequently explored domains, while automation and resource optimization, though emerging, received comparatively less attention.

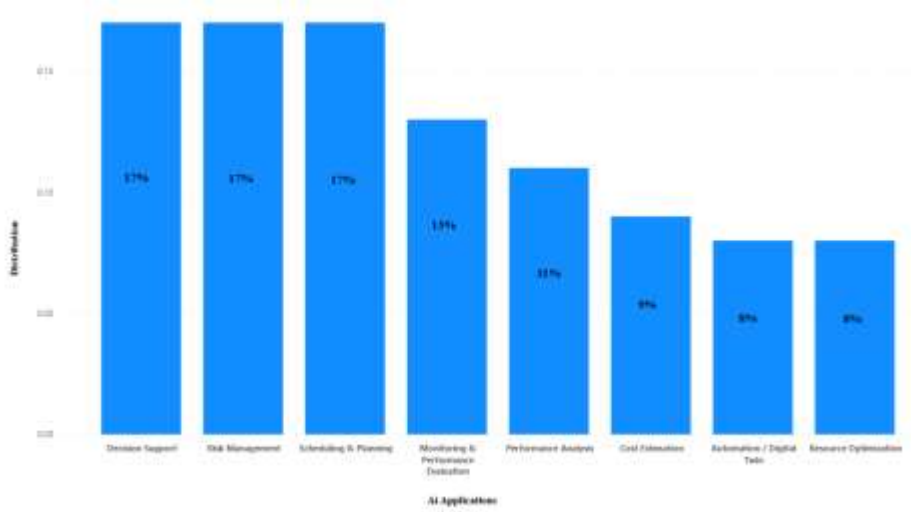

Figure 1: Bar chart showing the weighted distribution of AI application areas across the eight reviewed studies in engineering project management.

3. Literature Review

The reviewed studies reveal that artificial intelligence has been applied across multiple areas of engineering project management, including scheduling, cost estimation, risk management, decision support, and performance monitoring. Although the studies focus and methodologies vary, most indicate that AI enhances accuracy and enables project managers to make faster, data driven decisions. The following subsections outline the main conclusions based on significant themes discovered in the selected literature.

3.1 AI for Project Scheduling and Planning

Several scholars have worked on applying artificial intelligence to improve scheduling and planning operations. Machine learning models and optimization algorithms have been employed to predict project deadlines and dynamically adjust schedules using real time data (Al-Sinan et al., 2024; Jiang et al., 2024). Al-Sinan et al. (2024) demonstrated that AI assisted scheduling systems, integrating Machine Learning with Building Information Modeling (BIM), can automate schedule generation and reduce project delays by identifying bottlenecks and reallocating resources.

These studies emphasize that AI systems can outperform traditional scheduling methods, especially in large and complex projects where numerous dependencies exist. However, they also note that successful implementation depends on data quality and compatibility with existing project management software (Matel et al., 2019; Ekanayake et al., 2024).

3.2 AI in Risk Management and Decision Support

Risk management is a popular topic in AI related project research. Aziz et al. (2016) applied fuzzy logic models to assess and prioritize risks in construction projects. Additionally, Adelusi et al. (2023) developed a predictive analytics driven decision support system utilizing ensemble learning models to enhance Earned Value Management in megaprojects.

Both studies show that AI can considerably enhance risk prediction accuracy and assist managers in taking preventive measures before problems worsen. However, these studies highlight issues such as insufficient project data and the lack of interpretability of AI models, both of which can reduce trust among managers and stakeholders.

3.3 AI for Cost Estimation and Resource Optimization

AI techniques have also been utilized to enhance project cost estimation and optimize resource allocation. Matel et al. (2019) utilized Artificial Neural Network models for cost estimation in engineering services, achieving improved accuracy over traditional methods. Peng et al. (2023) applied Genetic Algorithms to optimize resource allocation and safety in construction projects.

These examples demonstrate that AI can manage the complexities of multi factor cost estimating and resource planning more effectively than manual methods. Most studies emphasize AI's capacity to learn from historical project data and refine future forecasts accordingly (Matel et al., 2019; Peng et al., 2023).

3.4 AI for Project Monitoring and Performance Evaluation

AI is increasingly applied in project monitoring systems to identify issues early and support continuous improvement. Ekanayake et al. (2024) developed deep learning models for automated as-built state recognition and progress monitoring in construction projects. Silvestri et al. (2025) implemented reinforcement learning models to optimize building control systems for energy efficiency and occupant comfort.

These studies show how artificial intelligence may alter project monitoring from a reactive to a proactive approach. The findings show that automated performance tracking lowers human bias and enables faster adaptation to changing project conditions.

3.5 Challenges and Research Gaps

Although the analyzed research indicates AI's strong potential in engineering project management, several constraints remain. Most existing studies rely on limited datasets, making it difficult to generalize results across different industries. There is also little discussion of how AI technologies may be integrated into current management systems without disturbing workflows. Furthermore, few studies take into account human variables including user trust, skill development, and change management.

These observations are consistent with earlier studies that emphasized similar barriers to AI integration in engineering project environments (Matel et al., 2019; Adelusi et al., 2023).

Future research should focus on creating common frameworks for AI adoption and investigating how human, AI collaboration might improve decision quality rather than completely replacing human judgment. Expanding research beyond isolated case studies would support the development of more consistent and transferable knowledge. To summarize the insights from the reviewed studies, a conceptual framework was developed to illustrate how artificial intelligence interacts with key phases of engineering project management and where major research gaps still exist. Figure 2 presents this framework.

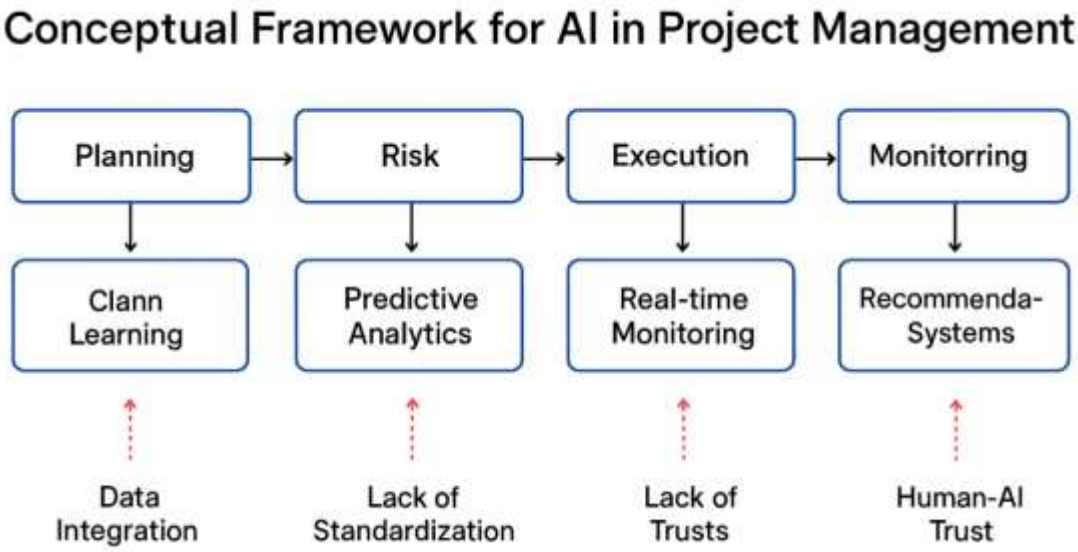

Figure 2: Conceptual framework showing AI integration and research gaps in engineering project management

4. Findings and Discussion

4.1 Key Insights from Literature

Artificial intelligence has become a critical enabler of data driven decision making in engineering project management. Machine learning and predictive analytics are typically used to estimate costs, optimize schedules, and identify risks. Several studies have demonstrated that AI models can process large scale project datasets much faster than traditional analytical tools, improving forecasting accuracy and early risk detection (Matel et al., 2019; Adelusi et al., 2023). However, AI adoption remains concentrated in specialized sectors such as construction and energy, with limited deployment during project execution and post project evaluation phases (Ekanayake et al., 2024; Silvestri et al., 2025).

4.2 Developments in AI Adoption

A recurrent tendency in the reviewed literature is a gradual transition from conceptual frameworks to real world implementation. Initially, most studies used simulated project data, but more recent research is validating AI models using real construction and engineering datasets (Adelusi et al., 2023; Al-Sinan et al., 2024). Another trend involves combining multiple AI technologies, such as neural networks and optimization algorithms to enhance scheduling accuracy and resource allocation efficiency (Matel et al., 2019; Adelusi et al., 2023). While major organizations have begun experimenting with such systems,

small and medium sized enterprises continue to face barriers due to limited financial resources and technical expertise.

4.3 Major Barriers

Despite promising results, various obstacles prevent complete integration of AI into engineering project management. The most often reported issue is data fragmentation, which occurs when project information is stored in incompatible formats, restricting AI model training. Another persistent impediment is the lack of established frameworks for assessing AI based project management solutions. Furthermore, human resistance continues to be a significant non-technical barrier, as many project managers prefer traditional decision-making approaches and remain skeptical of AI generated recommendations (Adelusi et al., 2023; Jiang et al., 2024).

4.4 Research gaps

The literature analysis and the conceptual framework described in Figure 2 reveal that the most critical research gaps involve interdisciplinary collaboration and model transparency. While AI has been shown to be effective for quantitative project data, there is limited research addressing qualitative aspects such as stakeholder communication and team dynamics. Moreover, few studies have explored the ethical dimensions of AI in project management, including data protection, accountability, and algorithmic bias (Matel et al., 2019; Adelusi et al., 2023). Future research should investigate hybrid human AI models that integrate human expertise with algorithmic decision support to foster trust, interpretability, and reliability in project environments.

4.5 Implications for Practice

The findings suggest that engineering organizations can significantly enhance project performance by adopting AI supported management tools. However, implementation should be gradual and guided by proper data governance policies. Training project managers to interpret AI outputs and encouraging collaboration between data scientists and engineers will be essential. Overall, the reviewed studies point to a future where AI acts as a decision support partner rather than a replacement for human judgment, allowing for smarter and more adaptive project management systems.

5. Conclusion and Future Work

The paper shows how artificial intelligence has begun to alter engineering project management by boosting predictive accuracy, decision making, and resource optimization. AI tools such as machine learning, natural language processing, and expert systems have demonstrated usefulness in cost prediction, schedule forecasting, and risk assessment (Matel et al., 2019; Al-Sinan et al., 2024; Aziz et al., 2016). However, the maturity of AI deployment varies between industries and project kinds.

Current research is still dominated by case study designs with little external validity. There is a definite need for further empirical research using various datasets and uniform evaluation methods. Figure 2 depicts significant research gaps in data integration, AI model interpretability, and human expert-

automated system collaboration. Addressing these issues will be crucial to ensure that AI systems are transparent, trustworthy, and adaptable to various project situations.

Future research should focus on establishing hybrid frameworks that mix machine intelligence and human judgment to produce balanced decision making settings. Integrating AI with digital twin technologies, cloud based project platforms, and block-chain enabled data management could lead to new avenues for dependable and secure project control. Practically, engineering organizations should invest in AI training and change management initiatives to bridge the gap between technical innovation and organizational culture.

Finally, artificial intelligence has enormous potential to revolutionize engineering project management by transforming data into actionable insights. Realizing this promise will be determined by how effectively academia and industry collaborate to build solutions that enhance, rather than replace, human talents in complicated project situations.

To visually highlight the proposed direction for future study, a conceptual model has been created that shows how artificial intelligence and human expertise might work together to improve engineering project management results. Figure 3 depicts the flow of input factors such as data integration and AI technologies through collaborative and interpretative processes, which result in improved project performance, trust, and adaptability.

Figure 3: Proposed Future Research Model for AI Integration in Engineering Project Management

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