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Research Article/ Review Article/ Perspective Article (Remove where relevant)

Artificial Intelligence and the Future Construction Workforce: A Qualitative Study of Emerging Skills

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Abstract

The U.S. construction industry is in a transitional phase characterized by the gradual yet accelerating integration of Artificial Intelligence across both field and administrative operations. This transformation is occurring amidst acute skilled labor shortages and an aging workforce, compelling firms to explore automation and artificial intelligence (AI) systems as means to enhance productivity, efficiency, and safety. While most existing research on AI in construction primarily focuses on technological innovation, the corresponding shifts in workforce skill demands remain underexplored. Based on four in-depth, semi-structured interviews with professionals at U.S. construction firms involved in AI implementation, this qualitative research study aims to address this gap by examining emerging workforce competencies and projected role shifts resulting from the adoption of AI. The findings include three primary skill competency categories: (1) AI-enabled operational proficiency, referring to the ability to work effectively with technologies such as drones, robotic equipment, and predictive analytics tools; (2) analytical interpretation, encompassing the capacity to critically engage with AI-generated data across functions such as scheduling, risk assessment, and cost estimation; and (3) contextual integration & adaptation competency, which captures the intersection of technological literacy and domain specific construction expertise necessary for effective AI systems implementation. Additionally, the study also reveals that AI adoption primarily augments rather than replaces construction roles, with traditional positions evolving to incorporate data interpretation and technology oversight responsibilities while retaining core domain expertise. New hybrid roles, such as construction data analysts and AI integration coordinators, are emerging to bridge traditional construction knowledge with technological implementation. This study contributes to the body of knowledge by advancing the understanding of the transformation of the construction workforce and the emerging competencies essential for the sustained adoption of AI in the construction industry.

Keywords: Artificial Intelligence; Construction; Competencies; Workforce

Highlights

- AI augments construction roles, requiring hybrid competencies of domain expertise and tech fluency.
- Three essential competency categories emerge from AI integration: operational proficiency, analytical interpretation, and contextual adaptation.
- Field workers face greater skills gaps than office roles, requiring specific upskilling for effective AI integration readiness.

Introduction

Despite significant contributions to the economy, the construction industry continues to face persistent challenges, including low productivity, frequent project delays, budget overruns, and safety risks (Garcia & Molloy, 2025). These issues are exacerbated by a growing labor shortage and the demographic reality of an aging workforce. More than 40% of construction workers in the U.S. are expected to retire by 2030 (Azad Abdulhafedh, 2023), and industry estimates suggest that over half a million additional workers will be needed each year to meet demand.

With the workforce shrinking and demand growing, productivity pressures are expected to worsen. This has prompted many firms to accelerate the adoption of advanced technologies as a strategy to mitigate labor gaps and enhance operational efficiency.

Among these technologies, artificial intelligence (AI) is rapidly gaining attention for its potential to transform construction workflows (Obi, Osuizugbo, and Awuzie, 2025). AI applications, such as computer vision for site inspections, machine learning for predictive scheduling, and robotics for task automation, among others, promise to improve accuracy, reduce rework, and augment safety (Obi, Osuizugbo, and Awuzie, 2025). For example, drones equipped with AI can perform site surveys in a fraction of the time it takes a human team, and AI-enabled survey layout robots can execute repetitive tasks with consistent precision (Kim *et al.*, 2025).

However, as the industry increasingly adopts the use of AI, a new issue emerges: the readiness of the workforce to utilize AI (Obi, Osuizugbo, and Awuzie, 2025). The successful implementation of AI does not depend solely on the technology itself but on the capacity of human workers to integrate it into their regular workflows. Without the appropriate skills, even the most advanced AI tools may go underutilized or be implemented ineffectively (Prieto, Xu, and García de Soto, 2024).

Despite the clear interdependence between AI and the workforce, much of the existing research on AI in construction has focused on the technological dimension, its development, capabilities, and implementation barriers, while the workforce side has received considerably less attention (Obi, Osuizugbo, and Awuzie, 2025). As a result, a critical knowledge gap remains regarding how AI is reshaping roles, skills, and required competencies within the construction workforce. This study addresses that gap and aims to examine how AI adoption is reshaping workforce skills in construction. To accomplish this, the research is guided by the following research questions:

- **RQ1:** What are the emerging skills/competencies required by the construction workforce in transition to the use of AI in construction?
- **RQ2:** How are existing construction industry job roles being reshaped by AI technologies?

Literature Review

The construction industry has historically lagged behind other sectors in digital transformation. Recent research indicates that, as of early 2024, only approximately 1.5% of U.S. construction firms were utilizing AI, although usage is poised to grow rapidly (Winsheimer & Tiernan, 2024). This slow adoption rate contrasts sharply with other industries, where AI integration has been more substantial. The construction sector's hesitation can be attributed to several factors, including fragmented project structures, a risk-averse culture, and limited technology infrastructure. However, the potential for AI in construction is significant. Applications range from automated site surveying using drones to predictive analytics for project scheduling and risk management. AI-enhanced safety monitoring systems using computer vision can detect PPE violations and hazards in real-time, with early adopters reporting up to 25% fewer on-site accidents (Brown, 2024)

To keep pace with the increasing use of AI, the construction workforce should be trained and upskilled. The skills gap is particularly acute given the aging workforce and rapid technological change. Enhanced skill sets should be provided to site and office personnel to manage the challenges faced by the construction industry.
The literature reveals a significant disconnect between the pace of AI advancement and workforce development initiatives in the construction industry (Olanipekun &Sutrisna, 2021).The successful implementation of AI systems in the construction industry requires workers to develop new competencies that bridge traditional construction knowledge with digital fluency.

Methodology

With the objective of investigating the skill competencies required in the construction industry for the rapid evolution of AI implementation, the researchers designed the study around an extensive literature review followed by exploratory, qualitative, semi-structured interviews with experienced construction professionals actively implementing AI technologies. To begin the research study, the researchers conducted a comprehensive literature review on AI applications in construction and digital skills transformation. Building on the information collected in the literature review, the next phase of the research involved developing an exploratory interview protocol that focuses on identifying emerging workforce competencies and role transformations resulting from the adoption of AI.

The development of interview questions followed DiCicco-Bloom and Crabtree's (2006) recommendations to include experience/behavior questions, opinion/values questions, and knowledge questions. The open-ended interview questions primarily focused on current AI applications, observed changes in job roles and responsibilities, the impact on the workforce and skills, and the future implications of AI integration in the construction industry, as shown in Table 1.

Table 1. Interview Protocol

Category	Interview Questions
Current AI Applications	1) What AI technologies is your company currently using in construction operations? 2) Which roles in your organization interact directly with these AI systems?
Workforce Impact and Skills	3) How have job responsibilities changed for workers who now use AI tools? 4) What new skills have workers had to develop to work effectively with AI systems?
Role Transformation	5) Which roles have been most significantly impacted by AI implementation? 6) Have any new positions been created as a result of AI adoption?

To identify potential participants with expertise in construction AI implementation, the researchers employed a snowball sampling approach, initially approaching professionals from their network who were known to be actively utilizing AI technologies in construction operations. The researchers extended invitations to participate in the research, and each interviewee who accepted the opportunity was asked to provide further contacts and introductions. This approach led to identifying a few potential participants, of whom four participated in the interview process based on their availability, willingness to discuss proprietary implementation strategies, and alignment with the qualification criteria. The qualification criteria for selecting potential participants were as follows:

1. Currently employed in a construction firm actively implementing (or) piloting AI technologies for at least 6 months.
2. A minimum of 8 years of experience in the construction industry; and
3. Hold senior or mid-level positions with direct involvement in AI implementation decisions.

The participant information, their background, and company information are provided in Table 2.

Table 2. Participant Information

Participant	Experience (years)	Position	Primary AI Applications
Participant 1	15	Operations Director	Drone surveying, predictive analytics
Participant 2	12	Senior Project Manager	AI scheduling, safety monitoring, AI progress monitoring
Participant 3	10	Technology Integration Specialist	Robotics, BIM automation
Participant 4	18	Project Controls Director	Cost analytics, risk prediction

While four interviews may appear limited, Mason (2010) argues that sample size in qualitative research becomes less relevant when the emphasis is placed on data quality rather than quantity. The participants in this study were selected because of their extensive experience, specialized expertise in AI implementation, and willingness to provide detailed information. According to Simms and Rogers (2006), implementing such a strategy increases the richness of data due to the commitment and expertise of the interviewees.

The semi-structured interviews lasting 55-70 minutes were conducted via video conference between April and July 2025. All interviews were recorded with participant consent and subsequently transcribed for data analysis purposes. The data analysis included analyzing interview transcripts through thematic analysis using Braun and Clarke's (2006) framework. The researchers employed manual thematic coding to analyze the collected data.

Findings

The thematic analysis of interview transcript data revealed three primary competency categories that construction workers must develop to effectively work collaboratively with AI technologies.

1.1 AI-Enabled Operational Proficiency

Participants consistently identified operational technology skills as the most immediate requirement for workers interfacing with AI-enabled construction tools. This competency encompasses practical skills for operating, maintaining, and collaborating with AI systems deployed on construction sites and within project workflows.

All four participants emphasized drone technology as the primary AI application requiring immediate workforce adaptation. Additionally, regarding AI-enabled robotics integration, Participant 1 noted: "When we piloted AI-enabled layout robots, our layout crews initially struggled with the interface. The successful workers were those who could understand both the traditional layout principles and troubleshoot the software when calibration issues arose". This illustrates the requirement for workers to develop hybrid competencies combining traditional trade knowledge with technology troubleshooting capabilities. Table 3 illustrates the operational skills required by various construction roles due to the emergence of AI systems.

Table 3: AI-Enabled Operational Skills by Construction Role

Traditional Role	AI Tool Integration	New Operational Skills Required
Site Surveyor	Drone-based surveying, LiDAR scanning	UAV piloting certification, 3D point cloud processing, aerial photogrammetry
Safety Manager	AI vision monitoring, wearable sensors	Dashboard interpretation, exception response protocols, predictive risk assessment
Equipment Operator	Semi-autonomous machinery	Fleet supervision, remote operation interfaces, and diagnostic troubleshooting
Site Superintendent	Integrated project dashboards, AI-enabled progress monitoring	Real-time analytics interpretation, automated scheduling, and progress validation
Crane Operator	AI-assisted load management	Computer-aided precision controls, automated safety systems

1.2 Analytical Interpretation Competency

The second competency category involves the construction workforce's ability to critically evaluate and act upon AI-generated insights and recommendations. Participants described a fundamental shift from intuition-based decision-making to data-driven approaches, which require statistical literacy and analytical reasoning skills. As participant 3 described the transformation: "Our project managers used to rely heavily on experience and gut feeling. Now they need to understand statistical models, interpret confidence intervals, and know when to trust or question AI predictions." This requires analytical reasoning skills to understand both the underlying data and the context in which AI recommendations should be applied. This is further supported by participant 1, as he indicated that estimators must now validate AI-generated quantity take-offs, understand variance analysis, and identify anomalies in cost projections. Further, he explained: "The AI can process thousands of historical projects to predict costs, but we need people who can spot when something doesn't make sense for our specific situation." Additionally, as mentioned by two participants, quality control and assurance AI systems for quality inspection and progress monitoring generate vast amounts of data that human workers must interpret and act upon. This requires developing skills in basic statistical analysis, understanding false positive rates, and knowing when human judgment should override AI recommendations. Table 4 presents the analytical interpretation skills required for various construction roles.

Table 4: Analytical interpretation skills required by various construction roles

Role Level	Primary AI Analytics	Required Analytical Skills	Current Gap Assessment
Field Level	Foreman / Superintendent: Progress tracking, crew productivity, resource allocation, etc.	Dashboard reading, variance analysis, efficiency analysis, trend identification, etc.	High - limited digital experience
Field Level	Quality Inspector: Defect detection pattern recognition, compliance monitoring, etc.	False positive identification, statistical validation, etc.	Medium - some digital tools familiarity
Project Level	Project Manager: Schedule optimization, risk prediction, contractual risk analysis, etc.	Predictive model interpretation, decision trees or modelling, etc.	Medium - existing PM software experience
Project Level	Estimator: Cost modelling, quantity take-offs	AI validation, historical trend analysis, anomaly detection, etc.	Medium - strong analytical background
Administrative	Safety Manager: Compliance monitoring, incident patterns, regulation/citation analytics, etc.	Exception analysis, predictive assessment, etc.	Medium - some digital tools familiarity
Administrative	Procurement Specialist: Supply chain optimization	Demand forecasting, vendor performance analytics, etc.	Medium - data analysis required

1.3 Contextual Integration & Adaptation Competency

The third competency category captures the intersection of construction domain expertise with AI literacy, a hybrid skill set that enables effective human-AI collaboration in construction contexts. All participants emphasized that effective AI collaboration requires a workforce that can contextualize AI outputs within construction-specific knowledge frameworks while maintaining proficiency with evolving AI technological interfaces.

Contextual problem-solving construction work involves numerous site-specific variables that AI systems may not fully capture. Workers must develop the ability to provide contextual input to AI systems while understanding how that input affects algorithmic outputs. Participant 4 emphasized the importance of contextual application: "The most valuable team members are those who can validate AI recommendations against real-world construction constraints. They understand both what the technology is telling them and whether it makes sense given site conditions, material limitations, or crew capabilities."

All participants noted that workers must develop adaptive learning capabilities and adaptive technology integration skills to keep pace with rapidly evolving AI tools. As AI technologies continue evolving rapidly, workers need skills for continuous learning and adapting to new tools. This meta-competency involves understanding how different AI applications integrate with existing workflows and being able to quickly adapt to technological updates. As Participant 1 explained: "We're implementing new AI features quarterly. Workers need to be comfortable with continuous learning rather than mastering one system and using it for years."

1.4 Construction Roles Transformation Patterns

To answer RQ2, the data analysis identified that AI adoption is reshaping existing roles rather than simply replacing them. Three primary patterns emerged across different organizational levels and functional areas within construction companies as shown below in Table 5.

Table 5: Current vs. Transformed Construction Roles

Current Role	Primary Transformation	New Responsibilities	Skills Retained	Skills Added
Superintendent	Enhanced oversight capabilities	AI dashboard monitoring, exception management	Leadership, problem-solving, safety oversight	Data interpretation, tech troubleshooting
Project Manager	Data-driven coordination	Multi-project oversight, AI validation	Client relations, contract management	Analytics, risk modelling
Estimator	AI-assisted analysis	Strategic pricing, complex scope evaluation	Market knowledge, cost analysis	AI output validation
Safety Manager	Predictive safety oversight	Exception response, safety analytics	Regulatory compliance, incident response	Predictive analysis, sensor monitoring
Project Engineer	Digital integration specialist	BIM-reality coordination, measurement validation	Technical design, quality control	Digital measurement, system integration

The participants emphasized that AI primarily augments human capabilities rather than replacing workers entirely. Safety managers, for example, now monitor AI-generated compliance reports while focusing on strategic safety planning. Participant 1 explained: "The AI catches 95% of the routine violations, such as missing hard hats, improper harness use. Our safety team can now focus on the complex situations that need human judgment, like evaluating whether a work procedure is inherently unsafe."

Additionally, participants noted that new roles are emerging to facilitate the effective integration of AI systems. Participants described roles such as "construction data analysts" and "AI integration coordinators," which didn't exist five years ago but are becoming increasingly essential for effective AI implementation. These roles bridge the gap between traditional field operations and advanced data analytics, facilitating seamless collaboration between human expertise and technological intelligence.

Discussion

The findings reveal that AI adoption in construction is driving a fundamental transformation in the required competencies of the workforce, with changes occurring across various construction roles. Unlike simple automation that replaces human tasks, AI integration demands sophisticated hybrid skills that combine domain expertise with technological fluency.

The three competency categories identified represent a deviation from traditional construction education and training approaches. Historically, construction workers have developed expertise through apprenticeships that focused on craft skills and gained project experience. The AI era requires supplementing this foundation with data literacy, systems thinking, and continuous adaptation capabilities in technology.

While universal AI momentum projections suggest substantial automation potential, the reality observed by participants indicates a construction industry-specific contextual evolution where human expertise remains central but must adapt to integrate and work effectively with AI systems. These findings challenge the universal narratives about AI employment displacement and highlight the importance of investing in workforce development rather than planning for job elimination.

However, the research reveals disparities in readiness across different construction roles. Project management and administrative positions show higher current AI integration levels and lower skills gaps, largely due to existing software experience and analytical backgrounds. In contrast, field-based roles face significant barriers, including limited digital literacy and traditional training approaches that emphasize hands-on learning over technological integration. It is essential to equip the field workforce with AI skills to fully realize the potential of AI in the construction industry.

Conclusions

This exploratory study offers initial insights into how the adoption of AI is reshaping workforce competencies in the construction industry. It has identified three primary competency categories: AI-enabled operational proficiency, analytical interpretation, and contextual integration & adaptation skills. These findings indicate that successful AI integration necessitates comprehensive workforce development, extending beyond mere technological implementation. The research highlights critical implications for multiple stakeholders. Educational institutions must integrate digital literacy and AI skills into their construction curricula, while construction firms need to invest in strategic workforce development, including upskilling and the development of hybrid AI competencies. The study's limitations include a small sample size of four participants, primarily from large firms. However, as this is an ongoing study, additional interviews are scheduled to expand the participant pool and strengthen findings for a comprehensive journal publication. Future research should expand through larger-scale mixed-method studies, longitudinal studies of workforce adaptation, and examination of training effectiveness. This research contributes construction-specific insights to the growing literature on AI skills for the workforce, as it addresses a critical gap in existing research by focusing on the skill dimensions of AI integration.

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