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# AI-Enabled Workflows and Their Implications for Entry-Level Employment and Construction Management Education

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This study explores how artificial intelligence (AI) enabled workflows are reshaping employment criteria for entry-level construction management (CM) professionals and how these changes may inform future CM curricula. A quantitative survey was distributed to forty construction professionals in California who are directly involved in hiring, supervising, or evaluating project engineers. Descriptive statistics were used to summarize current and anticipated levels of AI adoption, perceived effects on entry-level training, and expectations for skill development. Results suggest that AI adoption across construction workflows remains moderate, indicating growing interest but limited implementation to date. Respondents noted that automation is beginning to replace certain repetitive estimating and scheduling tasks, which may reduce some traditional task-based training opportunities. At the same time, participants expressed cautious optimism that automation could create opportunities for higher-order analytical work. Overall, the findings highlight that while AI integration in construction is advancing gradually, its influence on workforce development remains uncertain, underscoring the need for CM programs to balance foundational technical instruction with emerging competencies in AI oversight, data literacy, and ethical decision-making.

Keywords: Artificial Intelligence, Construction Management, Workforce Readiness, Training, Curriculum Development

## Introduction and Background

The rapid expansion of artificial intelligence (AI) across multiple industries is transforming how professionals plan, manage, and deliver projects. Although the construction industry has historically lagged in adopting digital technologies, recent advances in AI-driven estimating, scheduling, quality-control, and risk-analysis tools are beginning to alter conventional construction management (CM) practices. These developments raise important questions regarding how entry-level construction professionals are trained and evaluated, and whether current CM curricula remain aligned with evolving industry expectations.

Despite growing interest in AI applications, adoption within construction remains uneven. Compared with sectors such as manufacturing or telecommunications, construction's project-based structure and variable site conditions have constrained widespread automation (Abioye et al., 2021; Pan & Zhang, 2021). Scholars remain divided on AI's long-term workforce impacts. Some argue that automation

will displace labor, while others contend that it will generate new roles emphasizing human oversight and judgment (Acemoglu & Restrepo, 2019; Choi & Leigh, 2024). For construction management, the likely outcome lies between these perspectives. As AI reduces repetitive estimating and scheduling tasks, early-career professionals may spend less time performing manual work and more time verifying, interpreting, and managing automated outputs. This shift implies increasing demand for competencies related to data literacy, ethical reasoning, and system validation.

While prior research has examined AI adoption and digital transformation in construction, limited empirical evidence exists regarding how industry practitioners perceive AI's implications for entry-level roles, training pathways, and emerging competency requirements. Few studies have captured the perspectives of professionals directly involved in hiring, supervising, and evaluating early-career CM personnel. This gap is particularly important given the growing influence of AI-enabled workflows on project delivery and organizational decision-making.

Accordingly, this study examines how AI-enabled workflows are influencing employment criteria for entry-level construction management professionals and how these changes may inform CM academic programs. For clarity, the term entry-level engineer is used to refer broadly to early-career construction management professionals, while project engineer denotes a specific industry job title commonly held by individuals in entry-level roles. By capturing practitioner perceptions of AI adoption, anticipated changes to entry-level training, and evolving skill expectations, this study provides early empirical insight into how construction education and practice may need to evolve in parallel within an increasingly data-driven industry.

## Literature Review

This section reviews key literature on AI to establish the conceptual foundation for the study and to identify areas where this research contributes to existing knowledge. The literature examines how AI enabled workflows are influencing CM practices, how these changes may affect skill requirements for entry-level professionals, and how construction management programs are responding to evolving workforce demands. The review focuses on AI adoption and labor market dynamics, the transformation of construction management practices, evolving skill requirements, and educational implications for CM programs, culminating in the identification of gaps motivating the present study.

### *AI Adoption and Labor Market Dynamics*

AI has begun transforming industries such as manufacturing, retail, and telecommunications, though adoption remains uneven and its long-term effects on human work are unsettled (Abioye et al., 2021; Simon, 2019). Within the literature reviewed, two dominant perspectives emerge. One suggests that task automation will substitute for human labor and displace workers across occupations, raising concerns about workforce disruption (Choi & Leigh, 2024). The other contends that AI adoption will generate new tasks that complement human judgment and oversight, creating demand for workers with AI-related skills (Acemoglu & Restrepo, 2019). Despite differing predictions, both perspectives acknowledge that AI technologies are increasingly capable of replicating functions once considered uniquely human, including pattern recognition and predictive analysis (Abioye et al., 2021; Choi & Leigh, 2024). Consequently, assessments of AI's workforce impact must account for both task displacement and the creation of AI complementary roles. For construction management, this dual dynamic has direct implications for how entry-level professionals are trained and evaluated as they increasingly operate within hybrid human and AI workflows.

### *Digital Transformation in Construction Management*

Technological advancement and AI driven innovation are widely recognized as forces reshaping organizational processes, though their impacts on construction management remain less fully understood. Prior research suggests that effective AI adoption often requires complementary organizational changes to align technology with workflows and decision-making (Dwivedi et al., 2021; Zulu & Khosrowshahi, 2021). Historically, CM has emphasized technical competencies such as cost estimation, scheduling, quality control, and safety management (Abioye et al., 2021). Existing literature indicates that although the construction industry has begun adopting AI-enabled tools, implementation remains limited and uneven compared to other sectors (Abioye et al., 2021; Dwivedi et al., 2021; Holzmann & Lechiara, 2022). Current applications include AI-assisted scheduling, risk forecasting, material selection, and safety monitoring (Abioye et al., 2021; Dwivedi et al., 2021). However, the project-based and dynamic nature of construction continues to constrain full automation, making AI integration more complex than in manufacturing or telecommunications (Pan & Zhang, 2021; Brozovsky, 2024). Despite these challenges, investment in AI based solutions is expected to increase, with broader integration anticipated across both field and office operations (Pan & Zhang, 2021).

### *Evolving Skill Requirements and Workforce Readiness: Educational Implications for Construction Management Programs*

As AI enabled workflows to become more prevalent, skill requirements for construction professionals are evolving beyond traditional technical competencies. The literature suggests a growing emphasis on data interpretation, system oversight, and collaboration with intelligent tools (Antwi et al., 2025; Brozovsky, 2024; Chen et al., 2024; Dwivedi et al., 2021). Employers increasingly seek graduates who can validate AI-generated outputs and exercise professional judgment rather than perform repetitive task-based work (Okonkwo et al., 2025). These shifts place pressure on higher education institutions to adapt curricula to better prepare students for a data-driven professional landscape. Despite growing recognition of AI's relevance, many CM and civil engineering programs continue to emphasize traditional methodologies, with AI related content often introduced in isolated courses and rarely evaluated for effectiveness (Elzomor et al., 2020; Chen et al., 2024). From a curriculum design perspective, this fragmentation suggests a misalignment between desired workforce competencies and instructional structure, a gap that backward design and competency-based education frameworks explicitly seek to address. Recent work in construction education, such as the project-based AI instructional approach described by Antwi et al. (2025), reinforces the value of embedding AI tools within authentic learning experiences while maintaining accountability for underlying technical understanding.

### *Identified Areas of Proposed Contribution*

While existing literature offers theoretical insight into AI adoption and digital transformation, a critical gap remains regarding construction management workforce development. Few studies have directly examined how construction professionals perceive AI adoption, what competencies they expect from entry level CM graduates, or how academic programs should adapt curricula accordingly. Much of the existing research treats AI technologies and educational strategies independently, leaving limited empirical connection between industry expectations and academic preparation. This study addresses that gap by capturing the perspectives of construction professionals involved in hiring, supervising, and evaluating project engineers. By examining perceptions of AI adoption, anticipated skill requirements, and curriculum implications, the study bridges theory and practice and provides empirical insight to inform CM education in an AI enabled environment.

## Research Design

This quantitative, descriptive study investigates how AI enabled workflows such as takeoffs, estimating, scheduling, and RFI and submittal processing are reshaping employment criteria for entry level CM graduates and what implications these shifts hold for CM academic programs. The research was conducted through an online survey designed to collect data from construction professionals who are directly involved in hiring, supervising, or evaluating PEs. The survey structure and distribution approach were selected to obtain broad industry on AI adoption, workforce expectations, and educational preparedness.

### *Participants and Sampling*

The target population for this study consisted of construction industry professionals in California with direct hiring, supervisory, or evaluative responsibility for entry level engineers. Participants were required to be adults aged 18 years or older, currently employed in the construction industry, and actively involved in assessing entry-level personnel. Individuals without such experience were excluded. A combination of convenience and snowball sampling was used. Initial participants were recruited through professional networks and industry contacts, with additional respondents identified through professional referrals and distribution via LinkedIn. This approach was selected due to the exploratory nature of the study and the difficulty of accessing a targeted population of practitioners with direct oversight of entry level PEs through random sampling. While this method facilitated access to relevant respondents, it may introduce selection bias and limit the generalizability of findings. The survey was administered between January and March 2025, capturing industry perceptions of AI-enabled workflows during that period. No survey responses were excluded from analysis. All responses were complete and met the inclusion criteria, and no additional filtering mechanisms were applied. The final sample included professionals from general contracting, specialty contracting, and owner organizations, representing a range of firm sizes and experience levels. Findings are interpreted as exploratory and descriptive rather than representative of the broader construction industry.

### *Investigator Qualifications*

The principal investigator, Dr. Jason Miller (DBA), is an Assistant Professor in the Department of Construction Management at California Polytechnic State University, San Luis Obispo, with 25+ years of construction industry experience and three years of university teaching. Dr. Miller holds an active CITI Social-Behavioral-Educational Research certification (valid through December 8, 2025).

### *Procedures and Data Collection*

Data was collected using an online Qualtrics survey organized into three primary blocks: (1) respondent demographics, (2) AI adoption in construction workflows, and (3) workforce development and educational implications. The demographic block captured professional role, organization type, firm size, and geographic location to contextualize the sample. The second block examined current and anticipated AI use in estimating, scheduling, document processing, safety, and quality control, while the third addressed perceptions of AI's impact on entry-level training, skill development, and curriculum needs. To enhance transparency, representative survey items are provided to illustrate how key constructs were measured. Respondents rated statements such as "AI tools are currently used for estimating and quantity takeoffs in my organization" and "Automation may reduce traditional task-based training opportunities for entry-level engineers" using a 5-point Likert scale ranging from strongly disagree to strongly agree. Additional items assessed expectations for future competencies, including validation of AI-generated outputs and application of professional judgment in AI-assisted workflows. Two open-ended questions invited qualitative comments regarding future project engineer

roles and academic preparation. The survey was distributed to California construction professionals via direct email invitations and a LinkedIn post, with one follow-up reminder. Participation was voluntary and anonymous, and the survey required approximately 10–15 minutes to complete. Participants reviewed an electronic consent form prior to beginning the survey. Data were stored in encrypted form and accessible only to the principal investigator in accordance with Cal Poly IRB guidelines for exempt research.

### *Data Analysis*

Survey data were analyzed using IBM SPSS Statistics. Descriptive analysis focused on calculating mean scores to summarize responses across each survey item, including levels of AI adoption, perceived training impacts, and skill and curriculum priorities. Results were presented using bar graphs to illustrate overall patterns and relative differences among variables. Open-ended responses were reviewed and coded thematically to identify recurring ideas related to workforce readiness and educational implications. Because the study was exploring with a modest sample size (n = 40), the analysis emphasized interpretation of observed trends rather than statistical inference.

### *Limitations of the Study*

As with most survey-based research, this study has several limitations that should be acknowledged. The use of convenience and snowball sampling may limit the generalizability of the findings, as the sample was not randomly selected and may not represent the full range of perspectives within the construction industry. In addition, the sample was limited to construction professionals located in California, and regional market conditions, regulatory environments, and rates of technology adoption may differ in other geographic contexts. The sample size (n = 40), while appropriate for an exploratory study and descriptive analysis, restricts the ability to conduct inferential statistical testing or to draw conclusions beyond this respondent group. Although efforts were made to include participants from a range of roles and firm sizes, certain sectors or organizational types may be underrepresented. Finally, the findings reflect self-reported perceptions, which may not fully correspond to actual practices and may evolve as AI adoption in construction continues to mature. Despite these limitations, the study provides timely, practice-based insight into emerging industry perceptions of AI-enabled workflows and offers a foundation for future research examining broader samples, additional regions, and more advanced analytical methods.

## Results

This section analyzes the responses to survey questions designed to discover how construction professionals perceive the current and future role of AI in construction management workflows, its impact on entry-level training and skill development, and what implications these trends hold for construction-management education. Although each participant shared a unique perspective based on personal experience, descriptive and thematic analysis revealed consistent patterns across respondents. Although AI adoption across construction workflows remains moderate, the findings suggest a clear directional shift in how entry level construction professionals are expected to engage with technology. Respondents indicated that AI tools are increasingly being used to automate repetitive estimating, scheduling, and documentation tasks, potentially reducing traditional task-based learning opportunities for early-career professionals. At the same time, participants emphasized the growing importance of higher-order skills such as data interpretation, validation of automated outputs, and professional judgment. Taken together, these findings suggest that AI is not eliminating the need for entry-level construction managers but rather reshaping the nature of early-career work. The rationale for this study is therefore not to predict widespread automation or workforce displacement,

but to identify how emerging AI enabled workflows may alter the competencies required of graduates entering the construction industry. By synthesizing practitioner perceptions, this study highlights a potential misalignment between traditional construction management curricula and evolving industry expectations, reinforcing the need for curricular approaches that balance foundational technical instruction with emerging competencies in AI oversight, data literacy, and ethical decision-making.

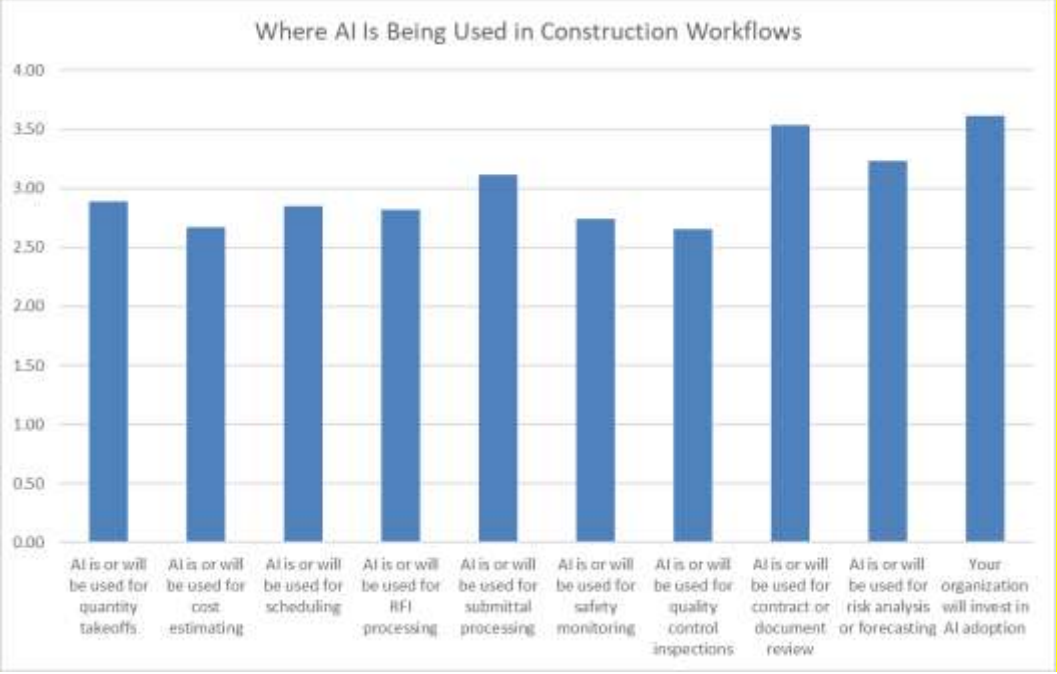
### *Respondent Demographics*

Forty construction professionals participated in the survey, representing a diverse cross section of the California construction industry. Most respondents identified as project managers or project engineers employed by general contracting firms, with additional participation from specialty contractors, owners, and consultants. Company sizes ranged from less than $50 million to more than $500 million in annual revenue, indicating participation from both small and large firms. Most organizations operated within California or the broader western United States. Approximately two-thirds of respondents reported having personally used AI tools in their current roles, suggesting that exposure to AI enabled processes is already present in everyday operations, even if overall integration remains limited.

### *AI Adoption in Construction Workflows*

Survey items A6 through A15 asked respondents to rate the degree to which AI is or will be used for quantity takeoffs, estimating, scheduling, RFI and submittal processing, safety, quality control, and related workflows. Respondents characterized AI present and future use as moderate, which indicates evidence of growing interest, but not yet broad implementation. Cost estimating and scheduling received the highest average ratings, suggesting these areas are leading AI integration efforts, while safety monitoring and submittal processing scored lowest. The results are represented in the bar graph (figure 1) below.

**Figure 1. AI adoption across construction workflows (A6–A15).**



Although most participants viewed AI as an inevitable component of future construction workflows, their responses also reflected uncertainty about how quickly and to what extent it will be incorporated. This measured outlook aligns with the literature, which portrays construction as an industry in transition of actively exploring AI applications while the full scope of its long-term impact remains uncertain.

### *Impact on Entry-Level Training*

Survey items A16 through A25 examined perceptions of how AI adoption may affect early-career learning and professional development. Overall, respondents expressed moderate concern about the consequences for entry-level engineers. Many agreed that AI is beginning to replace the repetitive, task-based estimating and scheduling exercises that traditionally provided new engineers with foundational experience. The most frequently endorsed statement indicated that "losing task-based training may slow the professional development of entry-level engineers." However, some participants suggested that automation could create opportunities for junior staff to focus on higher-order analytical and managerial skills. The results are represented in the bar graph (figure 2) below. These mixed responses reveal both apprehension and optimism, illustrating that while the industry expects AI to reshape training, there is uncertainty about whether its impact will ultimately be beneficial or detrimental. This cautious perspective mirrors findings in the literature suggesting that AI's long-term influence on construction labor dynamics remains unsettled.

**Figure 2. Impact of AI on entry-level training opportunities (A16–A25).**


### *Skill Expectations and Curriculum Implications*

Survey items A26 through A61 addressed anticipated future skill requirements and implications for construction management education. Within this sample, respondents emphasized the growing importance of analytical reasoning, professional judgment, and oversight capabilities as AI assisted workflows become more prevalent. Many respondents highlighted the need for entry level

professionals to verify and validate AI generated outputs, apply ethical reasoning, and maintain sufficient technical understanding to identify errors produced by automated systems. Skills such as critical thinking, communication, and data literacy were frequently identified as essential for effective performance in AI enabled environments. With respect to educational implications, respondents indicated support for integrating AI related content within existing estimating, scheduling, and project-controls courses rather than introducing stand-alone AI coursework. At the same time, participants emphasized the continued value of manual instruction to ensure graduates understand the underlying logic of construction processes. Collectively, these responses suggest an industry that views AI as a complementary tool that enhances decision-making while reinforcing the need for foundational technical knowledge and accountability.

### *Themes of Open-Ended Responses*

The open-ended questions (A65 and A66) reinforced the quantitative findings and provided additional context. Three primary themes emerged:

1. Verification and Accountability: Respondents repeatedly stated that future engineers must be able to "trust but verify" automated outputs, emphasizing human responsibility for validating machine decisions.
2. Continuous Learning and Adaptability: Participants noted that because AI technology will continue to evolve rapidly, professionals must remain adaptable and committed to lifelong learning.
3. Balanced Curriculum: Respondents recommended that construction-management programs preserve traditional estimating and scheduling instruction while introducing AI-based tools to help students understand both manual and digital processes.

Collectively, these themes depict an industry cautiously embracing AI optimistic about its potential to improve efficiency but aware that technological change must be balanced with professional oversight, critical judgment, and continued skill development.

## Discussion

Consistent with the exploratory design of the study, the findings should be interpreted as indicative of emerging patterns in practitioner perceptions rather than predictive or causal relationships. Results suggest that AI integration within construction management is advancing at a moderate and uneven pace, with applications beginning to influence estimating, scheduling, and document processing while remaining limited across many workflows. This variability reflects differing levels of organizational readiness, leadership support, and investment, consistent with literature characterizing construction as being in the early stages of digital transformation. Perceptions of AI's impact on early-career training were mixed. While many respondents expressed concern that automation may reduce opportunities for hands-on task experience, others emphasized the potential for entry-level engineers to focus more on analytical, supervisory, and decision-making responsibilities. Overall, the findings suggest that AI is more likely to redefine than replace early-career roles, increasing the importance of oversight, validation of AI outputs, and critical thinking. These expectations align with existing research emphasizing data literacy, ethical reasoning, and human–machine collaboration. While formal subgroup analysis was not conducted, observed variation in responses suggests that organizational context and prior AI exposure may shape workforce expectations, underscoring the need for future research using larger, more diverse samples.

### *Ethical and Social Implications*

Study findings indicate that AI adoption in construction remains moderate but are beginning to automate repetitive estimating and scheduling tasks. Consistent with literature on AI driven task substitution and complementarity (Acemoglu & Restrepo, 2019; Choi & Leigh, 2024), respondents expressed concern that reduced task-based work may limit traditional training pathways for entry-level professionals, raising questions about equitable skill development. At the same time, participants anticipated greater reliance on entry-level employees to interpret and validate AI-generated outputs, introducing ethical considerations related to accountability and professional responsibility when automated recommendations influence project decisions. As noted in prior research, AI systems trained on historical project data may also reflect embedded biases, underscoring the importance of data quality and transparency (Abioye et al., 2021). Together, these findings suggest CM programs should emphasize ethical reasoning, data literacy, and AI oversight alongside technical competencies.

## Recommendations

Findings from this study suggest that both CM programs and industry organizations must take deliberate steps to prepare for AI integration. Academic programs should incorporate AI literacy, data validation, and ethical decision-making into existing estimating, scheduling, and project-management courses so students can connect traditional processes with emerging technologies. Manual estimating and scheduling instruction should remain central to preserve the conceptual understanding necessary for verifying automated results and developing sound professional judgment. Expanding these topics within current coursework, rather than creating isolated electives, would encourage students to see AI as a natural extension of established CM practices rather than a separate discipline. Stronger collaboration between academia and industry is also essential to bridge the gap between innovation and application. Internships, guest lectures, and applied research projects can provide students with exposure to real-world AI tools while allowing firms to evaluate their practical value. Educational partnerships can also help identify the specific technical and managerial skills employers will require as automation becomes more prevalent. In addition, continuing-education opportunities should be offered to current professionals through workshops or certification programs that address AI integration, data ethics, and digital adaptability. Finally, future research should continue to monitor how AI adoption evolves across project types and firm sizes to guide ongoing improvements in education and workforce development.

## Conclusion

This study depicts a construction industry cautiously embracing AI while still determining its long-term effects on professional practice and education. Respondents reported moderate adoption of AI tools and mixed opinions about their influence on training and skill development, reflecting the broader uncertainty described in the literature. The results emphasize that progress will require thoughtful adaptation rather than rapid transformation. While many professionals view AI as a valuable tool for efficiency and analysis, they also recognize the continuing need for human oversight, ethical decision-making, and a deep understanding of construction fundamentals. Integrating AI awareness into CM education, maintaining manual competencies, and promoting partnerships between academia and industry represent practical steps toward a balanced approach. These efforts will help ensure that technological innovation strengthens, rather than replaces, human expertise. As AI capabilities evolve, success will depend on how effectively CM professionals can merge digital proficiency with critical judgment and creativity.

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