The Role of AI Agents in Construction Project Management

Anja Brelih[1], Marko Robnik Šikonja[2] and Robert Klinc[1]
[1]University of Ljubljana, Faculty of Civil and Geodetic Engineering, Slovenia
[2]University of Ljubljana, Faculty of Computer and Information Science, Slovenia
E-mail(s): anja.brelih@fgg.uni-lj.si, marko.robniksikonja@fri.uni-lj.si, robert.klinc@fgg.uni-lj.si

Abstract: The integration of Large Language Models (LLMs) into Artificial Intelligence (AI) agents presents new opportunities for enhancing construction project management through improved collaboration, reasoning, and workflow automation. This paper investigates how LLM-powered AI agents can support complex construction tasks such as scheduling, resource allocation, risk assessment, and information coordination. We conduct a structured review of recent literature across construction informatics, AI-driven project management, and agent-based systems to identify trends, capabilities, and limitations. Our findings show that while AI agents offer strong potential to assist project teams with dynamic decision-making and routine task automation, their effectiveness is limited by data quality, domain adaptation, and the stochastic nature of LLMs. These insights are significant for researchers and practitioners aiming to introduce AI agents into real-world construction workflows, where reliability, explainability, and human oversight are essential. The paper highlights the need for further exploration of Human-in-the-Loop (HITL) designs and calls for standardisation of agent capabilities to ensure safe, transparent, and practical deployment in the construction industry.

Keywords: AI Agents, LLM, Project Management, Construction Workflows, Construction Informatics

DOI: 10.18154/RWTH-CONV-254903. Published in the conference proceedings of the 36. Forum Bauinformatik 2025, Aachen, Germany,

1 Introduction

Construction project management is increasingly shaped by digital transformation, driven by the need for greater adaptability and efficiency. Among the technologies reshaping this field, artificial intelligence (AI) has gained momentum for its ability to support decision-making, automate repetitive tasks and improve project outcomes in planning and monitoring. Construction projects are characterised by unique products that require a unique sequence of processes and group of partners [1], making standardised automation difficult. In this context, the emergence of AI agents, autonomous software units that are able to perceive their environment, reason, and execute tasks, offers new opportunities to manage the complexity and variability of construction workflows [2]. Unlike conventional systems, AI agents can learn from data, adapt to new constraints and collaborate with human stakeholders. Their potential is significantly enhanced by the integration of Large Language Models (LLMs), which enable advanced understanding of natural language, multi-step reasoning and interaction with external tools.

LLM-powered AI agents can act as intelligent collaborators that process diverse information, identify project tasks and facilitate communication [3], [4].

This paper explores the role of AI agents in construction project management. The rest of the paper is organised as follows. Section 2 outlines the theoretical and technological foundations, including the development of AI agents and construction informatics. Section 3 discusses the applicability of AI agents in construction management, covering their capabilities, suitability for specific tasks and integration into existing workflows. Section 4 addresses key challenges and limitations such as data security, trust and adaptability. Finally, Section 5 concludes the paper and identifies directions for future research and practical implementation.

2 Background and related work

This section outlines the theoretical foundations of AI agents in construction, grounded in construction informatics. It also traces the evolution from Construction 3.0 to 5.0, highlighting the growing role of LLMs and current research gaps.

2.1 Construction informatics and project management

Construction informatics addresses the unique characteristics of construction data, such as its fragmentation, its temporality and its project-specific context. As Turk [1] noted, the field investigates the processes of creating, processing and communicating construction-specific information, whether in human or machine-readable form. These processes are traditionally based on structured input-output relationships, with “glue” processes connecting information generation and use through static data formats, defined APIs or hard-coded scripts. Figure 1 illustrates this workflow structure and highlights the rigid, static nature of traditional data exchanges.

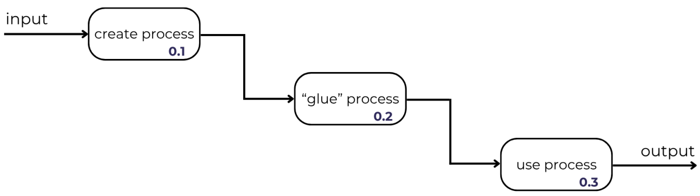

Figure 1: Construction Informatics Workflow [1].

Construction project management, while traditionally focused on time, cost and quality, is increasingly expanding to include environmental and social sustainability objectives [5]. In this broader context, digital tools, especially AI, are becoming increasingly important as decision support systems. AI agents, for example, are developing into valuable collaborators and can contribute to:

- **Automated monitoring and reporting:** Agents continuously assess alignment with schedule and budget constraints and can suggest corrective measures in the event of deviations [6].
- **Decision support:** By synthesising diverse data sources, agents can create alternative scenarios and help choose optimal project paths [7].
- **Risk forecasting:** By analysing current project statuses and historical data in real time, agents can identify emerging risks and suggest risk mitigation strategies [5].

These AI applications are well suited to the increasing complexity and unpredictability of modern construction projects. As such, construction informatics provides not only the technological foundation, but also the methodological framing for integrating AI agents into real construction workflows. While automated workflows follow fixed predefined steps, AI agents dynamically plan, execute actions with tools, and reflect on results (Figure 2).

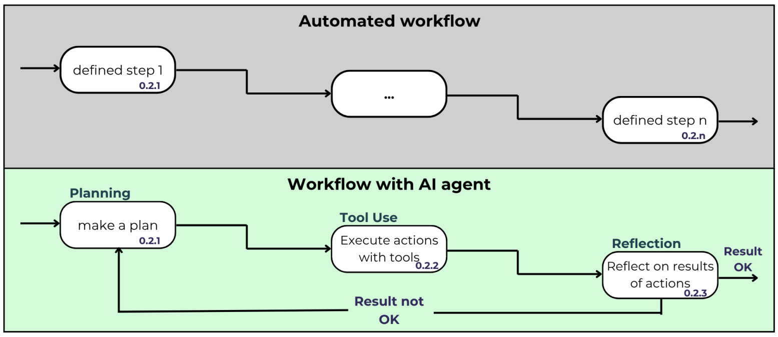

Figure 2: Comparison between Automated workflow and Workflow with AI agent. Adapted from [8].

2.2 From Construction 3.0 to 5.0

The construction industry has started to integrate LLMs and AI agents into project management workflows (Figure 2), which is an important step towards the Construction 5.0 paradigm. While Construction 3.0 is mainly about the separate use of digital tools, where a human interacts with a digital environment separate from the physical environment via a computer, Construction 4.0 is the digital transformation of the construction industry, i.e. the integration of the physical and digital environment through cyber-physical systems [9]. This creates a connected ecosystem between machines, data and the user. As an extension of the Industry 5.0 concept, Construction 5.0 focuses on people again and the development of intelligent systems that work together with people instead of replacing them, or in other words, from machine-to-machine integration back to human-to-machine integration [10]. In such environment, the AI agent does not take full control, but acts as a collaborator – with a clearly limited role, supervised by a human. This approach follows the Human-in-the-Loop (HITL) principle, which is one of the foundations of Industry 5.0. The connected ecosystem is further deepened in Construction 5.0 through the introduction of cognitive cyber-physical systems, where technologies not only monitor and control processes, but also understand context, collaborate with people and adapt to their needs.

2.3 AI Agents and Large Language Models

Research on AI agents is increasingly focusing on their integration into collaborative environments where they act as virtual team members. In this paper, we define AI agents as systems capable of autonomous task execution, contextual decision-making, and interaction with tools or users. Studies suggest that well-trained and accepted agents can improve information coordination and reduce conflicts in project teams. However, mistakes made by AI agents are often viewed more critically by users than those made by human colleagues [11].

With the rapid development of LLMs, a new generation of AI agents has emerged. These agents are able to understand natural language and generate complex, context-appropriate responses [3].

LLMs enable agents to interpret user input, perform structured reasoning using techniques such as Chain-of-Thought or Tree-of-Thoughts and interact with external tools and data sources via APIs [4], [6]. Additional relevant capabilities include processing images with Visual Language Models (VLMs) and structured inputs such as JSON and XML.

Recent developments include Large Reasoning Models (LRMs), which focus on strategic planning and high-level decision-making. In combination, LLMs and LRMs allow agents to execute tasks while also reflecting on their outcomes, significantly expanding the range of complex problems they can solve [12], [13]. In construction management, such agents are increasingly relevant for decision support, task assignment, risk prediction and communication between stakeholders [7], [11].

2.4 Research gap

Despite rapid advancements in the development and application of AI agents, several challenges remain unaddressed in the context of construction project management. While AI agents offer significant advantages in managing complex and dynamic workflows, they are not universally suitable for all project contexts. This highlights the need to first assess when and where the use of AI agents is feasible. Second, there is a lack of standardized approaches for integrating AI agents into construction-specific workflows, which often differ from other industries due to their one-of-a-kind nature. Third, while AI agents show potential for augmenting teamwork, research on human–AI collaboration (particularly in high-stakes, safety-critical environments like construction) is still limited. Additionally, issues of security, privacy, and explainability are insufficiently explored, especially with regard to sensitive project data and the traceability of agent-generated decisions [2]. Finally, although Construction 5.0 emphasizes values such as sustainability, human-centricity, and trust, these principles are not yet fully embedded in the design and deployment of AI agents [7]. These gaps underscore the need for a conceptual and methodological framework that supports the development of AI agents for construction project management.

3 AI Agents in Construction Management

AI agents enable natural language interaction, intelligent task automation and predictive real-time analyses. LLM-based agents enable construction professionals to engage in dialogue with systems and support both planning and tool usage through intuitive interfaces [4], [6]. Advances in reasoning capabilities, processing of images and structured data and formal language integration improve the ability of agents to accurately interpret complex construction tasks [12], [13]. In task automation, AI agents streamline project planning, resource allocation and risk assessment by dynamically adapting teams to project requirements and identifying potential bottlenecks at an early stage [5], [7]. Through workflows with AI agents, they adapt to the changing conditions on the construction site and thus meet the goals of the digital transformation of Construction 4.0 and 5.0 [8], [9], [10].

3.1 AI agents suitable tasks

Before using AI agents in construction workflows, it's essential to ask a fundamental question: *Is this task suitable for an AI agent, or would another solution be better?* Agents should not be seen as a one-size-fits-all solution. They are most valuable in workflows that are complex, dynamic and require interaction with multiple tools. However, their use must be carefully considered based on task characteristics and project risk.

As shown in Figure 3, there are several decision points that determine whether an AI agent is appropriate. This decision flow evaluates the task across multiple dimensions and helps to decide whether an AI agent, a simpler LLM-based solution or classic automation is more appropriate.

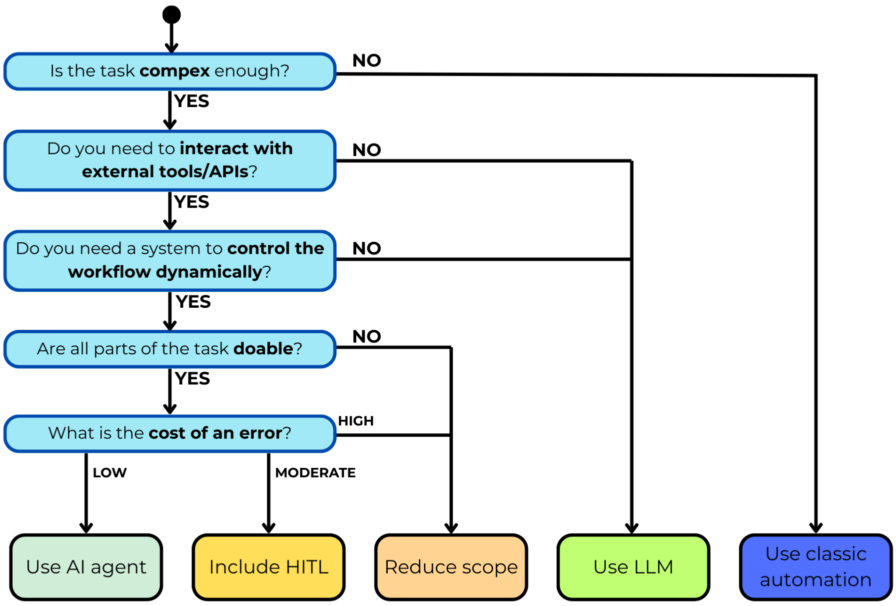

Figure 3: Task suitability evaluation for AI agents.

- **Task complexity**: If the task is not complex enough to require autonomous reasoning, a rule-based method or classic automation may suffice. Conversely, tasks that involve uncertain outcomes, coordination or adaptive planning may benefit from agent-based solutions.
- **Text-only and tool interaction**: If the task only involves creating or summarising text, a standard LLM is sufficient. However, if the task requires interaction with external APIs or tools, an agent may be needed.
- **Workflow control**: AI agents should only be considered if the system needs to dynamically control the workflow based on real-time input. Static or linear tasks do not justify the complexity of agents and their potential unreliability and stohastic behaviour.
- **Feasibility**: If not all parts of the task are yet automatable, the scope should be reduced or partially delegated. Tasks that remain too ambiguous should not be assigned to agents. In this case, the scope should be reduced or limited to what the agent can handle.
- **Error tolerance**: In safety-critical scenarios or scenarios where the stakes are high, as is typical in construction, humans must remain in control. Tasks with low error costs can be fully automated, but for tasks with moderate risk, agents should only support humans and not decide autonomously.

A full AI agent integrates memory, tool utilisation, context retrieval and workflow control. This makes them powerful, but also risky if used incorrectly. Figure 3 illustrates that many tasks in construction do not justify the use of a full agent and can be better handled with LLMs. In most construction scenarios, simpler systems with HITL are more suitable than fully autonomous agents, as they need to be accountable and explainable. Therefore, AI agents in construction should act as contributors rather than decision makers. They are most effective when they offer alternative solutions and support, while leaving the final decision to engineers. HITL should not only be a practical safeguard, but a necessary design principle in the field of construction (e.g. audit logs of agents, checkpoints for human overrides, thresholds for confidence in decisions). AI agents should be designed from the outset to enable traceability and validation by engineers at key decision points.

3.2 Integration with Construction Workflows

AI agents can be integrated into construction workflows to enhance communication, decision-making, and task execution. This section briefly presents interaction scenarios with stakeholders and illustrates possible use cases in construction project environments.

3.2.1 Communication with stakeholders

AI agents equipped with LLMs and VLMs enable intuitive and context-aware communication between systems and stakeholders. Instead of requiring structured input formats, users can interact with agents via queries (e.g. ask for project status, request scenario comparisons, delegate task updates). This lowers the barrier to information access and helps bridge fragmented communication across roles and disciplines. For example, a site manager could ask an agent for real-time material delivery forecasts or potential delays and receive a response based on integrated project data.

In addition, agents can translate technical information into appropriate formats for stakeholders. When communicating with non-technical personnel or clients, agents can create customised summaries that reflect the relevant information. This supports transparency and helps align diverse expectations on construction projects.

3.2.2 Example workflows or theoretical use cases

In practise, AI agents can be integrated into several important construction workflows:

- **Schedule coordination**: Agents can automatically update project schedules based on current progress reports or external disruptions, and can also simulate alternative schedules when constraints change. For instance, in a disrupted schedule coordination scenario, an AI agent could propose a sequence swap based on material delays and flag it to a human supervisor for validation.
- **Resource allocation**: AI agents can suggest resource shifts based on evolving site needs, helping teams respond more quickly to shortages or bottlenecks.
- **Risk assessment**: Agents can continuously scan inputs such as progress logs, cost reports or environmental conditions to identify early warning signs of potential risk.
- **Documentation and reporting**: Agents can automatically generate site reports, meeting summaries or compliance logs, improving administrative efficiency and reducing human error.

These examples show how workflows with AI agents differ from traditional digital tools. Instead of executing pre-programmed steps, agents monitor progress, select contextual actions and dynamically adapt the workflow [8]. This makes them particularly valuable in the fragmented, evolving conditions typical of construction.

4 Challenges and limitations

Despite the promising capabilities of AI agents, their use in construction project management raises some challenges that need to be addressed to ensure responsible and effective adoption.

4.1 Data security and privacy

Construction projects contain sensitive data including contracts, costs, personnel records and safety documentation. When AI agents process such data (often via APIs or cloud services), there is a risk of data leakage or misuse. Deng et al. [2] emphasise that AI agents are particularly vulnerable to the unpredictability of multi-step user inputs, the complexity of internal executions, the variability of operational environments and interaction with untrusted external entities. This risk is magnified in construction, a highly regulated industry. Clear architectural guidelines for secure data flows and on-premise deployment options should be considered to meet compliance requirements.

4.2 Bias, transparency, and trust

AI agents that rely on LLMs inherit the limitations of these models, including possible biases in the training data which can influence decision-making. One of the most pressing challenges is the explainability of agent decisions. In domains where the stakes are high, users need to understand not only the outcomes, but also the reasoning behind them. As Dennis et al. [11] point out, human trust in AI agents relies heavily on perceived clarity. Designing agents with built-in mechanisms for explanation, oversight and human override is critical.

4.3 Adaptability to dynamic project environments

Construction projects are dynamic by nature and often require rapid re-planning due to design changes, weather conditions or resource availability. While AI agents show promise in managing this complexity through contextual reasoning and workflow adaptation, their effectiveness in practise is limited by generalisation issues and an insufficient foundation of project-specific data. Agents trained on generic corpora may struggle to adapt to the unique terminology and evolving requirements of individual sites. Their stochastic nature raises concerns about reliability, reproducibility, and deployment risks, especially for consistent behavior in real-world applications. Without customised integration and domain adaptation (as highlighted by Taboada et al. [5]), AI agents run the risk of making irrelevant or impractical suggestions. A HITL approach, where agents support decision making but engineers remain in control, offers a more resilient solution that meets the needs of construction domain.

5 Final remarks

AI agents offer a promising new dimension to construction project management by improving adaptability, communication and decision support. This paper highlights their potential role, their current limitations and the importance of careful task selection. To move forward, standardisation, HITL integration and domain-specific adaptation are essential. As we move towards Construction 5.0, future research should focus on practical implementation strategies that align AI agents with human supervision and develop common benchmarks for evaluating the trustworthiness and effectiveness of agents in construction projects.

Acknowledgements

This research was supported by the Slovenian Research and Innovation Agency (ARIS) under the Young Researcher funding program and research programs E-Construction (P2-0210) and Language Resources and Technologies for Slovene (P6-0411).

References

[1] Ž. Turk, "Construction informatics: Definition and ontology", *Advanced engineering informatics*, vol. 20, pp. 187–199, 2006.

[2] Z. Deng et al., "AI Agents Under Threat: A Survey of Key Security Challenges and Future Pathways", *ACM Computing Surveys*, vol. 57, no. 7, 2025. DOI: 10.1145/3716628

[3] Z. Xi et al., "The rise and potential of large language model based agents: A survey", en, *Science China Information Sciences*, vol. 68, no. 2, 2025.

[4] Z. Liu et al., *AgentLite: A Lightweight Library for Building and Advancing Task-Oriented LLM Agent System*, 2024. arXiv: 2402.15538.

[5] I. Taboada, A. Daneshpajouh, N. Toledo, and T. de Vass, "Artificial Intelligence Enabled Project Management: A Systematic Literature Review", *Applied Sciences*, vol. 13, no. 8, 2023. DOI: 10.3390/app13085014

[6] J. Ruan et al., "TPTU: Large Language Model-based AI Agents for Task Planning and Tool Usage", in *NeurIPS 2023 Foundation Models for Decision Making Workshop*, 2023.

[7] N. Mikhridinova, F. A. Yurdakul, and C. Wolff, "Using Large Language Models for Project Staffing: Evaluation of GPT-Based Mapping of Teams to Projects", in *Proceedings of the 12th IPMA Research Conference*, 2024, pp. 1–19. DOI: 10.56889/cykr4175

[8] M. Newhauser, L. Monigatti, P. Yadav, and T. Çelik, *What Are Agentic Workflows?*, Mar. 2025. [Online]. Available: https://weaviate.io/blog/what-are-agentic-workflows

[9] R. Klinc and Ž. Turk, "Construction 4.0 - digital transformation of one of the oldest industries", *Economic and business review*, vol. 21, no. 3, pp. 393–410, 2019.

[10] M. A. Musarat, M. Irfan, W. S. Alaloul, A. Maqsoom, and M. Ghufran, "A Review on the Way Forward in Construction through Industrial Revolution 5.0", *Sustainability*, vol. 15, no. 18, 2023. DOI: 10.3390/su151813862

[11] A. R. Dennis, A. Lakhiwal, and A. Sachdeva, "AI Agents as Team Members: Effects on Satisfaction, Conflict, Trustworthiness, and Willingness to Work With", *Journal of Management Information Systems*, vol. 40, no. 2, pp. 307–337, 2023. DOI: 10.1080/07421222.2023.2196773

[12] Z. Li, W. Hua, H. Wang, H. Zhu, and Y. Zhang, *Formal-LLM: Integrating Formal Language and Natural Language for Controllable LLM-based Agents*, 2024. arXiv: 2402.00798.

[13] X. Zhou et al., *Exploring the Necessity of Reasoning in LLM-based Agent Scenarios*, 2025. arXiv: 2503.11074.