AI-POWERED AUTO-SCHEDULING OF CONSTRUCTION PROJECTS FOR IMPROVED EFFICIENCY

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This systematic literature review explores the integration of artificial intelligence (AI) with auto-scheduling in construction projects. (The gap). The study assesses the current practice of AI applications in scheduling, emphasising their potential to enhance decision-making and efficiency. By analysing 31 carefully selected relevant papers, we identify key trends, opportunities, challenges and requirements associated with these technologies. This semi-systematic literature review identified nine key technologies mapped across four primary functions: (1) resource allocation, (2) schedule optimisation, (3) schedule development and (4) decision making. This illustrates AI's effectiveness in scheduling. Our findings indicate that AI can significantly improve scheduling accuracy, reduce project delays, and optimise resource allocation. However, challenges categorised into technical, organisational, financial, security, and skills-related barriers, include issues with data quality, difficulties in system integration, resistance to stakeholder acceptance, financial limitations, and a lack of skilled professionals must be resolved. This is the first paper to map the nine key technologies to enable AI applications in construction scheduling, laying the groundwork for future research and implementation strategies.

Keywords: algorithm; artificial intelligence; auto-scheduling; construction project management; systematic literature review; technology integration

INTRODUCTION

Every construction project, like most observable phenomena, is inherently unique, characterised by a certain degree of risk and uncertainty. The interaction and interconnectedness of project activities contribute to this risk and uncertainty, consequently resulting in project complexity. This dynamic nature, coupled with the high level of risk associated with the construction industry, makes effective planning and scheduling an essential component for project success (Vaghela, 2020; Hamad, Tayeh and Al Aisri, 2021). For the most part, the repetitive nature of construction activities makes auto scheduling a potential contributor to project success (García-Nieves *et al.,* 2019). Extant literature has consistently demonstrated a positive correlation between robust project scheduling and successful project outcomes, further highlighting the importance of effective and efficient planning and scheduling (Derbe

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et al., 2020; Faghihi *et al.,* 2015; García-Nieves *et al.,* 2019). Notably, construction projects are familiar with the lack of dynamic scheduling, inadequate planning, poor project management practices, a deficiency in proactive risk management, and ineffective resource allocation which ultimately lead to delays and budget overruns (Cooke and Williams, 2025; Muhammad *et al.,* 2022). AlMunifi and Almutairi (2021) echoed these findings, attributing many of the challenges in achieving project success to shortcomings in the pre-construction phase, including unrealistic scheduling. The failure to anticipate and address these issues early in the project process often leads to costly delays, quality compromises, and inefficiencies.

The automation of scheduling activities has been a topic for discussion for decades (Chevallier and Russell, 1998; Faghihi *et al.,* 2015). We define automatic scheduling as the application of advanced computing and software to automatically generate, and update construction schedules based on defined data inputs such as task dependencies, durations, and resource data and their availability. Hence, it comes as no surprise when the adoption of AI in scheduling has been identified as an innovative solution for scheduling challenges. Modern project management tools can facilitate more precise planning, dynamic scheduling, and real-time updates, enabling construction project managers to respond proactively to emerging challenges (Cooke and Williams, 2025).

Zwikael (2009) sees the role of planning and scheduling being central to all construction activities and therefore it is considered a critical skill and competence for effective management of projects. The complex interdependence of construction activities signifies that scheduling is an intense task that requires unhindered and upfront access to accurate information, including, task breakdowns, detailed account of hard, soft and monetary resources needed, risks, supply chain and the necessary logistics to get the resources when and where they are needed; to mention a few. This complex interaction of construction processes and activities means that planning and scheduling cannot be an exact science and would require experience to arrive at a justifiable guesswork. The centrality of scheduling regarding its influence on effectiveness of other construction project management systems qualifies it to be a system of systems which can best be explored through the lenses of systems theory (Prieto, 2020).

This study assesses the current practice of AI applications in scheduling, emphasising their potential to optimise scheduling processes, enhance decision-making and efficiency, and in reducing delays. This paper seeks to answer two questions:

- To what extent is AI currently being utilised in the industry for scheduling construction projects?
- How can AI be used to auto-schedule construction projects?

The literature review on auto-scheduling of construction has confirmed that no previous papers have addressed the potential of the AI to automate the development of construction programmes. This paper, therefore, will be the first to offer specific recommendations on applicability of AI for automation and digitalisation in construction by synthesising insights on AI applications in construction scheduling, laying the groundwork for future research and implementation strategies.

METHOD

This paper uses semi-systematic literature review (SSLR) as the key source of data for the analysis. Systematic literature review (SLR) has become a popular data collection method in management research post-Covid-19 in recognition of its strength to capture the vast data accessible through open access policy (Sánchez-Garrido *et al.,* 2023). While traditional literature review lacks thoroughness and rigor, SLR uses a specific methodological approach to rigorously and reliably collect and synthesize existing knowledge.

Sources of data include research papers published in peer-reviewed journals and conference proceedings in the construction management field. Given the increasing research interest in the application of AI in the field, it was impractical to search through all available databases. As a result, the decision was made to focus on the most used online databases in construction to fulfil the requirements of a systematic review (Snyder, 2019). However, a semi-systematic review approach was ultimately selected as the preferred method for tracking the development of auto-scheduling technologies and their associated barriers over time. Unlike SLR, a semi-systematic literature review allows for purposeful selection of research papers or databases. Various databases were initially searched to identify the most effective one and to define the scope for the search using a combination of keywords. After several attempts, SCOPUS database was selected as the main source as it had more returns from reviewed research papers compared to other databases and it included most of the papers returned from other databases.

To further limit the scope, the search focused on papers that covered both automatic scheduling (also automatic programming) and construction project(s). Other related terms such as planning were too broad and returned papers beyond scheduling or construction scheduling. Prioritisation of papers for analysis was carried out in three steps:

- The first step was the keyword search using various combination of automatic scheduling and construction projects. This stage found 300 matching papers that were published in indexed journals and peer reviewed conferences.
- The second step was to review the abstracts to examine the relevance of these papers, remove duplications, and to check availability of the full text. This process reduced the overall number to 48 papers that met all requirements.
- Step 3 involved scanning through the full papers to confirm consistency and that they contained primary research. This further reduced the number of papers to 31 qualifying papers (as 6 papers were not fully related to auto-scheduling in construction projects and other 11 were literature review papers that do not address the questions raised in the current paper).

The involvement of four reviewers in the selection of the articles further demonstrates a rigorous process that ensures the quality and reliability of the search protocol. The 31 selected papers were then reviewed, and key information such as authors' names, year of publication, paper title, journal title, country of origin, research methods, research topics, etc. was recorded. Figure 1 presents the distribution of papers according to years of publication.

Figure 1 shows a sharp increase in the number of papers discussing auto-scheduling in construction since 2010. While prior to the year 2000, there were only four papers, with the earliest paper published in 1988, in the first quarter of 2025 there were already three papers published. Noteworthy, this research study only utilised papers based on primary research; if literature-based papers were included; the number would be significantly higher. The increasing number of publications demonstrates the growing desire to investigate innovative solutions to address the longstanding scheduling challenges.

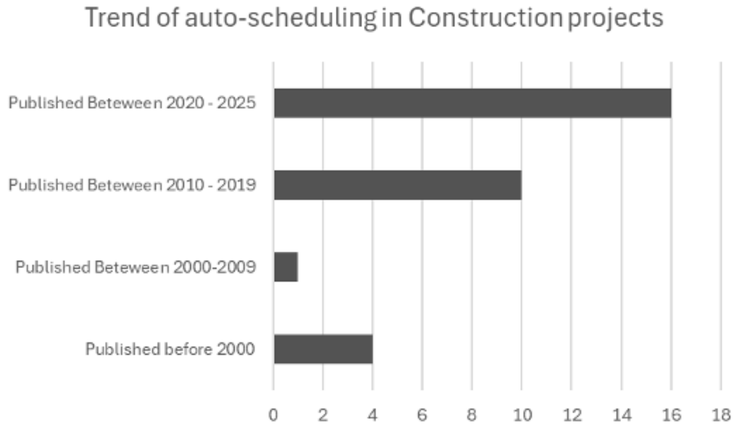

Figure 1: Distribution of papers published between 1988 and 2025

Thereafter, thematic analysis was used to extract data and summarise findings in a table for detailed analysis to answer the questions addressed by this paper.

AI Integration in Construction Scheduling

Evolution of AI in construction scheduling

The literature survey concludes that the construction industry has long struggled with poor planning and scheduling, with traditional methods being time-consuming and dependent on often unavailable data. The analysis has shown that AI is increasingly seen as a solution to these inefficiencies.

To understand this shift, it is essential to trace the evolution of AI applications in construction scheduling. Early knowledge-based systems, such as GHOST (Navinchandra *et al.,* 1988), pioneered rule-based automation for activity sequencing and dependency resolution, embedding construction norms and geometric data interpretation into scheduling logic. Subsequent advancements, like the Finite Element Project Planning (FEPP) method (Sirajuddin and Mawdesley, 1991), introduced dynamic visualisation of Gantt charts and resource usage graphs, enabling planners to analyse ripple effects of delays (Ayman Morad and Beliveau, 1991). These systems laid the groundwork for AI's role in transforming heuristic-driven Critical Path Method (CPM) frameworks into data-driven paradigms.

The 21st century marked a shift toward algorithmic optimisation, with genetic algorithms (GA) (Hui *et al.,* 2013) and fuzzy logic (Tavakolan and Ashuri, 2012; Oz, 2023) emerging as cornerstones for resolving multi-objective constraints. Hybrid models, such as the shuffled frog leaping algorithm (SFLA) integrated with fuzzy logic (Tavakolan and Ashuri, 2012), demonstrated robust handling of uncertainty in activity durations and productivity rates. Concurrently, AI-driven BIM integration automated data extraction for activity synthesis, reducing manual scheduling efforts by 97% in pipe system installations (Singh and Anumba, 2022; Aljebory and QaisIssam, 2019). Innovations like Foresight+AI (Hatami *et al.,* 2021) combined reinforcement learning with discrete-event simulation, enabling iterative refinement of schedules through scenario modelling.

This evolution underscores AI's capacity to address industry-wide inefficiencies while aligning with global priorities like smart infrastructure and digital twins. Emerging frameworks, such as the cloud-based convolutional neural network (CCAS) model

(Dong, 2024), signal a future where AI not only automates scheduling but also empowers adaptive, collaborative project ecosystems. By synthesising historical advancements and contemporary innovations, this paper highlights AI's transformative trajectory and its implications for construction management theory and practice.

Current AI applications in construction scheduling

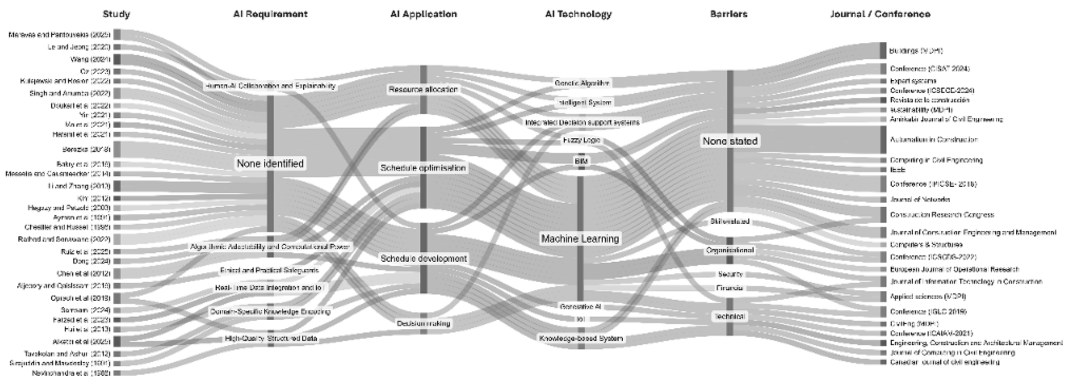

Figure 2: Sankey chart for AI applications in construction scheduling

Figure 2 presents an overview of AI capabilities in construction scheduling, highlighting the application of various technologies, the requirements for its use and the associated implementation barriers. From our thematic analysis, nine AI enabled technologies were identified and mapped against their applications in construction scheduling. These technologies support AI integration across four critical tasks: (1) resource allocation, (2) schedule optimisation, (3) schedule development and (4) decision making.

Table 1: Mapping AI technologies used in scheduling

Type of AI technologies	Decision making	Resource allocation	Developing schedule	Schedule optimisation	Total	%
Machine Learning	3	5	5	10	23	56%
KBS	0	0	4	0	4	10%
BIM - Related	0	0	1	2	3	7%
IDSS	1	1	1	0	3	7%
Fuzzy Logic	0	1	0	1	2	5%
Genetic Algorithm	0	1	0	1	2	5%
Intelligent System	0	1	0	1	2	5%
Generative AI	0	0	1	0	1	2%
IoT	0	0	1	0	1	2%
Total	4	9	13	15	41	
Popularity of use	10%	22%	32%	37%		

Key: IDSS- Integrated Decision support systems; KBS - Knowledge-based System; IoT - Internet of Things

Table 1 shows Machine Learning is the most prevalent AI technology applied for all four tasks, while other technologies were only limited to specific applications. For example, IoT, Generative AI and knowledge-based systems were only limited to generating inputs for schedule development. Nearly 70% of the AI usage was related to schedule development and its optimisation. However, the applications were limited to specific functions such as estimation of activity durations and productivity rates, schedule visualisation and prediction of scheduling issues.

Innovative technologies were adopted when they are believed to offer a solution to the persistent challenges such as inaccuracy of scheduling assumptions, resource allocation inefficiencies, and reactive decision-making

Modern methods have adopted metaheuristic algorithms and scalable infrastructure to address dynamic schedule challenges (Tavakolan and Ashuri, 2012), while cloud-based convolutional networks (CCAS) were used to synchronise real-time resource data for adaptive allocation (Dong, 2024). If these systems are coupled with high-performance computing, they can train deep learning models on datasets to process complex inputs such as resource demand curves to minimise idle time and costs (Chen *et al.,* 2012; Ruiz *et al.,* 2024). Other tools like Prolog-generated Work Breakdown Structures (WBS) can link outputs to inputs, fostering trust in AI logic (Iranmanesh and Madadi, 2008) and dynamic visualisation tools like Schedula Anima animates Gantt charts to prioritise rescheduling based on metrics like duration flexibility and float availability (Maravas and Pantouvakis, 2025).

AI has also demonstrated predictive capabilities such as the LSTM networks achieving 87% accuracy in forecasting delays at the Tehran Metro (Farzad *et al.,* 2023). In UAE, 4D BIM and UAV-tracked data detected spatial conflicts, enabling sustainability-focused resource allocation (Alketbi *et al.,* 2025). Generative AI tools like ChatGPT employed Monte Carlo simulations to revise timelines based on real-time site conditions (Samsami, 2024), highlighting the shift from static plans to responsive ecosystems. Metaheuristic algorithms, such as tabu search (Kulejewski and Rosłon, 2023), optimise ecological and economic objectives, balancing carbon reduction with cost efficiency. Despite these applications, no study has yet demonstrated a fully AI-integrated project schedule.

The requirements and barriers for applying AI into construction scheduling
To achieve the full potential, the effective application of AI in construction scheduling hinges on six critical requirements derived from historical, technical, and contextual advancements in the field. These requirements bridge inputs such as data and domain expertise to outputs like optimised schedules and risk mitigation, as evidenced by the evolution of AI systems across the analysed studies. The requirements are: (1) high-quality, structured data; (2) domain-specific knowledge encoding; (3) algorithmic adaptability and computational power; (4) human-AI collaboration and explainability; (5) real-time data integration and IoT; (6) ethical and practical safeguards.

Even though AI has promising potential, its integration in construction faces several barriers, which can be categorised into technical, organisational, financial, security, and skills-related challenges. These barriers hinder the widespread adoption of AI in construction scheduling. Technical challenges stem from the complexity of AI systems, uncertainties in the construction environment, dependency on AI expertise and varied maturity levels in AI use, unreliable infrastructure, poorly drafted project plan, classification of project type and cultural barriers (Alketbi *et al.,* 2025; Samsami, 2024; Rathod and Sonawane, 2022; Singh and Anumba, 2022; Yin, 2021; Oprach *et al.,* 2019; Bakry *et al.,* 2016; Chevallier and Russell, 1998; Navinchandra *et al.,* 1988).

There are also organisational barriers including poor data management, resistance to change and the lack of support and acceptance of AI technologies, including the fear of job replacement, and poor understanding of AI and algorithm functions (Rathod and Sonawane, 2022; Singh and Anumba, 2022; Oprach *et al.,* 2019; Messelis and Causmaecker, 2014; Tavakolan and Ashuri, 2012 Chevallier and Russell, 1998).

Alketbi *et al. (*2025) and Rathod and Sonawane (2022) identify the high cost of adopting and maintaining AI, shortage of skilled professionals to manage AI systems effectively, and security concerns, such as data leaks and hacking as further hinderances to adoption of AI. However, Figure 2 reveals that over 50% of the publications did not report any barriers, suggesting that AI holds significant potential in construction scheduling, provided the existing challenges are effectively addressed.

CONCLUSION

This study has demonstrated that integrating AI into construction scheduling holds significant promise for optimising workflows, enhancing efficiency, and reducing project delays through real-time data utilisation and automated schedule adjustments. By examining current AI applications, this research identified nine key technologies mapped across four primary functions, illustrating AI's effectiveness in automating resource allocation, timeline management, and progress updates. The integration of advanced algorithms, IoT devices, and real-time data enables dynamic schedule adaptation, resource optimisation, and delay mitigation. To achieve the full potential of AI, the following requirements are critical: (1) high-quality, structured data; (2) domain-specific knowledge encoding; (3) adaptable algorithms supported by robust computational power; (4) effective human-AI collaboration and explainability; (5) seamless real-time data integration and IoT connectivity; and (6) implementation of ethical and practical safeguards. However, the successful adoption of AI in construction scheduling hinges on overcoming challenges related to, inter alia, data quality and interoperability, system integration complexities, stakeholder acceptance, financial limitations, and a shortage of AI-skilled professionals.

Future research should prioritise improving data quality by for example, implementing automated data auditing tools that can detect anomalies and gaps in construction data streams, standardising data formats, and establishing comprehensive data-sharing frameworks to facilitate AI integration. Additionally, developing flexible AI algorithms capable of managing complex project variables and designing educational initiatives to equip construction professionals with AI management competencies are essential. This could be undertaken by partnerships between universities and industry bodies to integrate AI literacy into construction management curricula. Furthermore, advancing secure AI frameworks and data protection protocols will be vital to safeguarding sensitive project information, thereby enabling the broader and responsible adoption of AI in construction scheduling.

REFERENCES

Aljebory, K M and QaisIssam, M (2019) Developing AI Based Scheme for Project Planning by Expert Merging Revit and Primavera Software, *In*: *16th International Multi-Conference on Systems, Signals and Devices (SSD'19)*.

Alketbi, M A, Dweiri, F and Dalalah, D (2025) The role of artificial intelligence in aviation construction projects in the united arab emirates: Insights from construction professionals, *Applied Sciences*, **15**(1).

AlMunifi, A A and Almutairi, S (2021) Lessons learned framework for efficient delivery of construction projects in Saudi Arabia, *Construction Economics and Building*, **21**(4), 115-141.

Ayman Morad, B A and Beliveau, Y J (1991) Knowledge-based planning system, *Journal of Construction Engineering and Management*, **117**(1), 1-12.

Bakry, I, Moselhi, O and Zayed, T (2016) Optimised scheduling and buffering of repetitive construction projects under uncertainty, *Engineering, Construction and Architectural Management*, **23**(6), 782-800.

Chen, S M, Griffis, F H, Chen, P H and Chang, L M (2012) Simulation and analytical techniques for construction resource planning and scheduling, *Automation in Construction*, **21**(1), 99-113.

Chevallier, N and Russell, A D (1998) Automated schedule generation, *Canadian Journal of Civil Engineering*, **25**(6), 1059-1077.

Cooke, B and Williams, P (2025) *Construction Planning, Programming and Control*, Chichester: John Wiley and Sons.

Derbe, G, Li, Y, Wu, D and Zhao, Q (2020) Scientometric review of construction project schedule studies: Trends, gaps and potential research areas, *Journal of Civil Engineering and Management*, **26**(4), 343-363.

Dong, P (2024) Research on optimisation scheduling algorithm of engineering project resources based on cloud computing, *In*: *2024 IEEE 2nd International Conference on Sensors, Electronics and Computer Engineering, ICSECE 2024*, 720-727.

Faghihi, V, Nejat, A, Reinschmidt, K F and Kang, J H (2015) Automation in construction scheduling: A review of the literature, *International Journal of Advanced Manufacturing Technology*, **81**, 1845-1856.

Farzad, E, Manshadi, H D and Rahmatabadi, M A D (2023) Predicting construction project scheduling issues using LSTM neural network (long-term short-term memory), *Amirkabir Journal of Civil Engineering*, **55**(9), 1753-1764.

García-Nieves, J D, Ponz-Tienda, J L, Ospina-Alvarado, A and Bonilla-Palacios, M (2019) Multipurpose linear programming optimisation model for repetitive activities scheduling in construction projects, *Automation in Construction*, **105**, 102799.

Iranmanesh, H and Madadi, M (2008) An intelligent system framework for generating activity list of a project using WBS mind map and semantic network, *World Academy of Science, Engineering and Technology*, **16**.

Hamad, R J, Tayeh, B A and Al Aisri, H A (2021) Critical factors affecting the success of construction projects in Oman, *Journal of Sustainable Architecture and Civil Engineering*, **29**(2), 121-138.

Hatami, M, Franz, B, Paneru, S and Flood, I (2021) Using deep learning artificial intelligence to improve foresight method in the optimisation of planning and scheduling of construction processes, *In*: *Computing in Civil Engineering 2021 - Selected Papers from the ASCE International Conference on Computing in Civil Engineering*, 1171-1178.

Hui, L, Jingxiao, Z, Lieyan, R and Zhen, S (2013) Scheduling optimisation of construction engineering based on ant colony optimised hybrid genetic algorithm, *Journal of Networks*, **8**(6), 1411-1416.

Kim, J.-L and Asce, M (2012) Hybrid genetic algorithm parameter effects for optimisation of construction resource allocation problem, *Construction Research Congress (ASCE).*

Kulejewski, J and Rosłon, J (2023) Optimisation of ecological and economic aspects of the construction schedule with the use of metaheuristic algorithms and artificial intelligence, *Sustainability*, **15**(1).

Le, C and Jeong, H D (2020) Artificial intelligence framework for developing a critical path schedule using historical daily work report data, *In*: *Construction Research Congress 2020: Project Management and Controls, Materials and Contracts - Selected Papers from the Construction Research Congress 2020*, 565-573.

Li, H and Zhang, H (2013) Ant colony optimisation-based multi-mode scheduling under renewable and non-renewable resource constraints, *Automation in Construction*, **35**, 431-438.

Ma, Z, Li, S, Wang, Y and Yang, Z (2021) Component-level construction schedule optimisation for hybrid concrete structures, *Automation in Construction*, **125**.

Maravas, A and Pantouvakis, J P (2025) Schedula anima: Dynamic visualisation of Gantt charts and resource usage graphs in project scheduling, buildings, **15**(3).

Messelis, T and De Causmaecker, P (2013) An automatic algorithm selection approach for the multi-mode resource-constrained project scheduling problem, *European Journal of Operational Research*, **233**(4).

Muhammad, S, Alasan, I I and Afridi, F K (2022) Impact of success factors on project success: Empirical evidence from Khyber, *Pakhtunkhwa International Journal of Special Education*, **37**, 1379-1392.

Navinchandra, B D, Sriram, D, Member, A and Logcher, R D (1988) GHOST: Project network generator, *Journal of Computing in Civil Engineering*, **2**(3), 239-254.

Oprach, S, Steuer, D, Krichbaum, V and Haghsheno, S (2019) Smart data - Dealing with task complexity in construction scheduling, *In*: *27th Annual Conference of the International Group for Lean Construction, IGLC 2019*, 347-358.

Oz, B (2023) A new perspective in construction management; The metaverse, *Revista De La Construction*, **22**(2), 321-336.

Prieto, R (2020) Systems nature of large complex programs, *PM World Journal,* **11**(8).

Rathod, K and Sonawane, A (2022) Application of artificial intelligence in project planning to solve late and over-budgeted construction projects, *In*: *International Conference on Sustainable Computing and Data Communication Systems, ICSCDS 2022 - Proceedings*, 424-431.

Ruiz, J G, Díaz, H and Crespo, R G (2024) The application of artificial intelligence planning and scheduling in photovoltaic plant construction projects, *Expert Systems*, **42**, e13798.

Samsami, R (2024) Optimising the utilisation of generative artificial intelligence (AI) in the AEC industry: ChatGPT, Prompt: Engineering and Design, *Civileng*, **5**(4), 971-1010.

Sánchez-Garrido, A J, Navarro, I J, García, J and Yepes, V (2023) A systematic literature review on modern methods of construction in building: An integrated approach using machine learning, *Journal of Building Engineering*, **73**, 106725.

Singh, J and Anumba, C J (2022) Real-time pipe system installation schedule generation and optimisation using artificial intelligence and heuristic techniques, *Journal of Information Technology in Construction*, **27**, 173-190.

Sirajuddin, A and M J Mawdesley (1991) A knowledge-based system for recognition of work required for construction, *Computers & Structures*, **40**(1), 37-44.

Snyder, H (2019) Literature review as a research methodology: An overview and guidelines, *Journal of Business Research*, **104**, 333-339.

Tavakolan, M and Ashuri, B (2012) Development of fuzzy enabled shuffled frog leaping algorithm with activity splitting allowed, *In*: *Construction Project Scheduling Construction Research Congress*.

Vaghela, V N (2020) Risk management in the construction industry, *International Research Journal of Engineering and Technology*, **7**(6), 584-588.

Yin, W (2021) Multi-objective optimisation of construction schedule based on artificial intelligence optimisation algorithm, *In*: A*CM International Conference Proceeding Series*, 1621-1624

Zwikael, O (2009) Critical planning processes in construction projects, *Construction Innovation*, **9**(4), 372-387.