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AI and Construction Project Schedules Efficiency: A Review

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Abstract

The construction industry continues to grapple with problems relating to project delivery within the set timelines and budget due to consistent issues with project scheduling. In the recent past, the emergence of Artificial Intelligence (AI) has presented opportunities to transform the planning and execution of construction schedules. This review looks at the efficiency of construction project schedules due to the impact of AI technologies, analyzing peer-reviewed studies, industry reports, and case studies published between 2000 and 2023. The study incorporates key AI methodologies such as machine learning, deep learning, automated planning and scheduling systems, and language models, including ChatGPT, to assess their impact on delay prediction, resource optimization, and schedule automation effectiveness.

The research outcomes show AI-enabled systems enhance schedule precision, adaptability, and making better decisions when utilizing past data, real-time data, and integrating with Building Information Modeling (BIM). With appropriate structured data, several AI applications have been proven to enhance critical path delay identification and reduce planning time by as much as 30% for construction schedule optimization. Fragmented data, high cost of initial investment, low AI literacy among the professionals, and ethical issues are still barriers to applications of AI. The review concludes that AI, while not a replacement for human expertise, can serve as a vital augmentation tool in construction scheduling when applied responsibly and strategically. The paper offers targeted recommendations for construction firms, policymakers, and researchers to facilitate AI integration and foster sustainable digital transformation in the built environment.

Keywords: *Artificial Intelligence, Construction Scheduling, Project Management, Machine Learning, BIM, Delay Prediction, Automation, ChatGPT, LLMs.*

I. INTRODUCTION

The global construction industry continues to struggle with trillions of dollars worth of unprecedented inefficiencies, rampant delays, cost overruns, and low productivity. Research claims productivity in construction has only increased by 1% in the last 20 years, and cost overruns rest, on average, 80% over what was initially budgeted in the scope of the work (Parsamehr et al., 2023; Waqar et al., 2023). Traditional scheduling techniques like Gantt charts and heuristic-based scheduling done by seasoned professionals parallel a construction site's workflows resulting in a construction site's workflows becoming misaligned and poorly met.

Starting in the 2000s, the scheduling and planning problems of construction sites began to be tackled using Artificial Intelligence (AI). I recall the early AI solutions being implemented through knowledge-based and rule-driven expert systems. More recently however, I've noted a rise in the use of machine learning (ML) methods that offer a range of services from data driven decision making to predictive modeling and optimization ML methods are becoming more common. One of the last structured reviews published in 2024 notes a stunning shift from Industry 3.0 to 4.0 that favors machine learning and its planning and control phases.

As of the year 2023, scholars, including Bahroun et al. have completed systematic reviews concerning the application of AI onto project scheduling. They noted that while AI based strategies are not fully developed, they show promising results in the areas of schedule optimization, delay prediction, and task sequencing (covering literature from 1985 to 2021). In construction scheduling, Akhmedov and Khairova (2023) illustrate the identification of resource scheduling in a project-driven environment and how predictive analytics and machine learning techniques are capable of improving schedule design, reducing delays, and enhancing resource allocation in routine project workflows.

Prieto et al. (2023) undertook empirical research exploring the capabilities of large language models, particularly ChatGPT, focusing on the generation of preliminary construction project schedules. The majority of participants evaluated the plans as well-structured and time-efficient which suggests that automating the preliminary scheduling process could be possible. However, limitations in domain knowledge and scaling are notable.

II. LITERATURE REVIEW

- *Historical Evolution of AI in Construction Scheduling*

The implementation of AI in construction management has changed considerably over the last two decades. Early developments in the AI field, such as expert systems and rule-based scheduling, were implemented as novice AI in construction back in the 2000s (Marzouk & Moselhi, 2003). Such systems based on expert systems and rule-based scheduling suffered from the weaknesses of rigid logic and the need for over extensive manual coding. As these systems adapted poorly to the real world, they were replaced with more advanced machine learning (ML) strategies that could address the complexities of sprawling, dynamic, and interwoven project ecosystems.

Research during the 2010 and 2020 period focused on optimizing schedules using ML and genetic algorithms (Moselhi et al., 2010). AI and genetic algorithms were extensively used during this period for schedule optimization, advanced scheduling, and forecasting. With tools like Primavera and MS Project, these systems provided greater forecasting and rescheduling ability (Pardhasaradhi & Santhosh, 2016).

- *AI in Delay Prediction and Risk Management*

The construction scheduling and forecasting breakthroughs using ML have provided new opportunities for construction AI applications. AI's ability to accurately predict construction delays has provided a critical milestone. Predictive models based on CPM scheduling have proven impractical due to their dependence on rigid schedules and static frameworks. Instead, as shown by Akhmedov and Khairova (2023), models that incorporate ML, historical data, and dependencies outperform the CPM-based models in identifying schedule risks. AI models, as demonstrated in their research, showed the capacity to forecast delays with 90% accuracy when provided with scope, weather, and resource data (Genius Journals, 2023).

In a similar way, Bahroun et al. (2023) evaluated models for project scheduling supported by AI, and they concluded that machine learning allows for real-time updates and automated processes. Their conclusions imply that AI_functions improve efficiency in managing numerous interconnected elements influencing project deadlines (Bahroun et al., 2023).

- *Machine learning and BIM Integration*

The automated designing of schedules in project management systems by AI is one of the most powerful changes in the for the construction industry that concerns the integration of building information modeling (BIM) with AI. Based on Al-Sinan et al. (2024), they presented a machine learning–BIM hybrid framework for scheduling generation that automatically schedules and estimates the activities, duration, resources, and costs quantitatively and qualitatively at the level of IFC structured BIM files. Their model removes the constraint for the matrix and reduces more than thirty percent of the planning time (Al-Sinan et al. 2024).

The integration of BIM with AI enables real-time revisions and updates of the schedule based on data from sensors and site progress monitoring, which allows for adjustments to be made not only for the present but also anticipates future developments (Waqar et al. 2023). This integration improves the overall efficiency of the project by making it more adaptable to disruptions and by reducing the active waiting time for workers and machines.

- *Natural Language Processing and Large Language Models*

Exploratory studies have examined the usefulness of natural language processing technologies and large language models like ChatGPT for drafting construction schedules. Prieto et al. (2023) evaluated the performance of ChatGPT in drafting schedules for residential construction projects. Although the outputs provided sequentially made sense in most cases and were sensible by the construction industry's standards, the model, without some form of bespoke prompting, had difficulty interpreting constraints like regulatory documents and client imposed latter bound considerations (Prieto et al., 2023). This study, however, demonstrates, despite the model's shortcomings, the potential that exists in employing LLMs as intelligent scheduling assistants to improve early-stage planning and aid in the decision-making process.

- *Automated Planning and Neuro-Symbolic Scheduling*

Pallagani et al. (2024) performed a meta-review of more than 100 documents on automated planning and scheduling (APS). They noted the increasing focus on the integration of LLMs with symbolic reasoning (traditional planning algorithms) that is referred to as neuro-symbolic systems. With this type of construction planning, the planners can take advantage of automated schedule generation based on the logic framework of the system, yet still respect the logic system and constraints provided (Pallagani et al., 2024).

These systems are easier to deploy to sophisticated situations because they can create schedules within the given domain constraints and conditions noted in the project.

III. METHODOLOGY

Casado et al. (2022) have conducted a systematic literature review on the impact of AI technologies on the efficiency of construction project scheduling in peer-reviewed and industry publications to gather insights from credible sources. The review approach taken was ensured to be systematic so it would be transparent, repeatable, and relevant.

➢ *Research Design*

Following the guidelines, the SLR was set up by Kitchenham and Charters (2007) in evidence-based software engineering within construction project management. The goal was to identify and collect relevant literature published from 2000 to 2024, focusing on the most recent contributions from 2023 to 2024.

➢ *Search Strategy*

The following terms were used to search in academic databases: ScienceDirect, Google Scholar, MDPI, SpringerLink, IEEE Xplore and arXiv.

- Artificial Intelligence OR AI
- Construction scheduling OR project scheduling
- Machine learning in construction
- BIM and AI
- LLM in construction planning
- Construction schedule optimization

The date range for searches is English publications from January 2000 to July 2024.

➢ *Inclusion and Exclusion Criteria*

- *Inclusion Criteria:*

✓ Research specific to AI used for scheduling construction projects
✓ Studies that evaluate AI with quantitative or qualitative frameworks
✓ Literature reviews, case studies, empirical or simulation studies
✓ Reports from industry that provide methods or citation frameworks

- *Exclusion Criteria:*

✓ Articles behind closed paywalls
✓ Research pertaining to AI in non construction fields
✓ Published in languages other than English
✓ Non scholarly, unsubstantiated opinion pieces and blogs

➢ *Ethical Considerations*

Since this is a secondary research review, there were no human or animal subjects involved. That said, the responsible use of AI as discussed in primary sources such as (Liang et al., 2023) informed the critical analysis of the review in addressing the challenges and limitations.

IV. FINDINGS

This AI-driven construction scheduling project critique is informed by literature across the following key themes and subthemes: delay prediction, machine learning–BIM integration, large language models (LLMs), automated planning systems, efficiency metrics, and key implementation challenges of advanced construction project scheduling frameworks.

➢ *Delay Prediction and Risk Mitigation*

Delay prediction is perhaps the most notable use of AI for construction scheduling. Project delays used to be forecasted with risk registers and the critical path method (CPM). This approach was not very flexible, and responsive to change. However, ML algorithms have been used to sharpen precision using historical data, environment, available resources, and current input from the field.

Delay causes for residential projects have been accurately predicted by supervised learning models like decision trees and support vector machines (SVM) with 85 percent accuracy as shown by Akhmedov and Khairova (2023). Their research focused on the effectiveness of machine learning models as compared to conventional CPM techniques and their effectiveness in handling non-linear, dynamic, and multi-variable risks in real-time (Akhmedov & Khairova, 2023).

In the same relation, as noted by Bahroun et al. (2023), deep learning models, especially ANNs, are capable of deriving alerts from extensive data sets on contractor activities, budget changes, and even material movements to preemptively warn of possible schedule delays. These systems are useful in contexts with frequent interruptions of activities outside of a manager's direct control, especially concerning the climate, as they allow for the proactive allocation of resources and timelines.

➢ *The Automation of Scheduling Using Machine Learning and BIM*

The application of AI in Building Information Modeling (BIM) with Project Scheduling Join has developed. BIM systems configured in Industry Foundation Classes (IFC) format give a digital depiction of a building's information components. Enhanced with AI, these models become capable of scheduling and planning on their own.

Al-Sinan et al. (2024) developed a proposal with a machine learning enabled BIM with automatic extraction of construction related processes which included activity generation, duration estimation, material quantity calculation, and dependency relations identification. Their design removed manually created constraint matrices and using them integrated automation resulted in a scheduling phase time reduction of thirty percent. The described system adjusted and recomputed schedules on the fly, responding to changes made to prior activities (Al-Sinan et al., 2024).

Moreover, the integration of AI with BIM allows for the visualization of the progression of activities, which allows users to assess the impacts of different sequencing decisions on progress well ahead of time. This feature aids in the cooperation of different project stakeholders such as the architects, the engineers, and the contractors, as it reduces the chances of misunderstandings and conflicts of timing on the project.

- *NLP and LLMs for Initial Stage Scheduling*

The use of natural language processing NLP and large language models LLMs such as ChatGPT for the preliminary stage of scheduling for projects has recently gained popularity. These models are capable of analyzing project documents, determining the dependencies of the listed activities, and creating the necessary lists of activities in natural language which can later be transformed to structured schedules.

Prieto and colleagues in 2023 did one of the first assessments of the construction scheduling capabilities of ChatGPT. They asked ChatGPT to generate schedules for a single residential housing project with the use of prompts and it returned with logically structured and sequentially coherent outlines of schedules. Project manager participants of the study evaluated the output positively in regard to the relevance of the tasks and the overall structure, but also highlighted several areas for improvement, particularly in accuracy, estimating the cost, and tailoring to custom regulatory requirements (Prieto et al., 2023).

Although LLMs have yet to achieve fully autonomous scheduling for intricate construction processes, they can assist with rapid prototyping in preliminary feasibility assessments and client presentations. LLMs can automate some processes in preliminary planning in a way that streamlines and simplifies the initial planning stages and motivates even non-technical users to participate in the planning discussions.

- *Automated Planning and Scheduling with Neuro-Symbolic Systems*

Apart from the language processing tools, there is an increasing focus in artificial intelligence on automated planning and scheduling (APS) systems. These systems are built on a more formal representation of the planning problem, like temporal logic, causal networks, or even probabilistic dependencies to formulate reasonable sequences of actions.

Neuro-symbolic AI, which combines neural networks with symbolic reasoning, has been noted for its advantages by Pallagani et al. (2024). This development enables construction schedule creators to apply traditional logic rules, for instance, “Activity A must finish before Activity B starts,” while drawing upon the generative capabilities of LLMs and deep learning networks. Pallagani et al. (2024) report that neuro-symbolic scheduling systems are far better at dealing with constraint-heavy domains like high-rise building construction and large-scale infrastructure development.

These systems are useful for interdependent projects where a single delay can lead to a significant overrun. Construction managers are equipped with advanced planning systems (APS) that simulate thousands of scheduling scenarios in mere minutes to analyze different trade-offs and optimized plans.

- *Quantitative Evidence of Improved Efficiency in Actual Projects*

The adoption of AI technology in construction scheduling has been documented in multiple industry reports starting in 2023 and continuing onwards. Wifitalents (2025) cites that companies utilizing AI in their workflows are experiencing:

- Reduction of 25% to 30% in hours spent on manual scheduling
- Decreased project overruns by 20% attributed to sequencing mistakes
- Can respond to disruptions on site better in real-time
- More accurate forecasts for resources and crew estimate allocation (Wifitalents, 2025)

Software used in the construction industry that uses AI modules like Autodesk’s Construction IQ and Procore Predict has reported improvements in the speed of making decisions and adherence to scheduled goals. These tools are especially useful for large firms operating in fast-track delivery models such as design-build or integrated project delivery (IPD).

GIS User (2024) reported that project managers are more agile with project AI-Enhanced schedule tracking. AI can analyze site images, sensors, and weather data to proactively identify productivity roadblocks several steps in advance and reorganize tasks to optimize productivity (GIS User, 2024).

- *Issues with Execution and AI Ethics*

Although the advantages are pronounced, ethical issues and a lack clarity in regulations and policies are pronounced. Liang et al. (2023) conducted a thorough literature review of AI ethics in the architecture, engineering, and construction (AEC) domains. Some of the issues identified are the lack of human planners, the opacity of AI’s inner workings, and responsibility for mistakes made by AI. AI systems in safety-critical functions are also avoided (Liang et al., 2023).

Data quality poses another challenge. Many construction companies still use outdated and disjointed information systems. This harms data quality which in turn hinders the training of relevant AI models. Consequently, the predictions made in construction projects can become biased leading to a loss of trust from stakeholders. There is a growing agreement that incorporation of AI in the construction sector is only possible once data standardization at the BIM level is enforced along with sensor-based monitoring systems.

Additionally, the lack of financial resources and technical know-how remains an obstacle for small and medium sized companies. The construction industry is still lagging behind in the utilization of AI technology due to the exclusive data science to construction in-house talent ratio, coupled with high licensing costs and steep learning curves.

V. CONCLUSION

Inefficiencies in scheduling construction projects and the accompanying cost overruns, extended timelines, and resource mismanagement have for a long time sorely afflicted the construction industry. This review integrated literature from 2000 to 2024 and found that Artificial Intelligence (AI) can deal with these persistent problems. AI is being adopted more and more to increase the precision, responsiveness, and efficiency with which planning is done, through the use of machine learning algorithms for delay prediction and large language models for early-stage scheduling automation.

Research indicates that machine learning models accessible today outperform traditional critical path methods because they utilize both past and ongoing activity data to predict delays and reorder tasks. The application of AI to Building Information Modeling (BIM) improves scheduling efficiency and precision when used with data organization structures like IFC. Additionally, advanced neuro-symbolic planning and APS (Automated Planning and Scheduling) tools are facilitating the generation and evaluation of dynamic schedules in more sophisticated project settings.

RECOMMENDATION

From the undertaking of the AI-focused literature review, the following proposals are aimed at assisting in the efficient AI integrated construction schedule implementation during the project lifecycle management:

- *Create AI and Human Collaborative Scheduling Systems*

Construction companies ought to adopt collaborative systems that integrate the speed of computation of AI with the construction planner's situational awareness and planning ability. This collaborative model seeks to simultaneously address the challenges of AI faulty decisions and failure to utilize human productivity.

- *Standardize Data Formats and Promote BIM Adoption*

Achieving effective AI scheduling relies on clear, well-structured data inputs. Companies need to adopt standardized Building Information Modeling (BIM) practices across projects so that machine-readable data inputs compatible with AI tools are generated. Processing BIM models with the IFC standard enhances AI learning for schedule automation, driving automation and AI functionalities.

- *Begin Pilot Projects for AI Tools*

Organizations need to test the implementation of AI into the scheduling workflows through small pilot projects first before scaling up. This approach helps control risks, enables iterative learning, and helps adapt the AI solutions to the area of implementation.

- *Broaden Training Programs*

The issuing AI tools interpret the data and generate outputs. Integrating the schedules AI generates requires automation AI-reliant workflows to be managed, trained, and monitored by skilled professionals. This gap in the construction industry can be addressed through dedicated training offers on AI, data analytics, and digital construction technologies.

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