CHAPTER 24

Artificial Intelligence in Project Scheduling: A Comprehensive Review of Techniques, Applications and Future Opportunities

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ABSTRACT

The growing complexity of modern construction projects demands efficient scheduling to meet time, cost, and quality goals. Traditional methods like Critical Path Method (CPM), Program Evaluation and Review Technique (PERT), and Gantt charts, though widely used, struggle to handle uncertainties, dynamic conditions, and limited resources. This study reviews both conventional and Artificial Intelligence (AI)-based scheduling approaches to evaluate their effectiveness in construction project management. A comprehensive literature review of traditional methods identifies their strengths in simplicity and proven reliability but also highlights limitations in adaptability and resource optimization. Emerging frameworks such as the Fuzzy-GERT model, Repetitive Scheduling Method (RSM), and BIM-based scheduling have attempted to improve flexibility and precision. The paper further examines AI-driven techniques—Machine Learning (ML), Deep Learning (DL), Genetic Algorithms (GA), Reinforcement Learning (RL), and Fuzzy Logic—that enhance prediction, optimization, and automation. Integration with Building Information Modeling (BIM) and the Internet of Things (IoT) demonstrates promising potential for intelligent scheduling systems. Ultimately, the study compares both traditional and AI-based methods, offering insights into selecting suitable scheduling approaches based on project characteristics and emphasizing the future integration of AI with conventional techniques for adaptive and efficient project scheduling.

Keywords: Artificial Intelligence, Project Scheduling, Optimization, Traditional Scheduling methods.

1.0 Introduction

Delay, cost increase, poor resource use, and schedule change persist in construction as a result of the complexity of project, fluctuating site conditions, unpredictable productivity

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and change of design, which makes ineffective scheduling a key contributor to poor performance in infrastructure and building projects. Despite the simplicity that they are valued with, the traditional methods of planning such as Gantt charts, CPM and PERT are largely deterministic and reliant on human judgment. Therefore, they struggle to cope with resource constraints, space-temporal conflicts, and real-time fluctuation particularly in large-scale earthwork projects that often undergo numerous revisions that lead to incompetent and costly schedules.

Due to the recent advancements in AI, intelligent, data-driven, and flexible scheduling solutions are now feasible. Especially in equipment-intensive processes such as earthworks, such techniques as machine learning, genetic algorithms, reinforcement learning, and simulation-based optimization are effective at addressing challenging scheduling problems, optimizing resources, and reducing the project duration and cost.

Intelligent scheduling can be improved by using AI with BIM, sensors, and simulation platforms by automated WBS generation, AON modeling, and optimization via simulation. Nonetheless, there is a complexity of implementation, data accessibility, and lack of comprehensive and combined frameworks that hinder practical application, and studies remain scattered.

Thus, this review paper aims to provide a complete and systematic analysis of AI use in the construction schedules. Specifically, the research examines the flaws of traditional scheduling systems, collects AI-based scheduling protocols that appeared in the literature, and considers practical implementations, compares AI-based scheduling systems with traditional ones, and recommends future research directions to developing intelligent project scheduling systems.

2.0 Literature Review

2.1 Traditional project scheduling methods

The ease of use, transparency and simplicity of traditional methods of scheduling such as CPM, PERT, Gantt charts and RSM make them easy to apply. They aid in determining essential tasks, project estimation, tracking progress and repetition of project management. Nevertheless, they are largely deterministic and rely on the manual sequencing limitations and preset lengths of activities, which limits their ability to deal with project complexity and variability. (Fahihi, et.al,2014) Scheduling based on CPM often does not take into account dynamic spatial and time limitations of equipment intensive activities such as earthworks. The frequent adjustments of schedules that highly depend on human judgments reduce responsiveness and increase the potential of making bad decisions

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2.2 Artificial intelligence techniques in project scheduling

To avoid the disadvantages of traditional scheduling, researchers research AI-based project scheduling approaches that enable flexible decision-making, deal with uncertainty, and optimize multifaceted constraints.

2.2.1 Machine learning

Machine learning can be used to support data-driven scheduling by predicting the time periods of activities, based on the characteristics of delays. These techniques make forecasts more precise by using information about previous projects; however, the success of these techniques relies entirely on the quality and accessibility of such information. (Alikhani et al.,2023)

2.2.2 Genetic algorithms

Genetic algorithms are widely applied to schedule optimization, and they are effective to search for a high-dimensional solution space to improve the project duration, cost, and resource efficiency. The ASCE literature reveals that the heuristic CPM-based scheduling systems are worse than GA- and swarm-intelligence-based scheduling techniques, especially when combined with simulation. (Jeonghoon Lee et al.,2018)

2.2.3 Reinforcement learning

Reinforcement learning allows systems to communicate with the environment of the project and acquire optimal rules by modeling scheduling as a sequential decision-making process. Frameworks based on RL are highly promising in adaptive and real-time scheduling, yet often have a high processing power and training cost (Mingshu Li et al.,2024)

2.2.4 Fuzzy logic

It is due to uncertainty, fluctuation of productivity, risk levels, and linguistic reasoning that fuzzy-based scheduling is more resilient than deterministic approaches although there are interpretability and scalability problems since this kind of scheduling considers them during the scheduling process. (Sarra Dahmani & Jmal,2011)

2.2.5 Deep learning

Deep learning extends machine learning by modeling complex nonlinear interactions and has shown promise in large-scale prediction and pattern recognition for scheduling performance, though its application in construction scheduling is still in early stages. (Hatami et al.,2022)

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2.3 Applications of AI in project scheduling

In the construction of buildings, there are several significant scheduling processes that have been approached using AI means.

2.3.1 Delay prediction

The AI-based models allow proactive intervention compared to reactive control; the previous data is used on the project and the site to make a much more accurate forecast of schedule delays. (Alikhani et al.,2023)

2.3.2 Resource optimization

Artificial intelligence (AI) has tremendous potential in constrained scheduling by automating WBS creation, using AON networks, and optimising with simulation to create conflict-free plans that reduce effort, duration of project and project cost by a significant margin (Jeonghoon Lee et al.,2018)

2.3.3 Risk-aware scheduling

Risk-aware scheduling is achievable by modeling numerous situations and optimizing under uncertainty making AI achieve more flexible and reliable project schedules. (Egbedion, 2024)

2.4 AI integration with BIM and IoT

AI application and integration with BIM and IoT is directly connected to digital and paper-based building methods. The combination of AI, BIM and sensing technologies enhances construction scheduling by offering automated WBS, optimum sequencing, and real-time schedule updates which is dynamic and requires minimal human involvement. (Golparvar-Fard et al.,2023)

2.5 Literature gaps summary

Despite the huge progress, there are still significant research gaps. The existing literature is often constrained by its focus on specific kinds of projects in general or AI methods in particular. The barrier to the industry implementation is the complexity of models and the associated data requirements, and it does not provide numerous studies comparing the AI-based and traditional approaches to scheduling. The need to have standard and scalable scheduling systems is also exacerbated by the fragmented interaction with BIM, IoT, and decision-support systems. (Fouad Amer et al.,2021).

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2.6 Application of AI techniques in construction project scheduling

Table 1 compares the main functionalities of AI and AI-aid scheduling techniques, i.e., WBS generation, sequencing, resource optimization, conflict resolution, and adaptability. The traditional simulation models and optimization methods (GA, PSO) address some of the requirements but they are not flexible or learning based. In general, the authors come to the conclusion, which is scientifically proved, that hybrid AI scheduling systems are required since no single strategy suffices.

Table 1: Comparison of Main Functionalities of AI and AI-aid Scheduling Techniques

AI Technique / Method	WBS Genertion	Activity Sequencing	Resource Optimization	Conflict Resolution	Time Optimization	Cost Optimization	Schedule Automation	Real-Time Adaptability
Flow Network Optimization	✓	✓	✓	✓	✓	✓	✓	
Genetic Algorithm (GA)		✓	✓	✓	✓	✓		
Particle Swarm Optimization (PSO)		✓	✓		✓	✓		
Discrete Event Simulation (SDESA)			✓	✓	✓	✓	✓	
Automated WBS & AON Generation	✓	✓		✓			✓	
Resource-Constrained CPM (AI-assisted)		✓	✓	✓	✓			
Expert Systems (Knowledge-based)		✓						
Neural Networks (Reviewed)					✓			✓
Hybrid AI Models (AI–CPM / AI–BIM / Simulation–Optimization)	✓	✓	✓	✓	✓	✓	✓	✓

Source: Created by authors

3.0 Research Methodology

3.1 Review methodology

Databases used: The literature review utilized peer-reviewed scholarly materials, such as the ASCE Library (18 publications), the ScienceDirect (22 papers), and the Google

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Scholar (5 additional sources). The ASCE Library was particularly useful in the case of research on resource-constrained scheduling, AI-based planning, automated WBS generation, and AON network modeling.

Keywords and Search Strategy: A keyword-based search used AI, scheduling, and optimization terms, applying AND/OR operators to capture interdisciplinary construction and scheduling research.

Inclusion and Exclusion Criteria

Inclusion Criteria

- Peer-reviewed journal articles and conference proceedings.
- Research on construction project scheduling, planning or sequencing.

Exclusion Criteria

- Research that does not deal with timetable of construction or planning.
- Articles that are only concerned with cost estimation or safety not related to scheduling. Opinion or editorial or non-peer-reviewed articles.
- Redundant research in databases.

This screening was done to be consistent with the structured automation and optimization strategies outlined in the uploaded ASCE literature.

Time Span of the Review: The review covers studies from 2000–2024, highlighting the transition from CPM-based scheduling to AI-driven, simulation-based, and automated planning, supported by foundational WBS, AON, and resource-constrained scheduling literature.

3.2 Case study selection method

Type of case study: A real-life case study approach analyzed literature-reported AI-based scheduling implementations using peer-reviewed journals, conferences, and industry-validated research, without collecting primary project data.

The case study data sources: A phased roadmap is recommended, starting with CPM-based AI optimization, progressing to BIM and simulation integration, and advancing to AI with digital twins and sensors for real-time adaptive scheduling.

Methodological consistency: The case study was chosen as it is closely related to the goals of the review and represents:

- Construction conditions are equipment intensive.
- Active interactions of resources.
- The necessity of automated and flexible scheduling.

This consistency will guarantee that the insights based on the case study will be directly related to the comparative analysis and findings of the review.

4.0 Data Analysis

Even though it was a review paper, systematic data analysis was undertaken to determine patterns and trends based on peer-reviewed articles, conference papers, and case studies on AI in construction scheduling. The research makes records of frequently used AI methods, fields of application, perceived advantages, and frequent implementation issues.

4.1 Classification of reviewed literature

The primary strategy for scheduling and AI technology used for literature categorization was automated and optimized literature scheduling. For the literature collected, there was a clear movement away from scheduling that was deterministic to frameworks that incorporated automation and optimization.

Table 2: Classification of Scheduling Research Approaches

Scheduling Approach	Representative Techniques	Relative Frequency
Traditional methods	CPM, PERT, Gantt charts	Moderate
Optimization-based	GA, PSO, linear programming	High
Simulation-based	Discrete-event simulation, SDESA	High
Learning-based AI	Machine Learning, Reinforcement Learning	Emerging
Hybrid systems	BIM–AI, simulation–optimization	High

Source: Created by authors

4.2 Frequency of AI techniques used in scheduling research

The most frequently employed AI techniques and methods are optimization algorithms as indicated in the analyzed publications, due in part to their overall effectiveness and interpretability in the resource-constrained environments.

The main points are as follows

- Genetic Algorithms (GA) serve as the preeminent AI methodology for optimizing construction scheduling
- Simulation-based optimization tools (SDESA, for instance) are often interfaced with AI for managing dynamic resource interactions
- ML techniques serve predominantly for predictive tasks, in particular, forecasting delays
- Reinforcement Learning continues to be restricted to the experimental and design automation domains due to the excess data and training it entails.

4.3 Project scheduling AI application areas

The reconstructed literature was subjected to additional scrutiny encompassing the broad functional deployment of the AI techniques in the scheduling continuum.

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The prevalent functional application areas include:

- Automated work breakdown structure (WBS) generation • Activity sequencing and precedence modeling
- Resource allocation and leveling
- Conflict-free scheduling under spatial and temporal constraints
- Resource-constrained scheduling optimization

The ASCE case study exemplifies AI-enabled conflict-free sequencing of haul jobs and optimized resource assignment, thus overcoming the shortcomings of superintendent-driven CPM schedules.

4.4 Reported benefits of AI-based scheduling

From previous studies, the following benefits of AI Scheduling have been recorded:

- Shortened the duration in which projects can be completed
- Improved the management and distribution of company resources
- Removed conflicts that would best be described as spatial or temporal
- Increased flexibility to [site] conditions that may change
- Less need for manual or expertise

4.5 Challenges and limitations identified

The study finds that there are some major barriers to the AI-based scheduling, including biased inputs, low interpretability, workflow integration issues, and insufficient individuals knowledgeable in AI. ASCE recommends the resolution of issues via transparent simplified processes with the emphasis on AI methods, which are reliant on the simulation and optimization techniques.

4.6 Trend mapping and analysis

- Early: studies that utilized heuristic optimization and CPM enhancement
- Middle: The use of simulation-based scheduling
- Exploring integration of AI, BIM, and learning-based techniques in recent studies

5.0 Findings / Results

5.1 Comparative performance of traditional and AI-based scheduling methods

The discussion reveals that artificial intelligence solutions always perform better than traditional approaches to scheduling, particularly in complex and dynamic projects. AI-based tools are more flexible and optimizing as compared to deterministic classical technologies.

Table 3: Performance Comparison of Scheduling Approaches

Performance Criterion	Traditional Scheduling Methods	AI-Based Scheduling Methods
Adaptability to changes	Low	High
Handling uncertainty	Limited	Advanced
Resource optimization	Moderate	High
Automation level	Manual	Semi to fully automated
Scalability for large projects	Moderate	High

Source: Created by authors

These results indicate that while traditional methods remain effective for stable and small-scale projects, AI-based scheduling offers significant advantages for complex construction scenarios.

5.2 Dominant AI techniques in project scheduling research

The analysis reveals that some AI methods are more commonly used in construction scheduling studies because they offer a balance between computational speed and the optimization potential.

Key findings include:

- Genetic Algorithms (GA) and Machine Learning (ML) are the most common methods of AI application in scheduling studies.
- GA is applied mostly to the resource-constrained scheduling and optimization problems.
- Use It ML methods are typically used in prediction of delays, estimation of productivity, and pattern recognition.
- Reinforcement Learning and Deep Learning are new, yet not as widespread because of excessive information and computational demands.

5.3 Application trends in AI-based scheduling

The literature review has identified a number of overriding areas of use of AI.

Major application areas identified:

- Schedule delay and performance risk prediction.
- Labor, equipment and material allocation optimization.
- Activity sequencing and work breakdown generation, which is automated.
- Uncertainty-based and risk-conscious scheduling.

Resource optimization and automated planning are the most studied and practically implemented areas of application among them.

5.4 Practical implementation of AI-based scheduling

Although the technical benefits are proven in research studies, AI-based scheduling systems have not been applied in real-life yet.

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Observed findings include:

- The majority of AI-based scheduling applications are limited to pilot projects, simulations, or controlled case projects.
- Industry adoption is impeded by complexity of implementation, dependency of data and unskilled individuals.
- Construction practitioners still find the use of traditional tools like CPM and commercial scheduling software important.

Such discrepancy between business and scientific studies reveals the necessity of scalable and user-friendly AI scheduling solutions.

5.5 Effect of BIM-AI integration on the reliability of scheduling

The combination of AI and Building Information Modeling (BIM) and digital construction systems contributes greatly to the reliability of schedule and extended practicality.

Key results show that:

- The data of BIM allows work breakdown and sequencing to be done automatically and correctly
- AI optimization enhances the schedule robustness by removing both spatial and temporal conflicts.
- Independent BIM-AI systems facilitate the introduction of real-time schedule updates, as well as informed decision-making.

5.6 Summary of key findings

The review concludes that the AI-based scheduling is more flexible and more optimized in the context of uncertainty, compared to the traditional methods. Genetic algorithms and machine learning dominate the current research but are still not utilized in practice. The BIM-AI integration enhances schedule accuracy and hybrid systems that integrate traditional and AI-based approaches can provide a way forward in the future.

6.0 Case Study: AI-Based Project Scheduling in Earthwork Operations

This case study investigates the comparison of AI-based scheduling and the traditional methods in an equipment-intensive earthwork infrastructure project.

6.1 Case background

Project type: The given case study containing a relatively large infrastructure earthwork project involving dump trucks, compactors, and excavators is suitable to evaluate

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the AI-based scheduling due to its high equipment dependency, dynamic space-temporal interactions, and fluctuating productivity.

Scheduling challenges: Following the traditional methods the project was faced with some serious scheduling issues including conflict of resources between excavation and carrying machines, poor haul sequencing due to ignorance of the geographical boundaries and numerous human schedule amendments due to the change in site conditions. CPM timelines involved significant role in heuristics and experience to lead to inefficient utilization of equipment and a longer project timeline.

6.2 AI technique applied

Algorithm / system used

- Automated Work Breakdown Structure (WBS) generation,
- Creation of an Activity-on-node (AON) network
- Resource-constrained critical path scheduling
- The optimization by the use of the Genetic Algorithm (GA)
- Discrete-event performance evaluation.

Data Inputs

The AI-based scheduling system took into account the following inputs:

- Types, quantities and rates of productivity of equipment
- Automatically generated project layout activity definitions
- Distance of transportation and space restrictions.
- Resources and restrictions on operations.

6.3 Comparison with traditional scheduling

The AI-based schedule was directly compared to a traditional CPM-based schedule that was developed using common project management software

Table 4: Comparison of Traditional and AI-Based Scheduling Approaches

Parameter	Traditional CPM Scheduling	AI-Based Scheduling
Schedule preparation	Manual	Automated
Handling resource conflicts	Limited	Optimized
Equipment utilization	Moderate	High
Adaptability to changes	Low	High
Schedule flexibility	Low	High
Time efficiency	Lower	Improved
Cost efficiency	Moderate	Improved

Source: Created by authors

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By creating schedules free of conflicts, allocating equipment optimally, and cutting down on needless idle time, the AI-based method showed improved performance.

6.4 Results and retrospectives

Outcomes: The AI-based scheduling framework was implemented, and it was observed that,

- The general time taken on the project was reduced.
- Efficiency in the utilization of equipment was enhanced.
- Spatial and temporal conflicts were eradicated.
- Dependence on manual planning skills was reduced. the ability to evaluate the different scheduling alternatives was enhanced.

The results confirm that AI-based scheduling has a significant benefit compared to traditional CPM-based planning in the context of equipment-intensive construction projects. (Li & Du 2017), (Fouad Amer et al.,2021)

Lessons Learned: Some of the key lessons of the case study are as follows:

- There is reduced human bias and planning through automation.
- AI scheduling works very well with dynamic and resource-intensive operations.
- The integration of simulation and optimization improves schedule dependability.
- AI implementation is only possible with data quality and structured inputs.

7.0 Conclusion & Implications

7.1 Conclusion

Using a mixture of traditional methods, AI-dedicated approaches, areas of application, and a real-world case study, this review explores the topic of artificial intelligence in construction project scheduling. CPM, PERT and Gantt charts continue to be applicable in simple projects, but cannot support the complexity, uncertainty and resource constraints of modern construction. The AI-based scheduling, specifically the optimization and simulation-based models, offer more flexibility, optimization, and resolve conflicts in a better way. Learning-based approaches allow predictive scheduling, but again, it is limited due to computing and data needs. As the case study illustrates, the application of hybrid AI-solutions, in particular, in equipment-intensive projects, has a significant positive impact on the reliability of the schedules, time efficiency, and cost performance.

In the figure, the AI opportunities in the field of construction scheduling, including automated planning, optimization of resources, delay forecasting, and decision support, are mentioned. The new trends are digital twins, IoT, and BIM. The key barriers include cost, quality of data, experience, and interpretability; in order to implement it in practice, the next generation of research should focus on standardization, scalability, and explainable AI.

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Figure 1: Opportunities, Challenges, Emerging Trends, and Open Research Issues in AI-Based Construction Project Scheduling

Source: Created by authors

7.2 Academic implications

The review brings organization to the body of knowledge by categorizing AI techniques and their applications in construction scheduling. To bridge the theory-practice divide, future research will have to make the large-scale and real-world validation more of a priority compared to all simulation-based research and explore combining AI-based scheduling with digital twins, real-time sensing technologies, and BIM-driven decision-support systems

7.3 Industry implications

The findings provide certain recommendations on how AI can develop to be used in construction scheduling. The biggest construction and infrastructure projects, projects related to earthworks, and complex and resources-demanding processes are the most appropriate ones to address with AI-based scheduling. Despite a relative lack of historical information, optimization-based AI can quickly become more efficient, reducing the amount of effort needed to plan manually and utilize better resources. With the help of integrating AI and BIM, they are further able to obtain accurate, real-time, and field-level scheduling.

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8.0 Recommendations

The conclusions of this extensive evaluation and the lessons learned with the help of the illustrative real-life example allow to suggest several recommendations to help the successful implementation of artificial intelligence-based project scheduling in the construction industry and its further development.

8.1 Development of hybrid AI–CPM scheduling frameworks

AI must be used to supplement the scheduling that is based on CPM, not to replace it. Hybrid AI-CPM models allow allocating resources automatically, resolving conflicts, and dynamically updating as a result of merging traditional critical path visibility with AI-based optimization and simulation. Researchers and developers should focus on user-friendly hybrid solutions that can interoperate with the existing project management systems

8.2 Construction professionals training and capacity building

The deficit of technical knowledge and practical training of the experts in the construction field is one of the largest hindrances to AI-based scheduling. Companies are supposed to invest in special training involving AI principles, AI-created schedule reading, and the way AI technologies can be integrated with project management and BIM systems

8.3 Implementation of pilot projects

Pilot projects that involve limited settings should be used to test AI-based scheduling systems before they become widely used. Pilot installations enable organizations to determine the constraints of the system and the data requirements of the system as compared to traditional solutions.

8.4 Standardization of construction data for AI applications

Introducing AI scheduling in tasks with repetitive cycles, heavy equipment is useful in building trust. To offer AI-based solutions the ability to be interoperable with BIM systems and project management systems to enable scalable dependent scheduling solutions, effective adoption requires high-quality demonstrative construction data including WBS, activities, sequencing, and resources which are standardized.

References

1. D. Li duanshun@ualberta.ca, C. a. (2017). *Automation of Project Planning and Resource Scheduling on a Rough Grading Project.* ASCE.

DOI: 10.17492/JPI/NICMAR/260524 ISBN: 978-93-49790-68-1

2. Fouad Amer, S.-0.-2.-8. Y. (2021). *Automated Methods and Systems for Construction Planning and Scheduling: Critical Review of Three Decades of Research.* ASCE.
3. Hamed Alikhani, S.-0.-2.-2. D. (2023). *Sequential Machine Learning for Activity Sequence Prediction from Daily Work Report Data.* ASCE.
4. Mohsen Hatami, S. a. (2022). *Using Deep Learning Artificial Intelligence to Improve Foresight Method in the Optimization of Planning and Scheduling of Construction Processes.* ASCE.
5. Y. N., W. L., K. C., G. G., & a. C. (2015). Smart Construction Objects. *Journal of Computing in Civil Engineering*, 54.
6. A,. A. (2025). *Augmented Reality-based construction site management using optimized BIM and project schedule integration.* Science Direct.
7. A, N. (2024). *Applied artificial intelligence for predicting construction projects delay.* Science Direct.
8. A, R. (2024). *Research on Software Project Schedule Planning Technology Based on the Integration of PERT and CPM.* Science direct.
9. Aishwarya Thorat1*, K. U. (2024). AI-Driven Optimization of Construction Project Scheduling: Machine Learning Approaches. *Journal of Emerging Technologies and Innovative Research (JETIR)*, Nashik.
10. Albert Y. Chen, A. S.-T. (2024). *Systemwide Planning with a Branch-and-Price Algorithm for Pavement-Marking Assessment Data Collection via the Mobile Retroreflectivity Unit Routing Model.* ASCE.
11. Anu Pradhan, A., & and Burcu Akinci, A. (2012). *Planning-Based Approach for Fusing Data from Multiple.* ASCE.
12. Anu Pradhan, B. A. (2011). Planning-Based Approach for Fusing Data from Multiple Sources for Construction Productivity Monitoring. *Journal of Computing in Civil Engineering*, 50.
13. Authors: Jeonghoon Lee, A. a. (2018). *Multiple Modular Building Construction Project Scheduling Using Genetic Algorithms.* ASCE.
14. Bahroun Z., T. M. (2023). *Artificial Intelligence Applications in Project Scheduling: A Systematic Review, Bibliometric Analysis, and Prospects for Future Research.* Science direct.
15. Bello, S. A.-L. (2025). *Cloud computing for chatbot in the construction industry: An implementation framework for conversational-BIM voice assistant.* Science Direct.
16. Chan HeO, M. P. (2024). *Potential AI-Driven Algorithmic Collusion and Influential Factors in Construction Bidding.* ASCE.

DOI: 10.17492/JPI/NICMAR/260524 ISBN: 978-93-49790-68-1

17. Cheng, M.-Y. (2025). *Hybrid deep learning model for accurate cost and schedule estimation in construction projects using sequential and non-sequential data.* Science Direct.
18. Daniel M. Hall a, I. (2022). *Teaching generative construction scheduling: Proposed curriculum design and analysis of student learning for the Tri-Constraint Method.* Science Direct.
19. Egbedion, G. (2024). *Examining the Security of Artificial Intelligence in Project Management: A Case Study of AI-driven Project Scheduling and Resource Allocation in Information Systems Projects.* ASCE.
20. fahihi, V. (2014). *Automation of construction scheduling : a review of a literature.* ASCE.
21. Fareed Salih, I. H.-a. (2024). *Quantifying the Impact of Technology Utilization on Schedule and Cost Performance in Construction Projects.* ASCE.
22. Golparvar-Fard, F. A. (2023). *Construction schedule augmentation with implicit dependency constraints and automated generation of lookahead plan revisions.* science direct.
23. Golparvar-Fard, F. A. (2023). *Construction schedule augmentation with implicit dependency constraints and automated generation of lookahead plan revisions.* Science Direct.
24. Gosal, M.-Y. C.-T. (2025). *Hybrid deep learning model for accurate cost and schedule estimation in construction projects using sequential and non-sequential data.* Science Direct.
25. Hou, Q. L. (2024). *Classification and application of deep learning in construction engineering and management – A systematic literature review and future innovations.* Science Direct.
26. Kar, S. D. (2024). *Artificial intelligence and machine learning applications in the project lifecycle of the construction industry: A comprehensive review.* Science Direct.
27. Li, M. R. (2022). *Opportunities and Adoption Challenges of AI in the Construction Industry: A PRISMA Review.* Scence direct.
28. Mingshu Li, S., Qiu Zheng, P. M., & and Baabak Ashuri, M. (2024). *Application of Artificial Intelligence in Design Automation: A Two-Stage Framework for Structure Configuration and Design.* ASCE.
29. Mølle, G. M. (2024). *Digital Twin-based Demand-Driven Production Planning and Scheduling System: A New Conceptual Framework.* SCIENCE DIRECT.
30. Ngo, A. P. (2022). *Production scheduling in modular construction: Metaheuristics and future directions.* Science Direct.
31. Niu, Y., & Weisheng Lu, K. C. (2015). *Smart Construction Objects.* ASCE.
32. RANGA, M. (2025). *AI IN ARTEKS.* HYEDESATSJK: PEAROSN.

DOI: 10.17492/JPI/NICMAR/260524 ISBN: 978-93-49790-68-1

33. Ruchit Parekh 1, *. a. (2024). Incorporating AI into Construction Management: Enhancing Project Planning and Scheduling. *International Journal of Scientific Research and Applications*.
34. Sarra dahmani, A. J. (2011). *Resilient Project Scheduling Using Artificial Intelligence: A Conceptual Framework.*
35. Siddharth Banerjee, P. A., Colin M. Potts, P., & Arnav H. Jhala, P. a. (2023). *Developing a Construction Domain–Specific Artificial Intelligence Language Model for NCDOT's CLEAR Program to Promote Organizational Innovation and Institutional Knowledge.* ASCE.
36. Siddharth Banerjee, P. A., Colin M. Potts, P., Arnav H. Jhala, P., & and Edward J. Jaselskis, P. P. (2023). *Developing a Construction Domain–Specific Artificial Intelligence Language Model for NCDOT'sCLEAR Program to Promote OrganizationalInnovation and Institutional Knowledge.* ASCE.
37. Syeda Marzia, A.-S. (2023). *Automated process planning and dynamic scheduling for smart manufacturing: A systematic literature review.* SCIENCE DIRECT.
38. Tarek Hegazy a, E. (2022). *Schedule optimization for scattered repetitive projects.* Science Direct.
39. Teo, M. R. (2024). *Artificial intelligence and sustainable development goals: Systematic literature review of the construction industry.* Science Direct.
40. Tony Wauters, K. V. (2015). *A learning-based optimization approach to multi-project scheduling.*
41. Tsiutsiura, K. K. (2021). *Implementation of artificial intelligence in the construction industry and analysis of existing technologies.* Science Direct.
42. Weiße, O. R.-A. (2024). *Evaluating early predictive performance of machine learning approaches for engineering change schedule – A case study using predictive process monitoring techniques.* SCIENCE DIRECT.
43. Ying Hong a, H. (2022). *A graph-based approach for unpacking construction sequence analysis to evaluate schedules.* Science Direct.
44. Yongchang Rena, (2023). *Research on Software Project Schedule Planning Technology .* china: Science Direct.
45. Zhu1, H., Bon-Gang Hwang, M., Ngo3, J., & Tan4, a. J. (2022). *Applications of Smart Technologies in Construction Project Management.* ASCE.

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