Mapping Technological Frontiers in Construction Planning and Scheduling: A Bibliometric Review (2015-2025)

Mohd Haykal Adli Abdul Rahman*[1], Nurshikin Mohamad Shukery[1], Abdul Rashid Zailan[2], Muhamad Norfiqiri Hamid[3]

[1]Department of Quantity Surveying, Faculty of Built Environment and Surveying, Universiti Teknologi Malaysia

[2]Department of Student Affairs, UTMSPACE

[3]Department of Real Estate, Faculty of Built Environment and Surveying, Universiti Teknologi Malaysia

DOI: https://doi.org/10.47772/IJRISS.2026.100300088

Received: 07 March 2026; Accepted: 12 March 2026; Published: 26 March 2026

ABSTRACT

Construction planning and scheduling remain critical processes in project management, yet projects frequently experiences delay due to complex coordination, resource constraints, and dynamic project nature. While research into digital technologies to improve scheduling practices has increased steadily, systematic studies on the evolution of these solutions within the broader academic discourse of planning and scheduling remain limited. This study aims to map the development of technological solutions to construction planning and scheduling challenges through a bibliometric analysis of academic literature published between 2015 and 2025. Scopus databases were selected resulting in 359 peer-reviewed journal articles. Keyword co-occurrence analysis was conducted using VOS viewer to identify thematic relationships and research trends. The analysis revealed five major research themes: (1) optimization-based scheduling, (2) BIM and information integration, (3) operational construction management, (4) decision support and economic evaluation, and (5) artificial intelligence (AI) technologies. Results indicate that optimization algorithms remain backbone for methodological approach in addressing scheduling challenges, while BIM is the hub for digital platform in data integration and coordination. Emerging AI and machine learning themes currently augment predictive capabilities rather than replacing established scheduling methods. Overall, the finding demonstrates gradual shift in construction scheduling research from managerial-centric approaches towards computational aided optimization and digital planning environments. This study provides a structured overview of technological evolution in construction planning and scheduling domain.

Keywords: Construction planning and scheduling; BIM; Optimization; Artificial Intelligence; Bibliometric review

INTRODUCTION

Planning and scheduling are an integral part of project management in ensuring a successful project delivery in construction industry. It facilitates coordination of activities, resource allocation, risk management, and the establishment of baseline to monitor and control project progress (Hinze, 2020). It is a process that includes the definition of Work Breakdown Structure (WBS), activity sequencing, and duration estimation where project teams are able to organize complex project into a coherent plan (Brown et al., 2020; Kerzner, 2017). A construction schedule serves as a communication and coordination tools across stakeholders to understand how project will be executed in allocated time, cost, and standard quality (Basu, 2014). Effective scheduling therefore provides the basis for decision making related to resource allocation, productivity management, and project performance monitor.

However, lack of proper planning and scheduling remained a prominent challenge as discussed in academic discourse around the globe (Arantes & Ferreira, 2020; Sanni-Anibire et al., 2022; Yap et al., 2021). These challenges commonly stem from the inherent nature of construction projects, which is dynamic and uncertain,

leading complex interaction between resource availability, environmental condition, and coordination among stakeholders (Aziz et al., 2019; Baldwin & Bordoli, 2014). These complexities often lead to inaccurate schedule, inefficient resource allocation, and project delays. Developing reliable schedule requires professional with significant experience and domain knowledge to interpret project constraints and translate them into logical plans (Al Nasseri & Aulin, 2016). This issue was exacerbated by the heavily dependent of traditional scheduling methodologies such as Critical Path Method (CPM) and the Program Evaluation and Review Technique (PERT) which unable to capture the dynamic condition of real-world construction project.

Recently, growing interest in literature incorporating various digital technologies to improve traditional construction planning and scheduling mostly on exploration of optimization algorithm (Chen et al., 2024; Wang et al., 2020; Yin et al., 2024), Building Information Modelling (BIM) (Ke et al., 2023; León-Romero et al., 2024; Wefki et al., 2024) and recent buzz of Artificial Intelligence (AI) (Regona et al., 2023) to address scheduling uncertainties, complex coordination, and resource constraints. While previous studies often examine individual technologies such as optimization algorithms, BIM, or AI to improve scheduling performance, limited attention given to understand how these technological approaches evolve within the broader construction planning and scheduling research landscape. It remains unclear how technologies are positioned in relation to traditional scheduling and how research themes have developed over time in response to these issues. Thus, this paper aims to map the evolution of research themes in construction planning and scheduling literature between 2015 and 2025 using bibliometric analysis. By analysing keyword co-occurrence pattern and thematic relationship within literature, this study identifies dominant research cluster and examines how digital and computational technologies have been positioned within the construction scheduling research in the past decade.

METHODOLOGY

This study adopts a structured bibliometric approach to examine the evolution of research themes in construction planning and scheduling literature. The methodology consists of source selection, data collection, data screening and cleaning, and network visualization techniques using VOS Viewer software. To ensure transparency and structured selection process, this study adopted a screening protocol guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework to ensure a transparent and structured literature selection process. The PRISMA approach provides a systematic procedure for identifying, screening, and selecting relevant publication from academic databases (Page et al., 2021).

Data Source and Search Strategy

Bibliographic data were collected from the Scopus database, which is widely used in bibliometric studies due to its comprehensive coverage of peer-reviewed publications. Scopus was selected to maintain consistency of indexed construction management literature. The search query was designed to capture literature discussing challenges, constraints, and barriers related to construction planning and scheduling. Although such query focuses on challenges, many studies discuss these issues alongside technological or methodological solutions, which is reflected in the keyword network structure. A search conducted on 4th March 2026, resulting in 359 peer-reviewed journal articles published between the year 2015 and 2025. Inclusion criteria of journal article written in English were included to ensure quality and consistency in datasets. Furthermore, only papers specifically related construction planning and scheduling are selected, and non-related topics are omitted to ensure a focused review. The search query protocol is summarized in *Table 1*

Table 1 Search Query Protocol

Database	Scopus
Search String	TITLE-ABS-KEY ((“construction planning" OR "construction scheduling") AND (challenge* OR barrier* OR constraint* OR limitation* OR problem*)) AND PUBYEAR > 2014 AND PUBYEAR < 2026 AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English"))
Date Retrieved	4 March 2026

Time Range	2015-2025
Inclusion Criteria	English only, Article only
Retrieved Article	359 documents found

Bibliometric Mapping and Analysis

Next, bibliometric mapping was conducted using VOS Viewer version 1.6.20. A bibliometric mapping is a visualization tools commonly employed to analyse relationship between research topics through network structures. This software enables clustering, network visualization, and overlay analysis of keyword relationship. In this study, all keywords were used to construct the co-occurrence network. Co-occurrence analysis allows the identification of thematic relationships among research topics by examining how frequently keywords appear together within literature. Bibliometric datasets commonly contain large number of keywords with very low occurrences which may produce a denser and noisy network. To ensure thematic significance and network clarity, a minimum occurrence threshold of (7) seven keywords was established. This threshold was selected after iterative testing to eliminate semantic noise while retaining significant clusters that represent established research trend.

During verification process of keywords, several generic keywords were removed such as “construction planning”, “construction scheduling” and “construction project” due to search query used to define dataset. Keywords such as “case study”, “articles”, “human”, “bridges”, “costs”, “semi-structured interviews”, “students”, “China”, and “surveys” were also removed. This is because, it does not represent specific research theme and through removal of this high frequency domain descriptor, a clearer thematic structure can prevail. The resulting network visualization was then analysed to identify major research clusters in domain of construction planning and scheduling research. In addition, overlay visualization was used to examine the temporal development of research theme based on the average publication year of keywords.

RESULT

The network visualization applying co-occurrence analysis with minimum threshold of (7) seven occurrences generated a network consisting of 41 keywords grouped into five major thematic cluster using the VOS viewer clustering algorithm (Figure 1). As mentioned previously, keywords on construction planning and scheduling were excluded to distinguish clear clusters of how scheduling challenges is being addressed. Generally, the emerging clusters illustrate how traditional scheduling methods have progressively being incorporated with digital technologies, optimization, and intelligent decision support system backed with “Building Information Modelling (BIM)” and “optimization” keyword occupying the central position as most prominent suggesting BIM as hub and optimization as integrative role within this academic discourse.

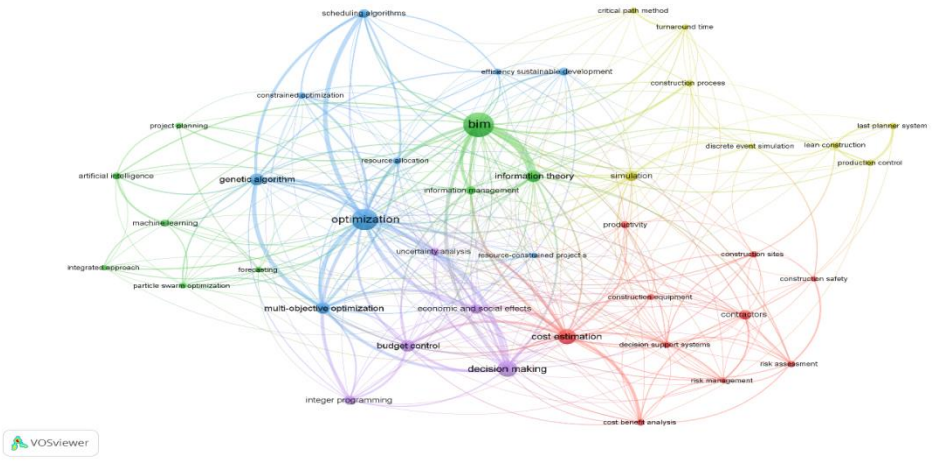

Figure 1 Keyword co-occurrences of network visualization for construction planning and scheduling research with minimum occurrence = 7

Optimization-based Scheduling

The most prominent and dense cluster is centred around "optimization" functions as its central node. It shows strong co-occurrence relationships with several metaheuristic approaches such as genetic algorithms (GA), multi-objective optimization, constrained optimization, scheduling algorithms, and resource allocation. This suggest that significant computational paradigm in contemporary planning and scheduling academic discourse. These terms indicate substantial portion of literature on solving Resource-Constrained Project Scheduling Problem (RCPSP). The high density of links between "genetic algorithm" and "optimization" suggest that scheduling problem is being treated as models and usage of meta-heuristic optimization techniques to solve it complex project trade-off. The maturity of this research stream suggesting that optimization algorithms is a computational backbone to address construction scheduling problems rather than changes in scheduling logic.

BIM and Information Integration

This cluster represents the digitalization of digital information infrastructure to support construction planning and scheduling and dominated by the keyword Building Information Modelling (BIM). The central node of BIM is strongly associated especially with information management, information theory, and project planning. BIM also appears as high-degree node within the network with strong connection with optimization-related keywords particularly with resource allocation and scheduling algorithms. However, weaker connections between BIM and operational-site level keywords suggest that BIM primarily functions as coordination and information integration platforms rather than addressing scheduling uncertainties. The presence of "information theory" also suggest a shift from data storage to data management. The network structure confirm that BIM do not replace traditional scheduling logic but supported a multidimensional environment to facilitate visualization among stakeholders.

Operational Construction Management

This cluster focuses on operational level challenges in construction projects. Prominent keywords within this cluster include simulation, construction safety, contractors, productivity, risk management, and risk assessment. These terms practically reflect on the conditions encountered during construction stages of project implementation where planned schedules must adapt to dynamic site conditions. The proximity of simulation and risk-related keyword suggest that simulation techniques are used to visualize operational uncertainty and evaluate alternative scheduling scenarios. It represents improvements of construction scheduling reliability through understanding of dynamic site conditions.

Decision Support and Economic Evaluation

This cluster connects decision making processes and economic considerations within project planning and scheduling. The key core keywords of "decision making", "cost estimation", and "budget control" are closely related with connections to economic and social effects, and integer programming. These concepts indicate that scheduling research incorporates economic considerations and decision-support framework when evaluating project strategies. Within this cluster, centrality of "decision making" nodes linked with cost-related variables with technical planning variables suggest on the role of scheduling as both technical and managerial processes that balance time, cost, and resource constraints.

Artificial Intelligence (AI) Technologies

The last cluster represents emergence of predictive technologies in construction planning and scheduling. Keywords within this cluster include artificial intelligence (AI), machine learning, forecasting, and integrated approach. In contrast with optimization cluster, these keywords appear with lower occurrence frequencies with relatively fewer connection between overall networks. The positioning of this cluster on the outskirts of network suggests that AI-related keywords show strong connection with forecasting and machine learning. The keyword appear with lower occurrences and fewer connections compared with optimization and BIM themes suggesting a developing research direction., it remains structurally less integrated with traditional scheduling methods such as BIM and optimization as Figure 2.

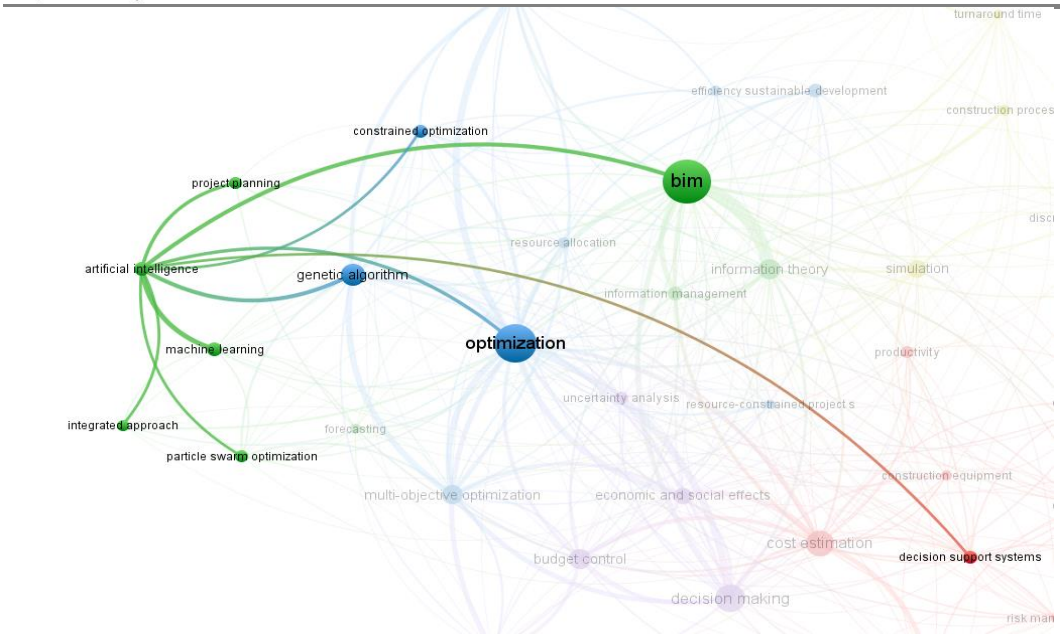

Figure 2 AI theme as illustrated in VOS Viewer

Overall, the network structure indicates that optimization and BIM form the central themes within construction planning and scheduling academic discourse. These topics show the strongest connections across multiple clusters. This suggests that it is the most established approaches used to address planning and scheduling challenges. In contrast, AI and predictive technologies related themes appear less connected, indicating it as an emerging topic within the field. Although the research query focuses on challenges in constructing planning and scheduling, but the result shows that substantial literature respond to these challenges through technological and methodological solutions such as optimization techniques, integration of BIM, and emerging AI-based technologies. The summary of identified research themes in construction planning and scheduling is summarized in Table 2.

Table 2 Summary of thematic clusters identified in the keyword co-occurrence network

Cluster (Theme)	Density Level	Keywords	Research Interpretation
Cluster 1Optimization-based Scheduling	*High*	*Optimization, GA, Multi-objective Optimization, Constrained Optimization, Resource Allocation*	*Focus on computational techniques to solve scheduling problems and improve trade-off*
Cluster 2 BIM and Information Integration	*Medium*	*BIM, Information Management, Information Theory, Project Planning*	*Use of BIM to integrate project data and support planning and coordination*
Cluster 3 Operational Construction Management	*Medium*	*Simulation, Construction Safety, Contractors, Productivity, Risk Assessment*	*Address operational uncertainty and risk affecting project schedule*
Cluster 4 Decision Support and Economic Evaluation	*Medium*	*Decision Making, Cost Estimation, Budget Control, Decision Support System*	*Linking scheduling decision with project management and cost control*
Cluster 5 Artificial Intelligence (AI) Technologies	*Low*	*Artificial Intelligence, Machine Learning, Forecasting, Integrated Approach*	*Emergence of data driven approaches for predictive scheduling and automated planning*

Overlay Visualization Interpretation

The overlay visualization in Figure 3 illustrates the temporal development of research themes in construction planning and scheduling between 2015 and 2025. Earlier research, represented by blue tones focuses on traditional scheduling practices such as critical path method (CPM), risk management, contractors, and construction process reflecting fundamentals site planning concerns. Themes appearing in green spectrum represent the middle phase of research development where studies increasingly emphasized computational approaches and digital integration through keywords such as optimization, genetic algorithms, resource allocation, and BIM. Recent topics in yellow tones include scheduling algorithms, efficiency, and sustainable development indicates growing attention towards enhancing schedule performance. Overall, the visualization suggest that construction planning and scheduling research gradually evolved from traditional-managerial methods towards integration of computational optimization and digital transformation. While AI have made appearances, but the network structure suggests that the technology remains as complementary analytical tool. In comparison, optimization-based method remains the dominant focus in this discourse.

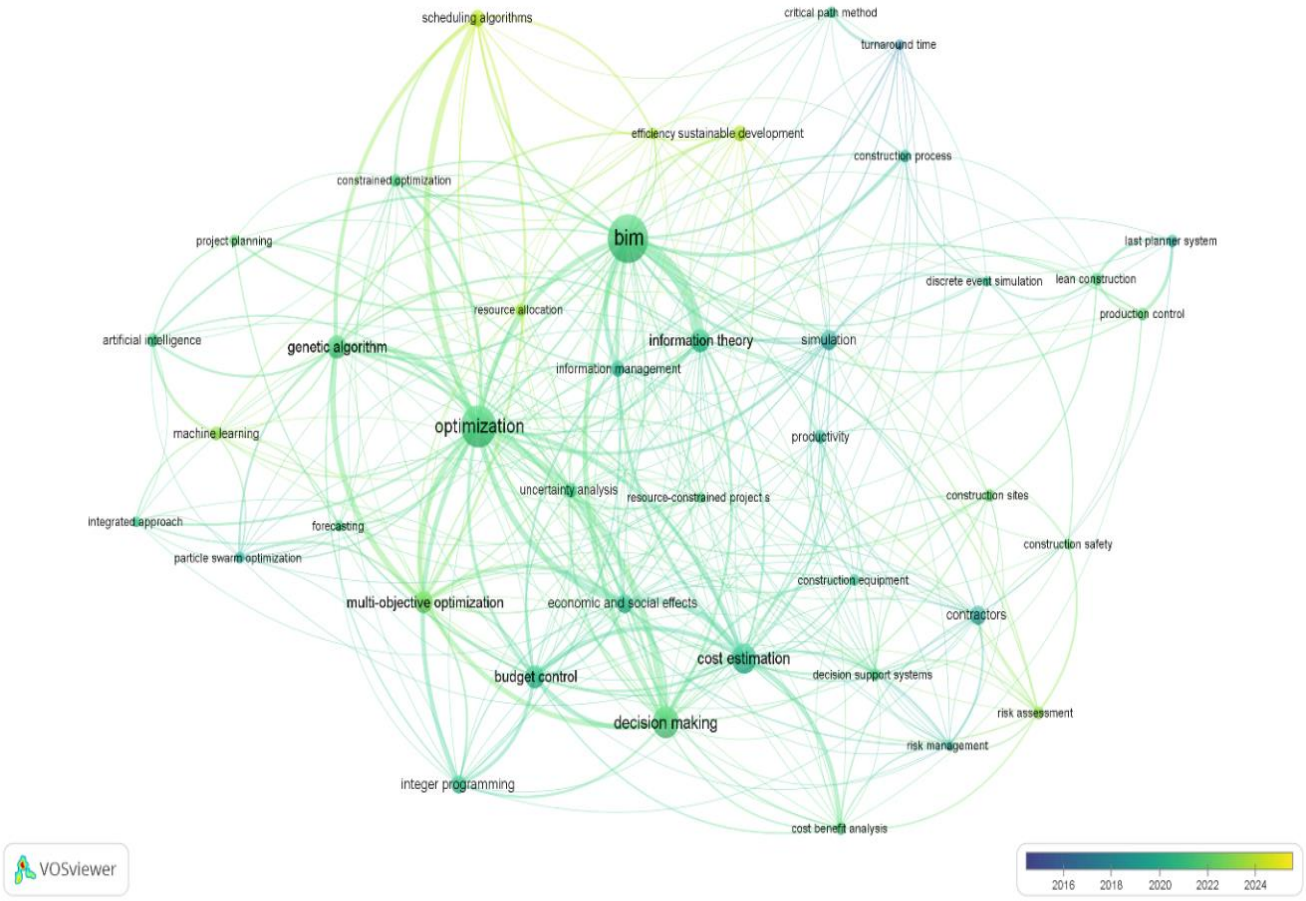

Figure 3 Overlay Visualization of keyword co-occurrence showing temporal evolution of research themes in construction planning and scheduling (2015-2025)

DISCUSSION

The findings of this bibliometric analysis provide insights into the evolution of construction planning and scheduling research. While the search query specifically targeted literature addressing challenges, barriers, and constraints. The identified clusters can therefore be interpreted as technological and methodological response developed by researchers to address recurring challenges. Generally, academic discourse predominantly focused on technological and methodological interventions as resolution mechanisms. This suggests a paradigm shift from descriptive problem identification towards a solution-oriented landscape dominated by computational and digital tools.

The Dominance of Algorithmic Optimization as a Problem Solver

The strong density and central position of Cluster 1 indicated algorithmic optimization remains the most established response towards scheduling constraints. Keywords such as resource allocation, genetic algorithm frequently appear together suggesting that scheduling challenges are treated as computational trade-off problems involving time, cost, and resources. These problems are widely recognized as variants of the resource constrained project scheduling problem (RCPSP). The maturity of this research stream suggesting that optimization algorithms is a computational backbone in scheduling research. Over the past decade, these techniques have been widely used as analytical tools for improving scheduling efficiency and managing complex resource constraints such as for tunnel construction and optimization of schedules trade-off (Alzara et al., 2023; Wei et al., 2024). It furthers affirm that algorithms serve as primary academic responses to the inherent complexity of construction scheduling problems.

BIM as Digital Information Platform

Next, the nearly centralized position of BIM in the network underscores its transition from a static 3D visualization tool to a digital information infrastructure to support construction planning and scheduling research. Unlike traditional CPM methods, BIM-integrated environment facilitates multi-dimensional environment to support communication and coordination among stakeholders. However, the structure also indicates that BIM are leaning towards planning coordination and data exchange rather than construction-stage issues. This affirms that in past decade, BIM has primarily been positioned as digital coordination platform for planning and design integration rather than direct solution to scheduling uncertainties. The emergence of this concept indicates growing interest in improving data interoperability and reducing fragmentation of data within construction projects.

The emerging role of Artificial Intelligence (AI)

Another significant finding is the relatively limited integration of AI within the academic research of planning and scheduling. Although keywords related to AI appears, they remain less connected compared with more mature theme such as optimization and BIM. This portrays that AI functions as a supporting analytical layer, adopted for predictive task such as delay forecasting and recovery (AlJassmi et al., 2023), performance predictions (Amer, Jung, et al., 2021; Hong et al., 2022), and schedule development support (Amer, Koh, et al., 2021; Amer & Golparvar-Fard, 2019). Rather than replacing traditional scheduling models, AI techniques are adopted to complement existing practices by introducing predictive capabilities and enabling adaptive planning strategies across stakeholders.

The relatively weaker connection between AI and BIM-related keywords also suggests that the integration between optimization algorithms and digital project environments remains limited in current academic discourse. This indicates a potential research direction where AI-drive analytics could be more closely integrated with BIM-based information environments to support automated planning processes as recently introduced by Al-Sinan et al., (2024).

Technological Evolution of Planning and Scheduling Research

In temporal evolution of research themes between 2015 and 2025 signifies a clear transition from traditional project management towards digitally driven paradigm. While earlier studies focused on fundamental methods like the Critical Path Method (CPM), the landscape progressively shifted towards computational optimization, evolutionary optimizations, and BIM integration. Recent trend emphasized on predictive capabilities and broader performance metrics such as sustainability, indicating the field has gradually emerged into computationally integrated ecosystems. Rather than replacing established scheduling methodologies, emerging technologies appear to complement existing optimization frameworks through improvement of information flow, predictive capability, and data-driven planning approaches.

Practical Implications for Practitioners

From an academic perspective, these findings highlight a significant shift from manual scheduling towards technology-integrated practice. Within the industry, it is increasingly evident that BIM, AI, and optimization algorithm are slowly gaining its traction within scheduling research. This suggests that construction industry stakeholders should leverage disruptive technology such as 4D-BIM simulations not merely for visualization, but as a dynamic data environment that support automated scheduling. Furthermore, the maturity of optimization algorithms provides a strong support for automated resource levelling during planning and scheduling stages which can significantly reduce the time spent on re-scheduling. Finally, the emergence of AI-driven forecasting offers a robust mechanism for proactive risk mitigation. This enables project managers to predict delays based on historical data patterns rather that relying on site reporting and past experiences.

CONCLUSIONS

This study mapped the evolution of research themes in construction planning and scheduling literature between 2015 and 2025 using bibliometric analysis. By analysing keyword co-occurrence patterns, the study has identified five major research themes: 1) optimization-based scheduling, 2) BIM and Information Integration, 3) Operational Construction Management, 4) Decision Support and Economic Evaluation, 5) Artificial Intelligence (AI) Technologies. The findings indicate that algorithms optimization remains a dominant methodological approach used to address scheduling challenges, while BIM maintain its status quo as digital coordination platforms for planning and scheduling. Although AI and machine learning (ML) begun to appear in recent studies, they play as supporting role rather than replacing established optimizations-based scheduling method and traditional scheduling.

Future research should explore on the convergence of Generative AI for automated scheduling, specifically regarding how Natural Language Processing (NLP) can interpret unstructured site reports to support automated scheduling. Furthermore, research into human-centred AI (HCAI) is essential to promote reliable, safe, and trustworthy application of these technologies. Transitioning from predictive analytics to prescriptive, self-recovery scheduling represent the next evolutionary phase in construction planning and scheduling.

Overall, the networks show that research in construction planning and scheduling evolved from focal of managerial-based scheduling towards digitally backed planning approaches. These findings highlight the increasing role of technologies in improving planning efficiency and suggest opportunities for future research to further integrate predictive analytics with digital construction environments in real-world applications.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the financial support provided by UTMSPACE Research Grant Potential Development Grant Vote No: SP-PDF2516. This support was essential for the successful completion of this research.

REFERENCES

1. Al-Sinan, M. A., Bubshait, A. A., & Aljaroudi, Z. (2024). Generation of Construction Scheduling through Machine Learning and BIM: A Blueprint. Buildings, 14(4). https://doi.org/10.3390/buildings14040934
2. Al Nasseri, H., & Aulin, R. (2016). Enablers and barriers to project planning and scheduling based on construction projects in Oman. Journal of Construction in Developing Countries, 21(2), 1–20. https://doi.org/10.21315/jcdc2016.21.2.1
3. AlJassmi, H., Abduljalil, Y., & Philip, B. (2023). Towards self-recovering construction schedules: a new method for periodically updating project plans and optimizing recovery actions. Journal of Asian Architecture and Building Engineering, 22(4), 2335–2347. https://doi.org/10.1080/13467581.2022.2153055
4. Alzara, M., Attia, Y. A., Mahfouz, S. Y., Yosri, A. M., & Ehab, A. (2023). Building a Genetic Algorithm-Based and BIM-Based 5D Time and Cost Optimization Model. IEEE Access, 11, 122502–122515. https://doi.org/10.1109/ACCESS.2023.3317137

5. Amer, F., & Golparvar-Fard, M. (2019). Automatic Understanding of Construction Schedules: Part-of-Activity Tagging. Proceedings of the 2019 European Conference on Computing in Construction, 1, 190–197. https://doi.org/10.35490/ec3.2019.196
6. Amer, F., Jung, Y., & Golparvar-Fard, M. (2021). Transformer machine learning language model for auto-alignment of long-term and short-term plans in construction. Automation in Construction, 132, 103929. https://doi.org/10.1016/j.autcon.2021.103929
7. Amer, F., Koh, H. Y., & Golparvar-Fard, M. (2021). Automated Methods and Systems for Construction Planning and Scheduling: Critical Review of Three Decades of Research. Journal of Construction Engineering and Management, 147(7). https://doi.org/10.1061/(asce)co.1943-7862.0002093
8. Arantes, A., & Ferreira, L. M. D. F. (2020). Underlying causes and mitigation measures of delays in construction projects: An empirical study. Journal of Financial Management of Property and Construction, 25(2), 165–181. https://doi.org/10.1108/JFMPC-03-2019-0029
9. Aziz, N. M., Mohd-Rahim, F. A., Chuing, L. S., & Le, E. W. (2019). Identification of project scheduling constraints using the quantitative approach. International Journal of Recent Technology and Engineering, 8(1), 374–381.
10. Baldwin, A., & Bordoli, D. (2014). Handbook for Construction Planning and Scheduling. In Handbook for Construction Planning and Scheduling. https://doi.org/10.1002/9781118838167
11. Basu, R. (2014). Managing quality in projects: An empirical study. International Journal of Project Management, 32(1), 178–187. https://doi.org/10.1016/j.ijproman.2013.02.003
12. Brown, R. B., Dysert, L. R., Orr, J. P., Shakourifar, A., & Warhoe, S. P. (2020, August 13). AACEI recommended practice No. 91R-16: Schedule development. AACE International. https://web.aacei.org/docs/default-source/toc/toc_91r-16.pdf
13. Chen, Z., Wang, H., Wang, B., Yang, L., Song, C., Zhang, X., Lin, F., & Cheng, J. C. P. (2024). Scheduling optimization of electric ready mixed concrete vehicles using an improved model-based reinforcement learning. Automation in Construction, 160(January), 105308. https://doi.org/10.1016/j.autcon.2024.105308
14. Hinze, J. W. (2020). Construction Planning and Scheduling. In The Civil Engineering Handbook. https://doi.org/10.1201/9781420041217-5
15. Hong, Y., Xie, H., Bhumbra, G., & Brilakis, I. (2022). Improving the accuracy of schedule information communication between humans and data. Advanced Engineering Informatics, 53, 101645. https://doi.org/10.1016/j.aei.2022.101645
16. Ke, Y., Zhang, J., & Philbin, S. P. (2023). Tradition and Innovation in Construction Project Management. Buildings, 13(6), 1537. https://doi.org/10.3390/buildings13061537
17. Kerzner, H. (2017). Project management : a systems approach to planning, scheduling, and controlling. In John Wiley & Sons, Inc (12th ed., Issue 12). John Wiley & Sons, Inc. https://doi.org/2016045434
18. León-Romero, L. P., Aguilar-Fernández, M., Luque-Sendra, A., Zamora-Polo, F., & Francisco-Márquez, M. (2024). Characterization of the information system integrated to the construction project management systems. Heliyon. https://doi.org/10.1016/j.heliyon.2024.e31886
19. Page, M. J., Mckenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-wilson, E., Mcdonald, S., … Moher, D. (2021). The PRISMA 2020 statement : an updated guideline for reporting systematic reviews Systematic reviews and Meta-Analyses. https://doi.org/10.1136/bmj.n71
20. Regona, M., Yigitcanlar, T., Hon, C. K. H., & Teo, M. (2023). Mapping Two Decades of AI in Construction Research: A Scientometric Analysis from the Sustainability and Construction Phases Lenses. Buildings, 13(9). https://doi.org/10.3390/buildings13092346
21. Sanni-Anibire, M. O., Mohamad Zin, R., & Olatunji, S. O. (2022). Causes of delay in the global construction industry: a meta analytical review. International Journal of Construction Management, 22(8), 1395–1407. https://doi.org/10.1080/15623599.2020.1716132
22. Wang, H. W., Lin, J. R., & Zhang, J. P. (2020). Work package-based information modeling for resource-constrained scheduling of construction projects. Automation in Construction, 109. https://doi.org/10.1016/j.autcon.2019.102958
23. Wefki, H., Elnahla, M., & Elbeltagi, E. (2024). BIM-based schedule generation and optimization using genetic algorithms. Automation in Construction, 164(October 2023).

https://doi.org/10.1016/j.autcon.2024.105476

24. Wei, J., Liu, Y., Lu, X., Feng, Y., & Wang, Y. (2024). applied sciences Optimization of Tunnel Construction Schedule Considering Soft Logic.
25. Yap, J. B. H., Goay, P. L., Woon, Y. B., & Skitmore, M. (2021). Revisiting critical delay factors for construction: Analysing projects in Malaysia. Alexandria Engineering Journal, 60(1), 1717–1729. https://doi.org/10.1016/j.aej.2020.11.021
26. Yin, J., Wang, H., Li, J., Zhang, Z., Cai, S., & Liu, W. (2024). Dispatching rule design for tower crane scheduling in prefabricated construction via genetic programming. Automation in Construction, 165, 105588. https://doi.org/10.1016/j.autcon.2024.105588