JACEP

Journal of Applied Civil Engineering and Practices

**Online (e-ISSN)**: e-ISSN 3109-2551 || 2026, Volume 2, No. 1, pp.31-41

# BIM-Enabled Workflow Automation for Construction Productivity in Civil Engineering Projects: A Systematic Review of Applied Evidence

**Fendi Hary Yanto[1,2*], Marseleno Ahmad Syafii[3], Alviano Victor Wicaksana[3]**

[1] Universitas Sebelas Maret, Vocational School, Department of Construction Management, Indonesia
[2] Universitas Sebelas Maret, Vocational School, Appropriate Structure Research Group Department of Construction Management, Indonesia, Indonesia
[3] Universitas Sebelas Maret, Vocational School, Department of Construction Management, Indonesia

*Corresponding Author: fendi@staff.uns.ac.id

**To cite this article:**
Yanto F. H., Syafii M. A. & Wicaksana A. V (2026). BIM-Enabled Workflow Automation for Construction Productivity in Civil Engineering Projects: A Systematic Review of Applied Evidence. *Journal of Applied Civil Engineering and Practice*, 2(1), Pp. 31-41. doi: 10.21831/jacep.v2i1.3092

**To link to this article:**
http://doi.org/10.21831/jacep.v2i1.3092

*Journal of Applied Civil Engineering and Practice* by Department of Applied Civil Engineering, Faculty of Vocational, Universitas Negeri Yogyakarta.

2026, Volume 2, No 1, pp.31-41, e-ISSN 3109-2551

Journal of Applied Civil Engineering and Practice

Journal homepage: https://journal.uny.ac.id/publications/jacep/index

**Research paper**

# BIM-Enabled Workflow Automation for Construction Productivity in Civil Engineering Projects: A Systematic Review of Applied Evidence

**Fendi Hary Yanto[1,2*], Marseleno Ahmad Syafii[3], Alviano Victor Wicaksana[3]**

[1] Universitas Sebelas Maret, Vocational School, Department of Construction Management, Indonesia
[2] Universitas Sebelas Maret, Vocational School, Appropriate Structure Research Group Department of Construction Management, Indonesia, Indonesia
[3] Universitas Sebelas Maret, Vocational School, Department of Construction Management, Indonesia

* Corresponding Author: fendi@staff.uns.ac.id

**ARTICLE INFO**

**Article History:**
Received: May 23, 2026
Accepted: June 8, 2026
Published: June 10, 2026

**Keywords:**
Building Information Modelling, construction productivity, workflow automation, digital construction, construction management

**How To Cite:**
Yanto F. H., Syafii M. A. & Wicaksana A. V (2026). BIM-Enabled Workflow Automation for Construction Productivity in Civil Engineering Projects: A Systematic Review of Applied Evidence. *Journal of Applied Civil Engineering and Practice*, 2(1), Pp. 31-41. doi: 10.21831/jacep.v2i1.3092

## ABSTRACT

**Purpose:** Construction projects still experience productivity losses caused by fragmented data, manual quantity processing, delayed progress reporting, and reactive quality control. This review evaluates how BIM-enabled workflow automation improves construction productivity compared with conventional construction

**Methods/Design:** A systematic literature review was conducted using a PRISMA-informed screening procedure. From 457 Scopus records, 36 studies were selected and synthesized thematically across pre-construction optimization, scheduling and progress monitoring, safety and quality assurance, and lifecycle-oriented digital integration.

**Findings:** The evidence indicates that BIM-enabled workflows improve productivity by automating quantity take-off, cost estimation, schedule visualization, progress tracking, defect detection, and operational feedback. Reported improvements include 33.33% manpower reduction in bar bending schedule preparation, 34.4% scheduling accuracy improvement, and progress detection accuracy of 89.1% in automated monitoring workflows.

**Practical Implication:** The review provides an applied evidence map for construction managers seeking to prioritize BIM automation investments while accounting for interoperability, model quality, and organizational readiness.

# INTRODUCTION

The construction sector remains a major component of infrastructure delivery, but its productivity performance continues to lag behind more digitally mature industries. Fragmented project information, manual work packaging, and delayed feedback loops are repeatedly identified as structural causes of inefficient project delivery and persistent cost or time overruns (Love et al., 2014; Wang et al., 2021; Caglayan & Ozorhon, 2023). Recent advances in computer vision, semantic modeling, and building performance analytics show that productivity improvement in civil engineering increasingly depends on integrated digital workflows rather than isolated software use (Ekanayake et al., 2024; Utkucu & Sacks, 2025).

This issue is highly relevant to applied civil engineering practice because construction management decisions are usually made under constraints of time, cost, quality, safety, and stakeholder coordination. Current JACEP publications have also emphasized applied project control themes, including construction work-progress information systems and productivity analysis in building works, indicating a growing need for evidence-based construction management tools within civil engineering practice (Anwar et al., 2025; Mezaluna & Prihadi, 2025). Building Information Modeling (BIM) has been widely positioned as a digital foundation for addressing such constraints because it links geometric, semantic, and project-management information in a shared model environment (Wen et al., 2021; Zhu et al., 2023).

However, BIM adoption alone does not automatically produce productivity improvement. The literature increasingly distinguishes between basic model use and BIM-enabled automation, where model data are connected to cost databases, construction schedules, sensing devices, artificial intelligence (AI), Internet of Things (IoT), reality capture, or Digital Twin systems (Abdelalim et al., 2025; Ma et al., 2025). This distinction is important because many construction productivity losses originate in repeated data entry, subjective site observation, delayed quantity calculation, manual schedule updating, and reactive defect identification. Automated BIM workflows attempt to reduce these losses by replacing fragmented document-based processes with model-driven and data-informed decision support.

Existing research has produced many studies on BIM benefits, digital construction, and project management technologies, but the applied evidence remains scattered across pre-construction cost planning, scheduling, progress monitoring, safety, quality assurance, and lifecycle operation. Prior reviews and bibliometric studies have mapped the growth of BIM research, yet fewer studies have synthesized the mechanisms through which BIM-enabled automation directly outperforms conventional practices in civil engineering projects (Wen et al., 2021; Caglayan & Ozorhon, 2023; Alshibani et al., 2024). Consequently, practitioners still face uncertainty in deciding which BIM-enabled workflow should be prioritized, what outcomes can realistically be expected, and what constraints must be managed.

The applied contribution of this review is an evidence map that links specific BIM automation mechanisms to measurable productivity outcomes and implementation constraints. This study asks: to what extent and through which mechanisms does BIM-enabled workflow automation improve construction productivity compared with traditional practices? The review focuses on four applied domains: quantity take-off and cost/material optimization, scheduling and progress monitoring, safety and quality assurance, and lifecycle-oriented digital integration. By emphasizing comparative evidence, the review supports construction managers, civil engineering educators, and project organizations in translating digital construction concepts into practical productivity improvement strategies.

## METHODS/DESIGN

This study used a systematic literature review (SLR) to synthesize applied evidence on BIM-enabled workflow automation in construction projects. The review followed PRISMA-informed reporting logic to make the search, screening, eligibility assessment, and inclusion stages transparent and reproducible (Page et al., 2021). An SLR was selected because the evidence base spans multiple civil engineering applications and uses heterogeneous methods, including case studies, simulation, automation frameworks, computer vision, machine learning, and lifecycle performance analysis.

Scopus was used as the primary database because it indexes major peer-reviewed journals in civil engineering, construction management, digital construction, and automation. The search was designed around three conceptual blocks: BIM or Building Information Modeling, traditional or conventional practices, and productivity or efficiency outcomes. The core Boolean query was: ("BIM" OR "Building Information Modeling") AND ("traditional methods" OR "conventional methods" OR "manual") AND (productivity OR efficiency OR automation OR comparison).

**Table 1**. Inclusion and exclusion criteria used for article selection.

| Category | Criterion | Operational definition |
|---|---|---|
| Inclusion | Language and source type | English-language scholarly articles and conference papers with clear methodological contribution. |
| Inclusion | Topical relevance | Studies addressing BIM, BIM-enabled automation, or digitally integrated construction workflows. |
| Inclusion | Comparative basis | Studies comparing BIM-enabled workflows with manual, traditional, conventional, or non-integrated practices. |
| Inclusion | Outcome relevance | Studies reporting productivity-related outcomes such as time, cost, accuracy, safety, quality, or operational performance. |
| Exclusion | Adoption-only focus | Studies discussing only awareness, policy, or barriers without performance evidence. |
| Exclusion | Insufficient evidence | Studies without baseline comparison, extractable findings, or adequate methodological detail. |

The inclusion criteria were English-language scholarly publications; studies published primarily from 2021 onward to capture recent digital construction developments; explicit discussion of BIM, BIM-enabled automation, or digitally integrated workflows; comparison with traditional, manual, conventional, or non-integrated practices; and extractable productivity-related outcomes. Studies were excluded when they focused only on adoption barriers, lacked baseline comparison, were non-scholarly outputs, duplicated another record, or did not provide sufficient detail for synthesis.

The screening process identified 457 records. After title and abstract screening, 174 reports were retained for full-text eligibility assessment. Forty-nine reports were excluded because they were outside the temporal scope, and 89 were excluded because they did not provide direct relevance to the comparative objective or sufficient extractable evidence. The final corpus included 36 studies. Figure 1 summarizes the selection process.

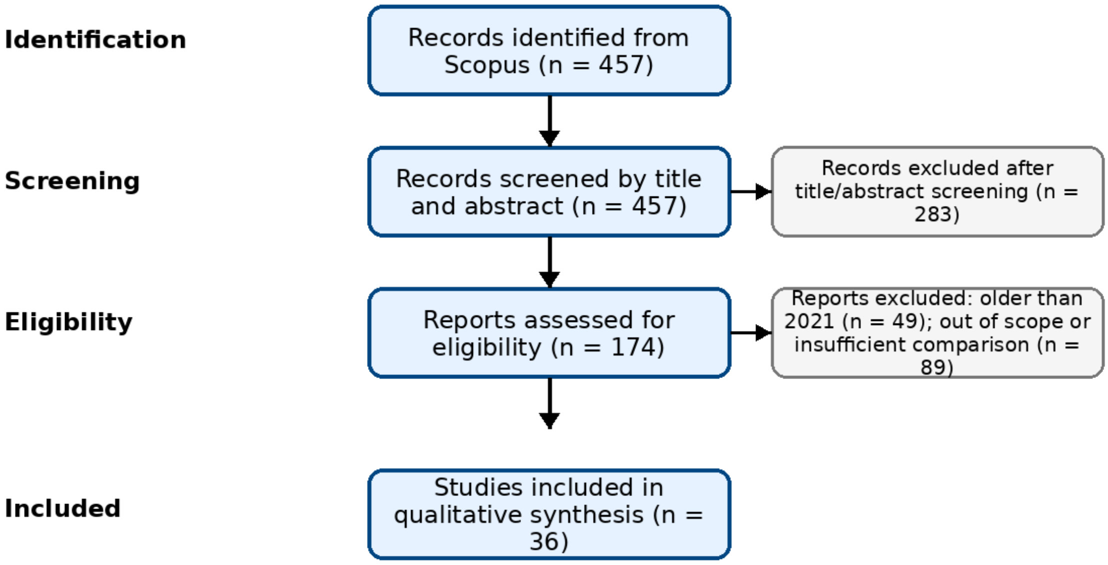

**Figure 1**. PRISMA-informed flow diagram of the identification, screening, eligibility, and inclusion stages.

Data were extracted using a structured matrix covering publication year, application area, BIM-enabled technique, traditional baseline, productivity outcome, and implementation limitation. The synthesis was thematic rather than statistical because the selected studies used different outcome metrics and project contexts. Four themes were developed: pre-construction optimization, scheduling and progress monitoring, safety and quality assurance, and lifecycle-oriented digital integration. The interpretation emphasized recurring mechanisms, measurable outcomes, and constraints relevant to applied construction management.

## FINDINGS

### BIM-enabled pre-construction optimization

The first theme concerns BIM-enabled automation in quantity take-off, cost estimation, and material optimization. Conventional quantity take-off relies on manual interpretation of 2D drawings and separate spreadsheets, which increases the risk of omissions and inconsistent calculations. BIM reduces this risk by linking quantities to object-based model elements and by enabling direct connection between model data, cost databases, and material planning systems (Akanbi & Zhang, 2021; Liu et al., 2022; Valinejadshoubi et al., 2024).

Several studies report measurable improvements. A BIM-based bar bending schedule algorithm reduced manpower demand by 33.33% and achieved a mean absolute percentage error of 1.13% (Khant et al., 2024). Automated quantity take-off systems improved estimation accuracy when models were sufficiently detailed and semantically structured (Liu et al., 2022; Valinejadshoubi et al., 2024). In cost prediction, BIM integrated with neural network approaches achieved strong predictive performance, while semantic enrichment using Industry Foundation Classes improved the usability of BIM data for cost estimation in complex infrastructure contexts (Zhang & Mo, 2024; Zhang et al., 2025).

These findings show that productivity benefits in pre-construction arise from reducing manual measurement, lowering information re-entry, and improving the traceability of design-to-cost assumptions. Nevertheless, the evidence also shows that BIM-based outputs are highly sensitive to model completeness, level of detail, and database integration quality. Case-based applications in cross-drainage works further show that BIM can improve design accuracy when model requirements are aligned with applied engineering tasks (Aranda et al., 2025). Therefore, pre-construction automation should be implemented with explicit model information requirements and validation procedures rather than treated as a direct replacement for professional estimation judgment (Huang & Hsieh, 2020; Yuliana et al., 2025).

**Table 2.** Evidence map of BIM-enabled productivity mechanisms in construction management.

| Domain | Automation mechanism | Reported productivity effect | Representative evidence |
|---|---|---|---|
| Pre-construction | Automated quantity take-off, semantic cost data, model-based material planning | Reduced manual measurement, improved cost reliability, better resource planning | Khant et al. (2024); Valinejadshoubi et al. (2024); Zhang and Mo (2024) |
| Scheduling and progress | 4D BIM, schedule optimization, UAV/laser scanning, computer vision, scan-to-BIM comparison | Improved sequencing, faster reporting, more objective planned-versus-actual control | Gandomkar Armaki et al. (2025); Pal et al. (2025); Tan et al. (2022) |
| Safety and quality | Rule checking, defect detection, AR/VR training, model-based inspection | Earlier detection of hazards and defects, improved repeatability of quality control | Solihin et al. (2024); Mostafa et al. (2023); Ramos-Hurtado et al. (2022) |
| Lifecycle performance | BIM-AI-IoT-Digital Twin integration, energy optimization, predictive maintenance | Improved operational feedback, performance monitoring, and lifecycle decision support | Abdelalim et al. (2025); Ma et al. (2025); Khan et al. (2024) |

### BIM for scheduling and progress monitoring

The second theme concerns scheduling and project execution. Traditional schedule management often relies on isolated Gantt charts, periodic site meetings, and manually updated progress reports. These methods provide limited spatial understanding and delayed feedback, especially when several work packages compete for access, labor, and equipment resources. BIM-enabled 4D scheduling improves this condition by linking construction activities with three-dimensional model elements, making sequencing conflicts and resource constraints more visible (Singh et al., 2021; Perez-Garcia et al., 2023; Castañeda et al., 2025).

Dynamic BIM-driven scheduling under uncertainty improved scheduling accuracy by 34.4% compared with conventional methods (Gandomkar Armaki et al., 2025). Other studies show that BIM-based simulation, process synchronization, and Lean-BIM integration can reduce scheduling burden and improve resource-flow reliability in complex or repetitive construction processes (Yang et al., 2021; Castañeda et al., 2025). These results are particularly relevant to applied civil engineering projects because time management failures often translate directly into labor inefficiency, delayed procurement, and increased indirect costs.

Progress monitoring becomes more powerful when BIM is integrated with field-captured data. UAV imagery, laser scanning, point clouds, and computer vision allow the as-built condition to be compared with the as-planned BIM model, reducing reliance on subjective visual reports (Tan et al., 2022; Meyer et al., 2023; Guerrero-Sevilla et al., 2025). Automated mapping of schedule activities to reality models also supports more objective progress tracking without requiring fully manual 4D model creation (Pal et al., 2025). These approaches improve the timeliness and reliability of project control but remain constrained by image quality, occlusion, registration accuracy, and interoperability between field data and BIM platforms.

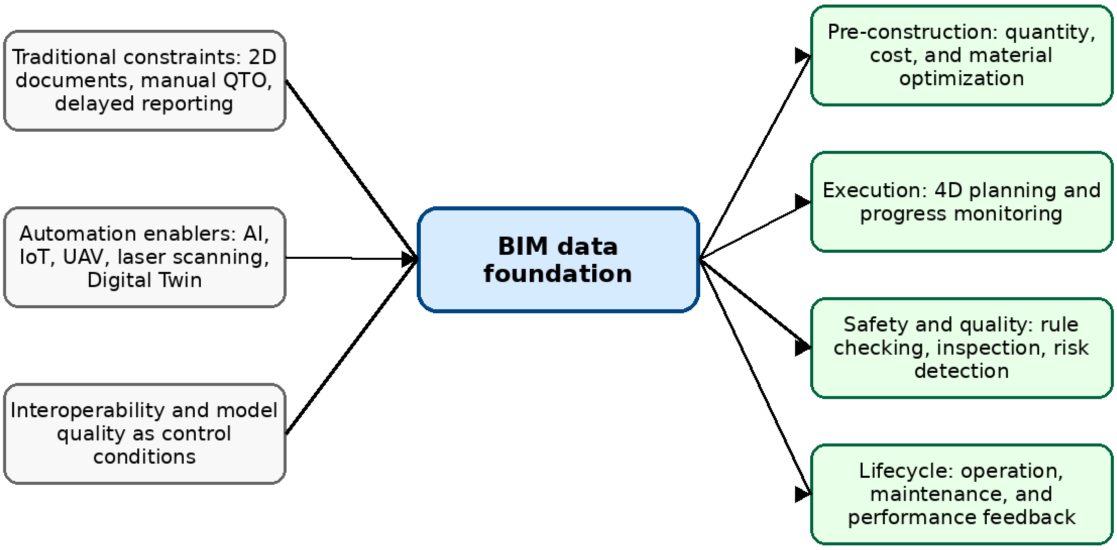

**Figure 2**. Applied framework linking traditional constraints, BIM data foundations, automation enablers, and productivity outcomes.

### BIM for safety, quality assurance, and defect detection

The third theme addresses safety, quality assurance, and defect detection. Traditional construction inspection frequently depends on checklists, human observation, and paper-based documentation. Although professional judgment remains essential, manual inspection is often reactive and may detect defects only after rework has become costly. BIM-enabled workflows can shift inspection toward proactive and repeatable control by connecting model requirements with rule-checking systems, sensing technologies, and visual analytics (Ramos-Hurtado et al., 2022; Solihin et al., 2024).

Computer vision and image analysis provide particularly strong support for automated quality assessment. Defect classification methods have achieved high identification and classification accuracy in built environments, while UAV-to-BIM workflows improve the speed and precision of exterior-wall inspection compared with manual inspection at height (Mostafa et al., 2023; Tan et al., 2022). BIM-supported augmented or virtual environments also improve safety communication because hazards and construction methods can be visualized before site execution (Foroughi Sabzevar et al., 2023; Szostak et al., 2024).

The applied lesson is that BIM improves safety and quality productivity by making requirements explicit, inspection evidence traceable, and deviations easier to communicate. However, implementation requires formalized rules, reliable data capture, and clear responsibility for model updates. If the model is incomplete or if inspection data are not correctly registered to model elements, the accuracy of automated safety and quality decisions can decline. Thus, automation should complement, not replace, qualified inspection and engineering judgment.

### BIM, AI, IoT, and Digital Twin integration for lifecycle performance

The fourth theme extends productivity from project delivery to lifecycle performance. Traditional facility management is commonly reactive, with maintenance decisions made after faults occur and with limited connection to design or construction information. BIM becomes more valuable when it acts as a digital backbone for AI, IoT, and Digital Twin systems that continuously collect, analyze, and return operational data to asset managers (Abdelalim et al., 2025; Ma et al., 2025).

In mega-facility management, AI and Digital Twin integration with BIM and IoT has been reported to reduce maintenance cost by 25% and energy consumption by 20%, with predictive analytics achieving F1 scores above 90% (Abdelalim et al., 2025). BIM-based energy and carbon assessment studies also show that model-linked data can improve early design evaluation, building-performance prediction, and carbon-emission calculation, especially when combined with explainable AI or lifecycle assessment frameworks (Khan et al., 2024; Yang et al., 2024; Moradabadi et al., 2024).

These results indicate a conceptual shift in construction productivity: productivity is no longer limited to the construction stage but extends into operation, maintenance, and performance feedback. Digital Twin workflows can connect reality capture, BIM, and operational scenarios for continuous model refinement and resilience analysis (Reynoso Vanderhorst et al., 2024). Nevertheless, lifecycle integration remains difficult because it depends on data governance, semantic interoperability, sensor reliability, and long-term organizational commitment (Costa & Sicilia, 2020; Quek et al., 2024; Utkucu & Sacks, 2025).

**Table 3.** Implementation constraints and applied implications for BIM-enabled workflow automation.

| Constraint | Effect on productivity gains | Applied implication |
|---|---|---|
| Interoperability | Data exchange failures create rework and manual re-entry, reducing the value of automation. | Use open standards, clear information requirements, and tested data-exchange protocols. |
| Model quality | Incomplete geometry or weak semantic structure reduces the reliability of automated quantities, schedules, or checks. | Define model development responsibility and perform model validation before automation. |
| Organizational readiness | Limited skills, resistance, and unclear responsibility prevent consistent workflow use. | Invest in training, collaborative procedures, and leadership support. |
| Scalability | Workflows validated in case studies may not transfer directly to different project types. | Conduct pilot implementation and measure outcomes before full deployment. |

### Cross-theme synthesis

Across the four domains, BIM-enabled productivity gains are strongest when BIM is embedded within wider automated workflows. In pre-construction, BIM improves productivity by automating quantity and cost information. In execution, it supports time control by linking model objects, activities, and field data. In safety and quality assurance, it strengthens defect detection and rule-based checking. In lifecycle management, BIM acts as a data foundation for Digital Twin and AI-supported decision-making.

The evidence also shows that the productivity benefit is conditional rather than automatic. Interoperability, model quality, organizational readiness, and governance of digital information determine whether BIM-enabled automation can move from pilot studies to reliable project practice. This is consistent with broader research on BIM adoption barriers, contractual management, and effective BIM governance in construction organizations (Alreshidi et al., 2017; Saad Alotaibi et al., 2024; Alshibani et al., 2024). Therefore, future applied research should not only demonstrate technological capability but also quantify implementation cost, long-term return on investment, and transferability across project types.

## PRACTICAL IMPLICATION

This systematic review shows that BIM-enabled workflow automation provides measurable productivity advantages over conventional construction practices in four applied domains. In pre-construction, BIM improves quantity take-off, cost estimation, and material planning by reducing manual interpretation and improving data traceability. In project execution, BIM improves schedule visualization and progress control through 4D planning, simulation, and planned-versus-actual comparison. In safety and quality management, BIM supports earlier detection of defects and hazards through model-based checking and sensing integration. In lifecycle management, BIM linked with AI, IoT, and Digital Twin systems extends productivity improvement into operation and maintenance.

The central finding is that BIM adoption alone is insufficient; the strongest productivity benefits occur when BIM functions as an interoperable data foundation for automated and evidence-based decision-making. The applied implication for civil engineering practice is that project organizations should prioritize workflow integration, model quality assurance, and staff readiness before expecting major productivity gains. Future studies should develop standardized productivity metrics, validate BIM-enabled automation across different project types, and quantify long-term economic benefits during operation and maintenance. These directions are necessary to transform BIM from a coordination tool into a reliable productivity-improvement system for civil engineering projects.

## ACKNOWLEDGMENT

The authors gratefully acknowledge the financial support provided under Grant No. 196/UN27/TM.00.07/2024 and 460/UN27.22/PT.01.03/2026 which significantly contributed to the completion of this study.This research was also supported by LPPM Universitas Sebelas Maret (UNS) through research grants under Contract 462/UN27.22/PT.01.03/2026 for the projects entitled: “Pengaruh Variasi Substitusi Limbah Cangkang Kerang terhadap Sifat Mekanis Paving Block sebagai Inovasi di Bidang Teknik dan Rekayasa Konstruksi Bangunan Gedung”.

## DISCLOSURE STATEMENT

The author declares that this research topic was carried out without any conflict of interest.

## NOTES ON CONTRIBUTOR

Marseleno Ahmad Syafii and Alviano Victor Wicaksana are bachelor's degree students in Department of Construction Management at the Vocational School, Universitas Sebelas Maret, Surakarta, Indonesia. Fendi Hary Yanto is a lecturer in Department of Construction Management at the Vocational School, Universitas Sebelas Maret, Surakarta, Indonesia. Their research interests are in structural engineering.

## REFERENCES

Alreshidi, E., Mourshed, M., & Rezgui, Y. (2017). Factors for effective BIM governance. Journal of Building Engineering, 10, 74-87. https://doi.org/10.1016/j.jobe.2017.02.006

Love, P. E. D., Matthews, J., Simpson, I., Hill, A., & Olatunji, O. A. (2014). A benefits realization management building information modeling framework for asset owners. Automation in Construction, 37, 1-13. https://doi.org/10.1016/j.autcon.2013.09.007

Costa, G., & Sicilia, A. (2020). Alternatives for facilitating automatic transformation of BIM data using semantic query languages. Automation in Construction, 120, 103384. https://doi.org/10.1016/j.autcon.2020.103384

Huang, C., & Hsieh, S. (2020). Predicting BIM labor cost with random forest and simple linear regression. Automation in Construction, 118, 103280. https://doi.org/10.1016/j.autcon.2020.103280

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., et al. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. BMJ, 372, n71. https://doi.org/10.1136/bmj.n71

Wang, J., Wang, X., Shou, W., Chong, H. Y., & Guo, J. (2021). Building information modeling (BIM) based integration of MEP layout designs and constructability. Automation in Construction, 122, 103474. https://doi.org/10.1016/j.autcon.2020.103474

Wen, Q., Ren, Z., Lu, H., & Wu, J. (2021). The progress and trend of BIM research: A bibliometrics-based visualization analysis. Automation in Construction, 124, 103558. https://doi.org/10.1016/j.autcon.2021.103558

Singh, J., Cheng, J. C. P., & Anumba, C. J. (2021). BIM-based approach for automatic pipe systems installation coordination and schedule optimization. Journal of Construction Engineering and Management, 147(10), 04021113. https://doi.org/10.1061/(ASCE)CO.1943-7862.0002077

Akanbi, T., & Zhang, J. (2021). Design information extraction from construction specifications to support cost estimation. Automation in Construction, 131, 103835. https://doi.org/10.1016/j.autcon.2021.103835

Liu, H., Cheng, J. C. P., Gan, V. J. L., & Zhou, S. (2022). A knowledge model-based BIM framework for automatic code-compliant quantity take-off. Automation in Construction, 133, 104024. https://doi.org/10.1016/j.autcon.2021.104024

Tan, Y., Li, G., Cai, R., Ma, J., & Wang, M. (2022). Mapping and modelling defect data from UAV captured images to BIM for building external wall inspection. Automation in Construction, 142, 104284. https://doi.org/10.1016/j.autcon.2022.104284

Ramos-Hurtado, J. A., et al. (2022). An augmented reality approach for construction progress and compliance inspection. Automation in Construction, 144, 104596. https://doi.org/10.1016/j.autcon.2022.104596

Meyer, T., Brunn, A., & Stilla, U. (2023). Geometric BIM verification of indoor construction sites by photogrammetric point clouds and evidence theory. ISPRS Journal of Photogrammetry and Remote Sensing, 195, 147-163. https://doi.org/10.1016/j.isprsjprs.2022.12.014

Mostafa, K., Hegazy, T., Hunsperger, R. D., & Elias, S. (2023). Using image analysis to quantify defects and prioritize repairs in built-up roofs. Facilities, 41(11/12), 523-540. https://doi.org/10.1108/F-08-2022-0119

Foroughi Sabzevar, M., Gheisari, M., & Lo, L. (2023). AR-QR code for improving crew access to design and construction information. Automation in Construction, 154, 105017. https://doi.org/10.1016/j.autcon.2023.105017

Perez-Garcia, A., Martin-Dorta, N., & Aranda, J. A. (2023). 4D BIM and virtual reality for construction planning. Automation in Construction, 151, 104860. https://doi.org/10.1016/j.autcon.2023.104860

Caglayan, S., & Ozorhon, B. (2023). Determining building information modeling effectiveness. Automation in Construction, 151, 104861. https://doi.org/10.1016/j.autcon.2023.104861

Zhu, J., Wu, P., & Lei, X. (2023). IFC-graph for facilitating building information access and query. Automation in Construction, 148, 104778. https://doi.org/10.1016/j.autcon.2023.104778

Ekanayake, B., Wong, J. K. W., Fini, A. A. F., Smith, P., & Thengane, V. (2024). Deep learning-based computer vision in project management: Automating indoor construction progress monitoring. Project Leadership and Society, 5, 100149. https://doi.org/10.1016/j.plas.2024.100149

Khant, L. P., Widjaja, D. D., Kwon, K., & Kim, S. (2024). A BIM-based bar bending schedule generation algorithm with enhanced accuracy. Buildings, 14(5), 1207. https://doi.org/10.3390/buildings14051207

Valinejadshoubi, M., Moselhi, O., Iordanova, I., Valdivieso, F., & Bagchi, A. (2024). Automated system for high-accuracy quantity takeoff using BIM. Automation in Construction, 157, 105155. https://doi.org/10.1016/j.autcon.2023.105155

Zhang, Y., & Mo, H. (2024). Intelligent building construction cost optimization and prediction by integrating BIM and Elman neural network. Heliyon, 10(18), e37525. https://doi.org/10.1016/j.heliyon.2024.e37525

Alshibani, A., Aldossary, M., Hassanain, M. A., Hamida, H., Aldabbagh, H., & Ouis, D. (2024). Investigation of the driving power of the barriers affecting BIM adoption in construction management through ISM. Results in Engineering, 24, 102987. https://doi.org/10.1016/j.rineng.2024.102987

Saad Alotaibi, B., Waqar, A., Radu, D., Khan, A. M., Dodo, Y. A., Althoey, F., & Almujibah, H. (2024). Building information modeling adoption for enhanced legal and contractual management in construction projects. Ain Shams Engineering Journal, 15, 102822. https://doi.org/10.1016/j.asej.2024.102822

Solihin, W., Liu, Z., Lu, Y., & Wei, L. (2024). BIM-based automated rule-checking in the AECO industry: Learning from semiconductor manufacturing. Automation in Construction, 162, 105406. https://doi.org/10.1016/j.autcon.2024.105406

Szostak, M., Mahamadu, A. M., Prabhakaran, A., Caparros-Perez, D., & Agyekum, K. (2024). Development and testing of immersive virtual reality environment for safe unmanned aerial vehicle usage in construction scenarios. Safety Science, 174, 106547. https://doi.org/10.1016/j.ssci.2024.106547

Khan, A. M., Tariq, M. A., Ur Rehman, S. K., Saeed, T., Alqahtani, F. K., & Sherif, M. (2024). BIM integration with explainable AI using LIME and multi-objective optimization for automated green building energy performance analysis. Energies, 17(13), 3295. https://doi.org/10.3390/en17133295

Yang, Y., Yue, X., Luo, Y., Jin, L., & Jia, B. (2024). Building Information Modeling-Life Cycle Assessment: A novel technology for rapid calculation and analysis system for life cycle carbon emissions of bridges. Sustainability, 16(23), 10574. https://doi.org/10.3390/su162310574

Moradabadi, B., Noorzai, E., & Abbasi, S. (2024). BIM-based optimization approach to reduce life cycle costs by focusing on the integration of construction and operation phases in officecommercial buildings. Journal of Building Engineering, 98, 111126. https://doi.org/10.1016/j.jobe.2024.111126

Quek, Y. H., et al. (2024). Interoperability barriers in BIM-based automated workflows for the built environment. Advanced Engineering Informatics, 60, 102398. https://doi.org/10.1016/j.aei.2024.102398

Anwar, S., & Pramudiyanto. (2025). Development of an information system for monitoring work progress in building construction projects: A case study of Voyou Hotel Surakarta. Journal of Applied Civil Engineering and Practice, 1(2), 126-134. https://doi.org/10.21831/jacep.v1i2.1838

Mezaluna, K., & Prihadi, W. R. (2025). Analysis of productivity in column work using formwork system with zoning cycle on the hospital construction project in Surakarta. Journal of Applied Civil Engineering and Practice, 1(2), 135-149. https://doi.org/10.21831/jacep.v1i2.840

Gandomkar Armaki, M. E., Shirzadi Javid, A. A., & Omrani, S. (2025). Dynamic BIM-driven framework for adaptive and optimized construction projects scheduling under uncertainty. Buildings, 15(17), 3004. https://doi.org/10.3390/buildings15173004

Pal, A., Lin, J. J., Amer, F., Hsieh, S. H., & Golparvar-Fard, M. (2025). Automatic mapping of schedule activities and reality models for tracking construction progress. Engineering, Construction and Architectural Management. https://doi.org/10.1108/ECAM-08-2024-1166

Guerrero-Sevilla, D., Rodriguez-Gomez, R., Morcillo-Sanz, A., & Gonzalez-Aguilera, D. (2025). Optimising construction site auditing: A novel methodology integrating ground drones and BIM analysis. Drones, 9(4), 277. https://doi.org/10.3390/drones9040277

Aranda, J. A., Perez-Garcia, A., Martin-Dorta, N., & Contero, M. (2025). BIM-based design to enhancing efficiency and accuracy in cross-drainage works. Journal of Engineering Research. https://doi.org/10.1016/j.jer.2025.06.008

Zhang, S., Zhang, S., Liu, H., Wang, C., Zhao, Z., Wang, X., & Yan, L. (2025). Semantic enrichment of BIM models for construction cost estimation in pumped storage hydropower using industry foundation classes and interconnected data dictionaries. Advanced Engineering Informatics, 65, 103670. https://doi.org/10.1016/j.aei.2025.103670

Abdelalim, A. M., Essawy, A., Sherif, A., Salem, M., Al-Adwani, M., & Abdullah, M. S. (2025). Optimizing facilities management through artificial intelligence and digital twin technology in mega-facilities. Sustainability, 17(5), 1826. https://doi.org/10.3390/su17051826

Ma, T., Xiao, F., Zhang, C., Zhang, J., Zhang, H., Xu, K., & Luo, X. (2025). Digital twin for 3D interactive building operations: Integrating BIM, IoT-enabled building automation systems, AI, and mixed reality. Automation in Construction, 176, 106277. https://doi.org/10.1016/j.autcon.2025.106277

Utkucu, D., & Sacks, R. (2025). Ontology for holistic building performance modeling and analysis. Automation in Construction, 175, 106197. https://doi.org/10.1016/j.autcon.2025.106197

Castañeda, K., Sanchez, O., Peña, C., Herrera, R., & Mejia, G. (2025). BIM-lean integration for construction scheduling of road intersections. Automation in Construction, 176, 106247. https://doi.org/10.1016/j.autcon.2025.106247

Reynoso Vanderhorst, H., et al. (2024). Scan-to-BIM-to-Digital Twin workflow for built asset management and resilience. Buildings, 14, 3278. https://doi.org/10.3390/buildings14103278

Yuliana, C., Fathonah, I., Kartadipura, R. H., & Widiastuti, E. (2025). Building Information Modeling-based cost estimation: The case study of the Guntung Payung Banjarbaru Community Health Center building project. Engineering, Technology & Applied Science Research, 15(1), 18990-18995. https://doi.org/10.48084/etasr.9890