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APPLICATION OF BIM IN CONSTRUCTION PROJECT MANAGEMENT

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ABSTRACT :

Building Information Modeling (BIM) has developed from three-dimensional (3D) digital representation into an integrated project-management environment that can connect model information with construction time, cost, resources, safety and operational data. This paper synthesizes the studies summarized in the supplied presentation, together with the supplied article "Building a Genetic Algorithm-Based and BIM-Based 5D Time and Cost Optimization Model." The reviewed studies examine BIM for quantity take-off and material control, 4D scheduling and progress monitoring, 5D cost planning, clash and mismatch management, worker-safety monitoring, augmented and virtual reality, blockchain-based information management, data mining, natural-language queries and artificial-intelligence-supported optimization. Across the studies, recurring reported benefits include improved multidisciplinary coordination, earlier identification of design and site conflicts, more consistent quantity estimates, better visualization of construction sequences, and stronger support for time and cost decisions. The supplied genetic-algorithm study reports a reduction in project duration from 439 to 344 days (approximately 20%) and a cost reduction of US$17,946 in its case study. However, the evidence is drawn from different project types and methods, so the reported numerical outcomes should not be treated as directly comparable. Common barriers include interoperability, implementation and training costs, organizational resistance, data quality and limited validation across large or diverse projects. The synthesis concludes that BIM provides the greatest project-management value when it is linked to reliable project data, coordinated workflows and suitable analytical tools rather than used only as a visualization model.

Keywords: Building Information Modeling; construction project management; 4D BIM; 5D BIM; time-cost optimization; genetic algorithm; clash detection; artificial intelligence; safety management

1. Introduction

Construction projects involve interconnected design, procurement, resource, scheduling, cost, quality and safety decisions. When these decisions rely on separate drawings, spreadsheets and discipline-specific information, inconsistencies can delay work, increase rework and make it difficult to determine the effect of a change on the overall project. Building Information Modeling (BIM) offers a shared digital representation of a facility and its associated information, supporting communication between project participants and coordination across the construction lifecycle.

The studies summarized in the supplied presentation describe BIM applications ranging from 3D visualization and clash detection to 4D scheduling and 5D quantity and cost management. Other studies extend BIM through augmented reality (AR), virtual reality (VR), blockchain, mobile safety applications, data mining, simulation and artificial intelligence (AI). These extensions indicate that BIM is increasingly treated as a platform for project information and decision support, not merely as a three-dimensional model.

A particularly relevant direction is the integration of BIM with optimization algorithms. Alzara et al. (2023) propose a genetic-algorithm (GA) model connected to a 5D BIM interface to search for project time-cost alternatives. This provides a specific example of how model-based quantities, activity schedules and cost data can be combined with computational optimization. The purpose of this paper is to synthesize the supplied studies, compare their approaches and reported findings, identify shared limitations, and outline practical directions for integrated BIM-based construction project management.

2. Review Method

This manuscript is a narrative synthesis of the journal and conference-paper summaries presented in the supplied PowerPoint, supplemented by the supplied full-text article by Alzara et al. (2023). The presentation summarizes studies on site material and progress control; time and cost planning; BIM-blockchain integration; BIM-based project management; adoption barriers and AI; expert evaluation of cost and schedule; AR/VR; data mining;

BIM-enabled safety monitoring; natural-language interfaces; integrated time-cost management; mismatch analysis; modular construction scheduling; financial scheduling; and automated time-space conflict management.

The studies were grouped by recurring project-management functions: (i) time and cost planning, (ii) coordination and mismatch prevention, (iii) materials and resources, (iv) safety and visualization, and (v) information management and emerging digital technologies. Reported numerical results are reproduced as described in the supplied materials. Because this is a synthesis of provided summaries rather than a new systematic review, it does not claim exhaustive database coverage, independent quality appraisal or a pooled statistical estimate. Some slide summaries omit complete bibliographic details; these are flagged in the references rather than guessed.

3. Literature Synthesis

3.1 Time, scheduling and cost management

The reviewed studies repeatedly connect BIM model elements with construction activities, durations, quantities and costs. Šuman, Pučko and Klanšek (2014) describe a workflow in which a 3D model is linked with resources, production rates, unit costs and activity relationships to generate an integrated network plan. Jrade and Lessard (2015) combine BIM with Earned Value Management in an integrated time and cost management system, including estimating, scheduling, visualization and performance reporting. The presentation also summarizes a seven-floor building study by Abdulwahhab, Naimi and Abdullah (2022), in which Revit quantity estimates were compared with manual calculations and were reported as close to the manual values while reducing calculation effort and potential human error.

The supplied article by Alzara et al. (2023) develops a 5D BIM and GA optimization model through a Navisworks plug-in. Its workflow combines quantity take-off, schedule and productivity data, cost databases and five time scenarios for activities. The article reports that a baseline project duration of 439 days and cost of US$1,271,306 changed to 344 days and US$1,253,360 after optimization. The authors report approximately 20% less time and US$17,946 in cost savings. These are results from the article's particular case study, not a guaranteed outcome for every project. The paper also notes that future versions could include resource allocation and leveling, additional activity alternatives and more extensive testing on megaprojects.

Other supplied studies reinforce the value of linking schedules to models. The modular-construction study by Mayouf et al. (2024) proposes a lean-integrated 4D BIM process to identify constructability, operational and health-and-safety implications. A 2025 study by Tavakolan and Nikoukar combines BIM, discrete-event simulation, resource and transport data, and financing optimization for a steel-structure project. The presentation also summarizes experimental evidence that 4D BIM can improve schedule compliance and reduce delays relative to traditional planning, although the preprint's study details and generalizability require careful consideration.

3.2 Coordination, clash detection and construction mismatches

Clash detection and coordinated model review are among the most consistent applications across the reviewed literature. Rui, Lim and Tan (2021) examine 3D visualization and clash detection, 4D construction simulation and 5D quantity/cost management in a Malaysian construction case study; the presentation reports 154 steel-component clashes identified in the project. Soni and Raza (2026) report a multi-storey commercial-building case study in India using Revit, BIM 360 and Navisworks, in which 371 interdisciplinary clashes were identified and 92.2% were resolved before construction. The same summary reports a reduction in schedule variance and project-cost savings, but these values belong to that specific case study.

Gharouni Jafari, Ghazi Sharyatpanahi and Noorzai (2021) focus on as-designed/as-built mismatches. Their BIM-based decision framework links mismatch types with root causes, possible solutions and project impacts, and compares the approach with traditional handling. The presentation gives an example in which an integrated solution reduced the additional cost and material consumption relative to a less coordinated solution. Taken together, these studies suggest that BIM is most useful when it supports early identification, evaluation and resolution of conflicts, rather than simply documenting them after they have affected site work.

3.3 Material, quantity and resource management

The site-management study by Nadeem and colleagues (2018) uses BIM as a shared information source for quantity take-off, material estimation and 4D progress control. The presentation reports material savings and a reduction of approximately 20 days in outrigger installation, alongside reported project savings. Hu, Lu and AbouRizk (2014) use BIM/Tekla material data and a regression-based data-mining model to estimate structural-steel fabrication man-hours. The slide summary reports a test correlation coefficient of 0.95 and lower error values than estimates based on professional experience. This indicates potential for model data to support labor forecasting and resource planning.

BIM-based quantity take-off and model-linked cost databases can also reduce repeated manual measurement and support updates when the design changes. Nevertheless, quantity accuracy depends on model completeness, correct classification, consistent measurement rules and coordination between BIM software and external cost or schedule systems. Therefore, automated quantities should be validated against project specifications and field conditions.

3.4 Safety, AR/VR and site visualization

Several studies extend BIM beyond planning and cost control. Hossain et al. (2023) describe a BIM-based smart safety-monitoring prototype that combines an Android GPS application and a cloud-based web interface to track workers relative to hazardous zones. The supplied presentation reports that the prototype issued alerts when users entered defined hazard areas, while noting a limit of ten simultaneous users. Ahmed (2018) reviews AR and VR applications for scheduling, progress tracking, worker training, safety, quality and defect management. Dallasega et al. (2020) examine a simulation

game combining lean construction, BIM, VR and AR, reporting improved time and productivity measures within the simulation.
These approaches can make planned sequences and hazards easier to understand, but their effectiveness depends on the reliability of location data, model updates, user training, site connectivity and integration into actual safety procedures. A digital alert should support, not replace, competent site supervision and formal safety management.

3.5 Information management, blockchain and AI

The presentation summarizes Ni, Sun and Wang (2021), who propose a BIM-blockchain mechanism for project information, traceability, security and responsibility tracking. Blockchain is intended to strengthen the auditability of multi-party records, while BIM provides model-based information and visualization. The review by Tran, Tran and Nguyen (2024) identifies opportunities for BIM-AI integration in prediction, scheduling, resource allocation and proactive risk management, alongside barriers such as interoperability, implementation costs, organizational resistance and training.
Additional studies explore natural-language interfaces for querying BIM data and agentic AI for project-lifecycle coordination. The presentation reports that a natural-language query interface reduced average query time compared with structured query language and software-interface retrieval, while complex queries remained difficult. A 2026 agentic-AI/PLM study summarized in the slides reports improvements in coordination latency, schedule adherence, communication errors and administrative cost across its pilot context. These promising results need independent replication, transparent evaluation and safeguards for data security, model reliability and human oversight.

4. Comparative Analysis and Discussion

The studies differ in scope and evidence type. Literature reviews identify broad applications and adoption barriers; case studies demonstrate workflows in particular projects; surveys capture professional perceptions; experiments compare planning or simulation methods; and computational models evaluate candidate schedules and costs. Their numerical findings cannot be pooled directly because they use different baselines, project types, performance measures and sample sizes.

Theme	Typical BIM approach	Reported contribution	Main limitation / condition
Time and cost	4D/5D BIM linked to schedules, quantities, cost databases, EVM or GA	Supports scenario comparison, time-cost planning and progress reporting	Depends on accurate activity, productivity, quantity and cost data; results are project-specific
Coordination	Federated models, clash detection, mismatch analysis and construction simulation	Finds design conflicts earlier and helps coordinate disciplines before site execution	Model quality and timely updates are essential; clash counts alone do not prove avoided cost
Materials and resources	Quantity take-off, BIM-linked material data and data mining	Improves quantity estimation and supports labor/material planning	Requires consistent model objects, measurement rules and validation against site conditions
Safety and visualization	BIM with GPS/mobile apps, AR/VR and hazard-zone models	Makes hazards and planned sequences more visible and can support worker alerts/training	Needs reliable location/model data, user adoption, privacy controls and safety procedures
Digital integration	BIM with blockchain, AI, natural-language interfaces and simulation	Can improve traceability, information access, prediction and optimization	Interoperability, cost, training, explainability, cybersecurity and real-world validation remain concerns

Across the reviewed evidence, the strongest common finding is that BIM improves the visibility and coordination of project information. Time and cost benefits arise when the model is connected to a usable schedule, cost database and resource assumptions. Clash detection and 4D simulation help teams see problems earlier, while safety and AI applications add value only when reliable data and clear operating procedures are available. The literature therefore supports an integrated, data-governed implementation strategy rather than a software-only approach.

5. Summary of Findings

- BIM's role extends from 3D modeling to 4D time planning and 5D cost/quantity management, with emerging links to safety, lifecycle management and AI.
- Model-based clash detection and mismatch analysis can help teams identify and resolve conflicts before construction, reducing the likelihood of avoidable rework.
- Linked quantity, schedule and cost data support more consistent estimating, material control, progress monitoring and project reporting.
- Optimization methods such as genetic algorithms can explore alternative activity-duration scenarios. In the supplied Alzara et al. (2023) case, the model reported approximately 20% shorter duration and US$17,946 lower cost.
- AR/VR, mobile safety systems, blockchain and natural-language interfaces extend BIM's usefulness, but evidence varies in maturity and scale.
- Recurring barriers are interoperability, implementation cost, training, organizational change, model/data quality, and the limited generalizability of individual case studies.

6. Conclusion

The supplied studies collectively indicate that Building Information Modeling can support more coordinated and informed construction project management when it integrates design, quantities, schedule, cost, resources and site information. The most established applications in the reviewed material are visualization, clash detection, quantity take-off, 4D scheduling and 5D cost planning. Emerging applications in AI optimization, blockchain, AR/VR, mobile safety monitoring and natural-language access broaden the potential role of BIM, but require careful validation and implementation planning.

The supplied genetic-algorithm paper provides a concrete example of time-cost optimization within 5D BIM, reporting a project-duration reduction from 439 to 344 days and a cost reduction of US$17,946. The result is encouraging but should be interpreted within the assumptions and scope of that case study. More generally, BIM does not automatically guarantee lower costs or shorter schedules: benefits depend on data accuracy, interoperability, competent users, clear workflows and continuous model updates. A practical implementation should begin with defined project objectives, establish common data standards, connect model objects to schedule and cost information, validate outputs, and measure outcomes against a documented baseline.

7. Future Scope

- Validate BIM-based time-cost optimization on more projects, including large and complex projects, and report consistent performance measures.
- Extend genetic-algorithm and other AI models to include resource leveling, labor and equipment constraints, procurement lead times, cash flow, risk and sustainability objectives.
- Improve interoperability among BIM authoring tools, scheduling software, cost databases, field applications and common data environments.
- Combine 4D/5D BIM with real-time site data, progress imagery, sensors and mobile applications while ensuring data quality and worker privacy.
- Evaluate AI-supported BIM tools for accuracy, explainability, cybersecurity and human review before using recommendations for high-impact project decisions.
- Conduct longitudinal and multi-project studies to determine whether reported savings persist across project types, regions and levels of BIM maturity.
- Develop practical training, implementation roadmaps and cost-benefit frameworks for small and medium-sized construction organizations.

REFERENCES

1. Ahmed, S. (2018). A Review on Using Opportunities of Augmented Reality and Virtual Reality in Construction Project Management. Organization, Technology and Management in Construction, 10, 1839–1852.
2. 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
3. Barati, R., Charehzehi, A., & Preece, C. N. (2013). Enhancing Planning and Scheduling Program by Using Benefits of BIM-Based Applications. Civil and Environmental Research, 3(5).
4. Dallasega, P., Revolti, A., Sauer, P. C., Schulze, F., & Rauch, E. (2020). BIM, Augmented and Virtual Reality Empowering Lean Construction Management: A Project Simulation Game. Procedia Manufacturing, 45, 49–54.
5. Feng, Y. (2022). Research on the Application of Computer-Based BIM Technology in Construction Projects. 2022 International Conference on Knowledge Engineering and Communication Systems (ICKES).
6. Gharouni Jafari, K., Ghazi Sharyatpanahi, N. S., & Noorzai, E. (2021). BIM-based integrated solution for analysis and management of mismatches during construction. Journal of Engineering, Design and Technology. https://doi.org/10.1108/JEDT-02-2020-0044
7. Hu, X., Lu, M., & AbouRizk, S. (2014). BIM-Based Data Mining Approach to Estimating Job Man-Hour Requirements in Structural Steel Fabrication. Proceedings of the 2014 Winter Simulation Conference.
8. Hossain, M. M., Ahmed, S., Anam, S. M. A., Baxramovna, I. A., Meem, T. I., Sobuz, M. H. R., & Haq, I. (2023). BIM-based smart safety monitoring system using a mobile app: a case study in an ongoing construction site. Construction Innovation.
9. Jrade, A., & Lessard, J. (2015). An Integrated BIM System to Track the Time and Cost of Construction Projects: A Case Study. Journal of Construction Engineering, 2015, Article 579486.
10. Mayouf, M., Jones, J., Elghaish, F., Emam, H., Ekanayake, E. M. A. C., & Ashayeri, I. (2024). Revolutionising the 4D BIM Process to Support Scheduling Requirements in Modular Construction. Sustainability, 16, Article 476.
11. Nadeem, A., Wong, A. K. D., Akhnova, G., Azhar, S., & Wong, S. N. (2018). Application of BIM in Site Management—Material and Progress Control. Springer book chapter; full publication details were not supplied in the presentation.
12. Ni, Y., Sun, B., & Wang, Y. (2021). Blockchain-Based BIM Digital Project Management Mechanism Research. IEEE Access, 9.
13. Raza, M. S., Tayeh, B. A., Abu Aisheh, Y. I., & Maglad, A. M. (2023). Potential features of BIM for application of project management knowledge areas in the construction. Heliyon, 9, e19697.
14. Rui, Y., Lim, Y.-W., & Tan, C. S. (2021). Construction Project Management Based on Building Information Modeling (BIM). Civil Engineering and Architecture, 9(6).

15. Soni, B. L., & Raza, Q. (2026). Application of Building Information Modeling (BIM) for Project Management in Construction: A Case Study Approach. International Journal of Research in Civil Engineering and Technology, 7(1), 208–216.

16. Šuman, N., Pučko, Z., & Klanšek, U. (2014). Building Information Modeling Based Time And Cost Planning In Construction Projects. Organization, Technology and Management in Construction, 6(1).

17. Tavakolan, M., & Nikoukar, S. (2025). A BIM and Simulation-Based Finance Scheduling Method for the Steel Structure Construction Project. KSCE Journal of Civil Engineering, 29, Article 100124.

18. Tran, T. V., Tran, H. V. V., & Nguyen, T. A. (2024). A Review of Challenges and Opportunities in BIM Adoption for Construction Project Management. Engineering Journal, 28(8).

19. Abdulwahhab, R. A., Naimi, S., & Abdullah, R. (2022). Managing Cost and Schedule Evaluation of a Construction Project via BIM Technology and Experts' Points of View. Mathematical Modelling of Engineering Problems, 9(6).

20. Kaur, R., Mwambegele, B. J., Abraham, A. G., Basheer, S. A., & Garia, S. (2025). A comprehensive review on building information modelling (BIM), its implementations and applications. Discover Civil Engineering, 2, Article 177.

21. Zaitsev, A., & Kisel, T. (2026). Digital autonomation of residential construction project lifecycle management via agentic-AI-driven PLM system. Journal of Intelligent Construction, 4, Article 9180130.