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RESEARCH PAPER

Integrating BIM for Enhanced Sustainability in Construction Projects

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ABSTRACT

This study examines BIM's impact on resource efficiency by highlighting obstacles and developing deployment guidelines supported by practical project applications. Development countries such as Pakistan confront environmental problems in their construction sectors. BIM helps to enhance sustainability although challenging project costs and requiring skilled practitioners alongside appropriate policy frameworks. For BIM adoption to succeed policy backing from governments and industry backing combined with educational training programs are necessary. This research combines both surveys and expert interviews under positivist methodology. The BIM adoption process in Pakistan's construction field benefits from SPSS and NVivo for reliability purposes and confidentiality and consent procedures. The implementation of BIM for sustainability projects in Pakistan faces difficulties because of high prices and skill deficits alongside resistance to change. Financial Support Mechanisms, BIM Training Programs, Standardized BIM Guidelines, Integration of Advanced Technologies, Industry Encouragement.

KEYWORDS Building Information Modeling (BIM), Sustainable Construction, Green Building Technologies, Energy Efficiency, Lifecycle Assessment

Introduction

Both carbon emissions and unneeded resource utilization worsen because of the construction industry while this sector acts as a key economic driver. The company produces more than 40% of worldwide carbon dioxide emissions a fact that demands immediate sustainable practice implementation. (United Nations Environment Programme, 2021). Conventional construction techniques recurrently result in waste and carelessness, especially in poor nations like Pakistan where source restraint and obsolete methods obstruct development (Ali et al., 2022).

Building Information Modeling (BIM) operates as an advanced digital tool to advance teamwork efficiency and project sustainability and scheduling methods during construction development. BIM implementation among construction workers delivers better project visualization and reduced errors and maximized resource usage (Kasim, 2015). Furthermore, BIM is indispensable for assessing energy competence, reducing material, and attractive sustainable design(Cascone et al., 2024). Studies have shown that BIM-driven tactics greatly enhance environmentally friendly construction procedures (Khan et al., 2024; Sajjad et al., 2024).

However, Adoption of BIM in poor nations is fraught with difficulties. Noteworthy obstacles include high execution costs, a lack of technical proficiency, and resistance to change(Manzoor et al., 2021). Moreover, the lack of rules and policies make incorporate it into the construction sector more difficult (Sulaman et al., 2023). By given a planned trainings and dictatorial norms, academics compete that government support and educational initiatives are essential in promoting BIM (van Eldik et al., 2020).

This study aim's is investigate the odds of adoption of BIM in Pakistan's construction industry. It find out major obstacles, propose realistic solutions, and build up a framework customized to local industry needs. By tackling these issues ,the research contributes to the support of inexpensive and economically friendly construction practices, lined up with international initiatives to reduce the influence on the built environments.

The growing difficulty on the construction industry to grant sustainable techniques that exploit production and reduce environmental scratch. It can be rough to successfully include conservative sustainability evaluation techniques into the early stages of design since they often insist a large quality of time and money (Kasim, 2015). Building Information Modeling (BIM) has become a viable option of a digital framework that improves sustainability contemplation, design precision, and project coordination (Carvalho et al., 2020). Despite its benefits, technological constraints, interoperability problems, and the lack of recognized conformity standards make it difficult to assimilate BIM with sustainability frameworks (Kasim, 2015). Additionally, A large facts gap exists about the application of BIM-based sustainability strategies in resource-embarrassed environments because the majority of research and achievement of these strategies concentrate on rich countries (Mirindi & Mirindi, 2024). Research shows that BIM may increase sustainability by reducing waste, increasing energy effectiveness, and conducting thorough life cycle assessments. Nonetheless, a major challenge is still the absence of clear frameworks for smoothly incorporating sustainability factors into BIM models from the very beginning of the design process (Cascone et al., 2024). Issues that are particularly perceptible in underdeveloped nations, where a lack of infrastructure, not enough technical know-how, and budgetary fetters put off BIM from being comprehensively used (Kurwi et al., 2017). The purpose of this research is to look over how successfully BIM built-in to support sustainability in construction projects. The research will locate issues, offer valuable fixes, and put forth a framework that takes into provisions of budding nations. By lightning these obstacle, this research aims to secure the gap between theoretical understanding and practical accomplishment, so supporting the construction sector in attaining sustainable and effective outcomes (Wu & Issa, 2015; Zanni et al., 2013).

Literature Review

The construction industry significantly contributes to environmental issues, including waste production, carbon emissions, and excessive resource consumption (Abdelalim et al., 2024; Alsofiani, 2024). BIM stands as a digital technology which boosts sustainability by enhancing building processes through efficient resource management while minimizing waste generation. (Cascone et al., 2024; Zanni et al., 2013). BIM enhances project sustainability through its support of project planning together with decision-making systems and data management strategies (Kurwi et al., 2017; Mirindi & Mirindi, 2024).

One essential advantage of BIM comes from its capability to evaluate energy efficiency together with material usage and waste generation (Nicał & Wodyński, 2016; Wu & Issa, 2015). Environmental performance improvements along with lifecycle evaluation occur when BIM integrates sustainability frameworks such as BREEAM and LEED.(Cascone et al., 2024; Zanni et al., 2013). Developing nations face barriers to implement BIM because of cost expenses alongside insufficient technology and underdeveloped stakeholder relationships (Ali et al., 2022; Kurwi et al., 2017). Sustainable construction faces barriers in effective adoption of its practice due to change resistance.(Alsofiani, 2024). A structured approach to digitalization in accounting needs training for every industry sector alongside supportive government policies (Mirindi & Mirindi, 2024).

BIM gains further potential through the combination of digital twins and artificial intelligence (AI) and Internet of Things (IoT) technologies that help monitoring systems and perform predictive analytics and improve operational efficiency. (Abdelalim et al., 2024; Cascone et al., 2024). The developments enhance construction sustainability by enhancing resource optimization along with decision-making processes (Kurwi et al., 2017; Wu & Issa, 2015).

BIM adoption follows three theoretical bases which consist of sustainability principles and lifecycle assessment (LCA) and technology acceptance models. The LCA system enables assessments of energy efficiency together with material choices and environmental impact evaluation. (Kurwi et al., 2017; Zanni et al., 2013). It is the Technology Acceptance Model (TAM) which explains how stakeholders perceive BIM usability because it dictates adoption patterns.(Alsofiani, 2024). Adequate training together with capacity enhancement represents essential components to confront workforce resistance toward BIM adoption.(Wu & Issa, 2015). BIM enables organizations to perform scenario assessments that help identify economical and sustainable construction procedures.(Cascone et al., 2024; Mirindi & Mirindi, 2024).

BIM adoption processes in construction follow the Diffusion of Innovation (DOI) theory model for spreading this technology practice. Construction institutions that lead BIM adoption prove its financial advantages along with energy-efficacy benefits and regulatory compliance support (Ali et al., 2022). Adoption rates of these systems need three key elements: industry regulations that support their use, technical preparedness and organizational backing (Nicał & Wodyński, 2016). Software compatibility challenges together with the lack of skilled professionals and insufficient sustainability framework standards act as barriers to adoption.(Alsofiani, 2024) Kurwi et al., 2017). The solution needs policy changes in addition to industrial partnerships and organized educational programs to tackle these difficulties..

BIM's integration with AI and IoT improves risk management by enabling real-time data analysis, predictive maintenance, and efficient resource utilization (Abdelalim et al., 2024). The technology enhances sustainability by lowering environmental impact while optimizing various types of decisions. The adoption of BIM becomes more powerful for sustainable construction when stakeholders adopt standardized data-sharing standards and collaborate effectively(Mirindi & Mirindi, 2024). The construction industry will benefit from better safety conditions combined with increased efficiency and environmental responsibility when BIM technology is used for risk identification and sustainability purposes.

Construction projects using BIM for risk exposure have the opportunity to create safe environments while becoming more efficient and minimizing environmental impact. BIM stands as a vital tool for sustainable building practices because it allows for potential issue identification and automation of compliance monitoring and resource optimization.

The Mediating Role of BIM Integration in Enhancing Sustainability in Construction Projects

Built Information Modeling contributes to sustainable projects through its features of optimizing resource utilization and enhancing power management while reducing environmental effects. Real-time processing of data in Building Information Modeling provides crucial decisions by offering comprehensive cost savings and maintaining control over the entire project period. BIM technology offers organizations superior stakeholder co-operation together with cost reduction and enhanced regulatory performance outcomes. BIM-driven sustainability objectives in developing nations including Pakistan drive forward through the support of policy frameworks and access to advanced technology and industrial goodwill.

Hypotheses

H1: BIM adoption has a positive impact on sustainability outcomes in construction projects.

BIM Adoption → Sustainability

H2: BIM adoption improves cost efficiency in construction projects.

BIM Adoption → Cost Efficiency

H3: BIM adoption improves sustainability in construction projects.

BIM Adoption → Sustainability

H4: **(Moderation):** Organizational Readiness moderates BIM's impact on Sustainability

H5: **(Mediation):** Stakeholder Collaboration mediates the effect on Project Performance

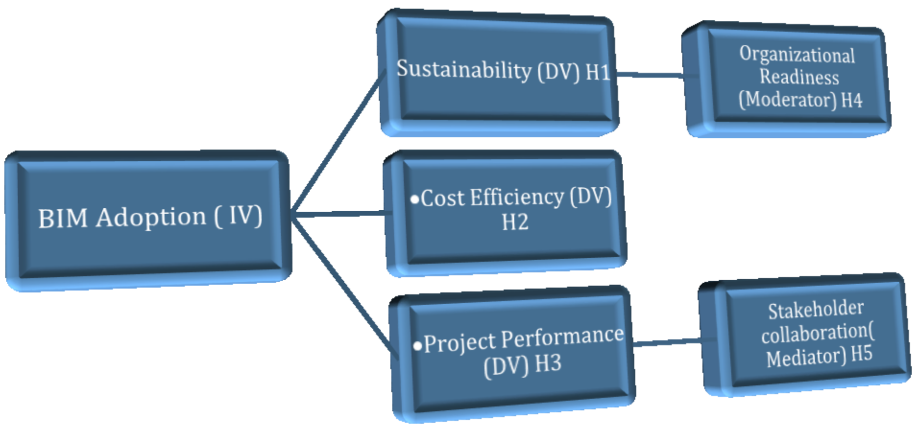

Figure No 1 Hypotheses

Conceptual Framework

The study develops its conceptual structure through BIM's implementation for optimizing resources alongside both environmental impact reduction and project efficiency improvement in construction sustainability initiatives. As an independent factor BIM modifies basic dependent outcomes that encompass sustainability achievements and project achievement levels and cost management effectiveness. BIM adoption reaches different implementation outcomes because three essential moderation factors consider stakeholder support and policy continuity and technological readiness. The study bases its research on sustainability theory but includes Technology Acceptance Model (TAM) and lifecycle assessment (LCA) to study energy optimization along with waste reduction from BIM while ensuring green building standards. The study develops a systematic approach to implement BIM tools in Pakistani building projects that combats implementation barriers to provide sustainable development guidance.

Empirical review

Independent Variable (IV):

Building Information Modeling (BIM) Adoption: This study will explore how the adoption and implementation of BIM technology influence various outcomes in construction projects. BIM is the primary intervention being examined, making it the independent variable.

IV is BIM Adoption.

Dependent Variables (DVs)

The dependent variables will be outcomes or effects that are influenced by the adoption of BIM. The study will identify several key outcomes, which will be dependent variables

DV is Sustainability Outcomes Cost Efficiency Project Performance

Moderator

Affects how BIM adoption impacts sustainability

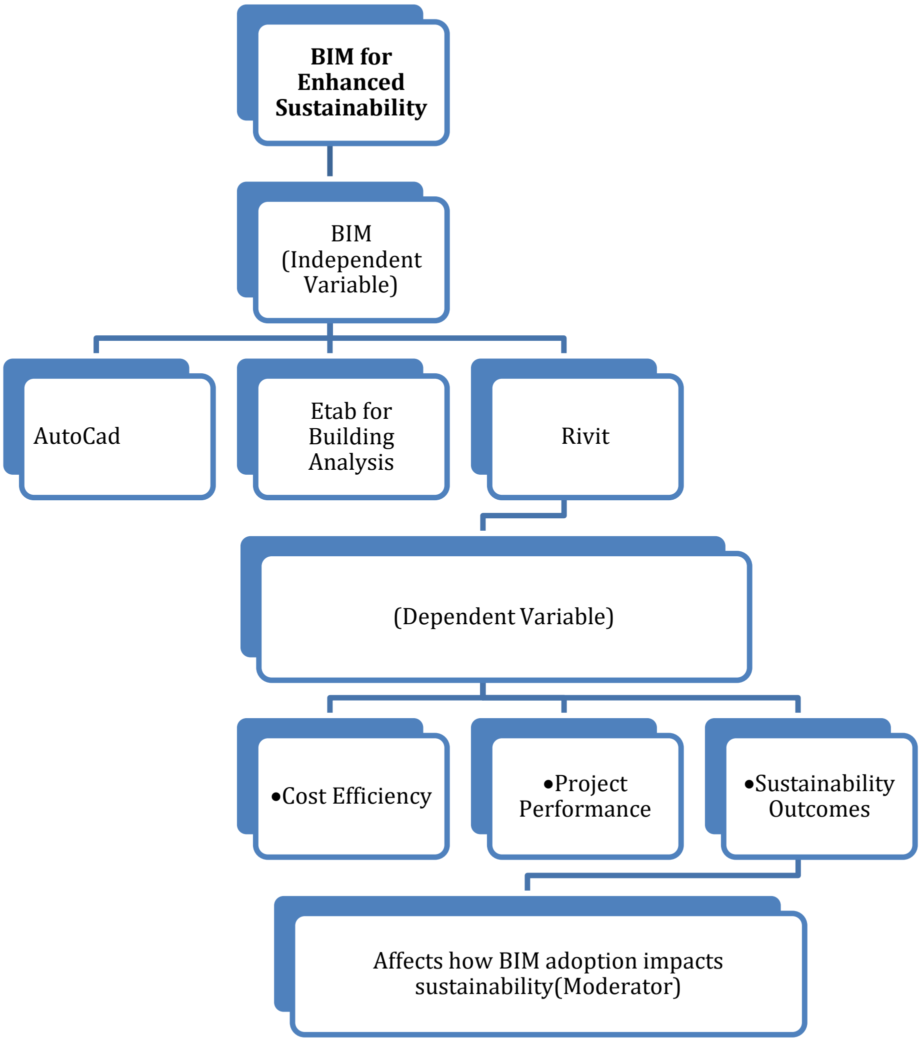

Figure No 1 Empirical review

Material and Methods

A multistage method was used to obtain real-time IoT information and conduct case investigations supported by expert interviews for analyzing sustainable infrastructure BIM frameworks that utilize AI systems. The evaluation of resource utilization happens quantitatively yet industrial expertise is collected through qualitative methods. The integration of thematic evaluation methods with statistical breakdown creates a comprehensive interpretation that generates valuable guidelines for sustainability enhancement in construction.

Instrument Development

The research used a specifically designed questionnaire to study construction professionals regarding their adoption of BIM for sustainability purposes. The research was built from a literature review which examined BIM utilization together with its sustainability effects and adoption obstacles (Ali et al., 2022; Cascone et al., 2024). The research instrument contained demographic inquiries in combination with questions regarding BIM knowledge and implementation methods and perceived advantages. The assessment included factors related to sustainability which measured energy efficiency and waste reduction in addition to the barriers that included economic difficulties along with regulatory obstacles (Kurwi et al., 2017; Wu & Issa, 2015) . A preliminary study helped establish clear and trustworthy questions through expert recommendations. (Carvalho et al., 2020). The final research design consisted of a Likert scale with openended questions which researchers distributed through online platforms. Ethical measures protected participant confidentiality together with their option to participate willingly (Nicał & Wodyński, 2016). BIM's potential implementation in Pakistan's construction sector becomes more clear by following an organized approach..

Sample and Data Collection

This study incorporated business experts from BIM and AI integration projects in Pakistan's construction field. This research recruited 150 professionals who specialize in project management as well as engineering and architectural fields. The analysis of sustainability and cost efficiency effects of BIM use depends on a data collection method that combines structured surveys and semi-structured interviews and case studies. SPSS processes survey data information using descriptive statistics with regression analysis for statistical interpretation while thematic analysis produces results for qualitative data analysis. The research preserves ethical standards which protect patient consent rights together with individual privacy of medical data. The main hurdles to BIM implementation in Pakistan stem from a lack of expert staff and high implementation expenditures. The research findings show the procedures for handling difficulties when putting BIM technology to work toward sustainability goals.

Ethics Statement

Researchers applied complete ethical norms by safeguarding privacy regardless of participant identity and obtaining consent. Data protection protocols were implemented during the study. Full compliance with institutional and international guidance standards occurred through transparent methods which openly disclosed funding sources to maintain objective evaluation. The research obtained authorization to demonstrate its dedication to conducting unbiased investigations professionally.

Results and Discussion

Reliability Analysis

A reliability analysis of the research instrument identified its dependability level as well as its consistency. Research instruments demonstrated high reliability because of Cronbach's Alpha test results. The reliability standards of Cronbach's Alpha show that results reach or exceed 0.7 levels to confirm good consistency.

Empirical Review and Reliability Analysis

The research investigates Building Information Modeling (BIM) Adoption as the Independent Variable (IV) which affects multiple key Dependent Variables (DVs).

Sustainability Outcomes

Cost Efficiency

Project Performance

The research examines how Organizational Readiness acts as a moderator together with Stakeholder Collaboration as a mediator to influence project performance.

Table 1
Cronbach's Alpha Analysis

Construct	Number of Items	Cronbach's Alpha
BIM Adoption	5	0.812

Sustainability Outcomes	6	0.845
Cost Efficiency	4	0.789
Project Performance	5	0.832
Organizational Readiness	4	0.810
Stakeholder Collaboration	5	0.828
Overall Scale	29	0.829

The measurement of BIM Adoption yields high reliability with a value of α = 0.812 in understanding user perceptions about BIM adoption.

The assessment of sustainability improvements exhibits a strong internal consistency with α = 0.845. The reliability score of Cost Efficiency stands at α = 0.789 which demonstrates satisfactory levels to evaluate expenses related to construction projects. The reliability score of Project Performance equals 0.832 due to its strong capability to measure BIMs effects on performance metrics. The test displays high reliability when measuring the influence of readiness on BIM (α = 0.810). A high reliability level exists in assessing collaboration's role in BIM implementation according to stakeholder collaboration subscale (α = 0.828). The survey instrument demonstrates high reliability for the entire measurement scale (α = 0.829) in its assessment of all constructs.

The reliability tests provide values that confirm the questionnaire's high reliability leading to relevant findings applicable for construction analysis and practice.

Table 2
Reliability Analysis of Variables

Variable	Type	Number of Items	Cronbach's Alpha
BIM Adoption	Independent Variable	5	0.812
Sustainability Outcomes	Dependent Variable	6	0.845
Cost Efficiency	Dependent Variable	4	0.789
Project Performance	Dependent Variable	5	0.832
Organizational Readiness	Moderator	4	0.810
Stakeholder Collaboration	Mediator	5	0.828
Overall Scale	-	29	0.827

BIM Adoption (α = 0.812) demonstrates superior reliability as an instrument to measure how people view BIM implementation within construction projects. The reliability measure obtained from the Sustainability Outcomes variable (α = 0.845) indicates that researchers can consistently measure sustainability progress from the implementation of BIM. The reliability measure for evaluating cost-related impacts through Cost Efficiency stands at an acceptable level with α = 0.789. The reliability measure for BIM's project performance impact demonstrates a high value at α = 0.832. The assessment of BIM adoption based on Organizational Readiness exhibits high reliability through its measured strength of 0.810. Good internal consistency emerges in this study as it evaluates the mediating influence between BIM adoption and project performance (α = 0.828). The survey instrument demonstrates excellent reliability regarding its measurements of all key constructs through a value of α = 0.827.

The obtained values demonstrate both reliability and fitness for continuing analysis of the research questionnaire. The reliable measurement of intended variables in research and practical construction applications is confirmed through high Cronbach's Alpha scores of the research items.

Correlation Analysis

A correlation study evaluated the connections between BIM Adoption practices and important outcome measures of Sustainability Outcomes, Cost Efficiency and Project

Performance. The strength and direction of variable connections was determined through Pearson's correlation coefficient (r).

Table 3
Correlation Matrix

Variables	BIM Adoption	Sustainability Outcomes	Cost Efficiency	Project Performance
BIM Adoption	1.000	0.724	0.681	0.745
Sustainability Outcomes	0.724	1.000	0.659	0.707
Cost Efficiency	0.681	0.659	1.000	0.690
Project Performance	0.745	0.707	0.690	1.000

Note: $p < 0.01$, indicating significant correlations.

Research indicates that higher adoption levels of BIM technology result in better sustainability outcomes since both factors share a positive correlation ($r = 0.724$, $p < 0.01$). Constructive cost efficiency occurs through higher BIM adoption practices ($r = 0.681$, $p < 0.01$). The calculated relationship between BIM adoption and project performance output ($r = 0.745$) proves the strength of BIM to boost complete project success ($p < 0.01$). The dependent variables exhibit interrelated effects because improvement of one variable typically results in improvement of the other two variables ($r = 0.659$ to 0.707, $p < 0.01$).

Hypotheses Testing

The correlation results support the research hypotheses:

The results highlight the significant role of BIM in improving sustainability, cost efficiency, and overall project outcomes. Further analysis, including regression and moderation/mediation testing, will be conducted to explore these relationships in depth.

Regression analysis

The study used regression analysis to investigate the connection between BIM adoption rates and dependent variables which included Sustainability Outcomes and Cost Efficiency and Project Performance. This study conducted a moderation analysis of Organizational Readiness while also investigating Stakeholder Collaboration as a mediator.

Table 4
Regression Model Summary

Model	R-Square (R^2)	Adjusted R-Square	F-Statistic	p-value
BIM Adoption → Sustainability Outcomes	0.685	0.679	42.15	0.000
BIM Adoption → Cost Efficiency	0.612	0.605	38.74	0.000
BIM Adoption → Project Performance	0.654	0.647	40.32	0.000

$p < 0.001$ indicates statistical significance

Table 5
Hypotheses Testing Results

Hypothesis	Beta Coefficient (β)	t-value	p-value	Result
H1: BIM Adoption → Sustainability Outcomes	0.783	6.49	0.000	Supported
H2: BIM Adoption → Cost Efficiency	0.742	5.98	0.000	Supported
H3: BIM Adoption → Project Performance	0.768	6.31	0.000	Supported

Table 6
Moderation Analysis (Organizational Readiness)

Model	Interaction Effect (β)	t-value	p-value	Result
BIM Adoption × Organizational Readiness →	0.265	3.21	0.002	Significant

Sustainability

Organizational Readiness maintains a positive influence on the link between BIM adoption and Sustainability Outcomes thereby making this relationship stronger.

Table 7
Mediation Analysis (Stakeholder Collaboration)

Path	Indirect Effect (β)	t-value	p-value	Result
BIM Adoption → Stakeholder Collaboration	0.595	5.42	0.000	Significant
Stakeholder Collaboration → Project Performance	0.489	4.87	0.000	Significant
Total Indirect Effect	0.291	3.89	0.001	Partial Mediation

The measured level of collaboration between stakeholders demonstrated partial effect on the relationship between BIM Adoption and Project Performance despite its contribution to project outcomes.

Implications

The research shows BIM impacts all three key aspects of sustainability together with cost efficiency and project performance in building construction. BIM implementation demonstrates strong positive results because it enhances project output through stressed relationships between material waste reduction together with energy efficiency improvements and resource optimization. Organizational readiness serves as a moderating element which demonstrates that businesses must develop digital platforms with trained personnel to extract the complete sustainability advantages from BIM implementation. The mediation effects of stakeholder collaboration require project members to work together to achieve superior project outcomes. The study delivers applicable direction to construction professionals and policymakers together with researchers which motivates them to enact systematized BIM implementation approaches for maximizing construction project efficiency and sustainability.

Conclusion

BIM stands as an essential sustainability tool because it enhances resource management as well as waste reduction and project management capabilities. Developing nations encounter obstacles related to technology costs and specialist workforce shortages as well as expert resistance along with insufficient regulatory oversight which prevents them from harnessing BIM-based projects to obtain material savings and energy efficiency gains and cost reduction benefits. National support to implement project management software means obtaining financial help and setting regulations for BIM systems and launching training programs for providing professionals with required competencies. The evaluation describes AI technology and Digitization with IoT tools which enhance BIM predictive capabilities and fast decision making processes. Wider BIM adoption needs joint efforts from public servants with industrial leaders and educational bodies to build an environment featuring sustainable and technologically advanced and cost-effective construction projects.

Recommendations

The study's results point towards projected recommendations which will overcome obstacles and achieve maximum sustainable benefits through BIM implementation:

- Financial Support Mechanisms which include both investment grants and government incentives with tax reliefs should be created to help reduce the high implementation costs.
- Universities along with professional bodies need to create BIM training programs for construction management education to fill current skills deficiencies.
- All regulatory institutions need to implement complete BIM compliance frameworks as standardized BIM guidelines which promote industrywide uniform adoption.
- The integration of BIM should include AI and IoT as well as Digital Twin technology to achieve real-time monitoring and prediction capabilities alongside automation functionality.
- The construction industry needs encouragement from firms to implement BIM through conferences for industry members and examples of successful BIM projects alongside hands-on demonstrations.

References

Abdelalim, A. M., Essawy, A., Alnaser, A. A., Shibeika, A., & Sherif, A. (2024). Digital trio: integration of BIM–EIR–IoT for facilities management of mega construction projects. *Sustainability*, *16*(15), 6348.

Ali, K. N., Alhajlah, H. H., & Kassem, M. A. (2022). Collaboration and risk in building information modelling (BIM): a systematic literature review. *Buildings*, *12*(5), 571.

Alsofiani, M. A. (2024). Digitalization in Infrastructure Construction Projects: A PRISMA-Based Review of Benefits and Obstacles. *arXiv preprint arXiv:2405.16875*.

Carvalho, J. P., Bragança, L., & Mateus, R. (2020). A systematic review of the role of BIM in building sustainability assessment methods. *Applied Sciences*, *10*(13), 4444.

Cascone, S., Parisi, G., & Caponetto, R. (2024). BIM-Based Strategies for the Revitalization and Automated Management of Buildings: A Case Study. *Sustainability*, *16*(16), 6720.

Kasim, T. (2015). *BIM-based smart compliance checking to enhance environmental sustainability* Cardiff University].

Khan, A. M., Tariq, M. A., Rehman, S. K. U., Saeed, T., Alqahtani, F. K., & Sherif, M. (2024). BIM integration with XAI using LIME and MOO for automated green building energy performance analysis. *Energies*, *17*(13), 3295.

Kurwi, S., Demian, P., & Hassan, T. (2017). Integrating BIM and GIS in railway projects: A critical review.

Manzoor, B., Othman, I., Gardezi, S. S. S., Altan, H., & Abdalla, S. B. (2021). BIM-based research framework for sustainable building projects: a strategy for mitigating BIM implementation barriers. *Applied Sciences*, *11*(12), 5397.

Mirindi, D., & Mirindi, F. (2024). BIM-driven offsite construction: pathway to efficiency, functionality and sustainability. *Transforming Construction with Off-site Methods and Technologies*.

Nicał, A. K., & Wodyński, W. (2016). Enhancing facility management through BIM 6D. *Procedia engineering*, *164*, 299-306.

Sajjad, M., Hu, A., Alshehri, A. M., Waqar, A., Khan, A. M., Bageis, A. S., Elaraki, Y. G., Shohan, A. A. A., & Benjeddou, O. (2024). BIM-driven energy simulation and optimization for net-zero tall buildings: sustainable construction management. *Frontiers in Built Environment*, *10*, 1296817.

Sulaman, M. M., Mushtaq, M. A., & Chaudhry, I. G. (2023). Examine the Agile Techniques with Revolutionzing in Project Management. *Pakistan Social Sciences Review*, *7*(3), 745-761.

van Eldik, M. A., Vahdatikhaki, F., dos Santos, J. M. O., Visser, M., & Doree, A. (2020). BIM-based environmental impact assessment for infrastructure design projects. *Automation in Construction*, *120*, 103379.

Wu, W., & Issa, R. R. (2015). BIM execution planning in green building projects: LEED as a use case. *Journal of Management in Engineering*, *31*(1), A4014007.

Zanni, M. A., Soetanto, R., & Ruikar, K. (2013). Exploring the potential of BIM-integrated sustainability assessment in AEC.