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THE ASSESSMENT OF THE IMPLEMENTATION OF BUILDING INFORMATION MODELLING (BIM) AND INTEGRATED PROJECT DELIVERY (IPD) IN THE CONSTRUCTION INDUSTRY: A CASE STUDY IN PAKISTAN

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Abstract

This research explores the implementation and impact of Building Information Modelling (BIM) and Integrated Project Delivery (IPD) within Pakistan's construction industry, examining how these methodologies could enhance project outcomes. Utilizing a quantitative survey, the study gathered data from industry professionals to evaluate the extent of BIM and IPD utilization, assess perceptions, and identify barriers to implementation. The results reveal that BIM adoption in Pakistan is notably low, with an estimated implementation rate of just 11% nationally, while findings from this study indicate an even lower rate among surveyed firms. Key challenges identified include a significant shortage of skilled professionals, insufficient training opportunities, and the high initial costs related with BIM technologies. Despite a growing awareness of the benefits of BIM and IPD, substantial gaps remain in their practical application, with many professionals still unfamiliar with or resistant to these modern methods. A comparative analysis with global adoption rates underscores a stark disparity between developed and developing nations. While developed countries have seen widespread integration of BIM and IPD, driven by government mandates and advanced infrastructure, developing countries like Pakistan face considerable hurdles. These include a lack of standardized practices, inadequate regulatory support, and limited resources for training and development. The study concludes that addressing these barriers is critical in maximizing the potential of BIM and IPD in Pakistan. Government support, through policy initiatives and incentives, combined with enhanced educational and training programs, is essential for overcoming the current obstacles. By focusing on these areas, Pakistan can fully leverage BIM and IPD to enhance efficiency and support the overall economic growth of the construction sector.

INTRODUCTION

The inefficiency of project delivery, non-cohesive teams, and lack of process integration have all been pointed out in the construction industry [1]. The traditional, fragmented processes pose challenges and uncertainties for multidisciplinary teams across various organizations. These issues hinder effective information sharing, resulting in communication gaps, repeated work, and reduced project efficiency and execution. With the introduction of Building Information Modelling (BIM) and Integrated Project Delivery (IPD), the construction sector has seen tremendous progress. BIM is an all-inclusive digital depiction of a constructed facility that comprises non-physical items, three-dimensional geometry, and related semantic data [3]. Conversely, IPD is a collaborative delivery method that promotes effective communication and cooperation amongst all project participants during the course of the project [4]. The construction industry is experiencing rapid and ongoing advancements in technologies and methodologies, coupled with escalating expectations for quality, efficiency, and sustainability. These evolving demands present substantial challenges for project managers. Recent data indicates that BIM adoption in Pakistan is as low as 11%, illustrating a substantial gap between the recognized benefits of these technologies and their practical implementation [9]. This research seeks to critically evaluate the current state of BIM and IPD implementation in Pakistan, identify the primary barriers to their adoption, and propose actionable strategies to facilitate their broader integration within the construction sector. Addressing these issues is crucial for advancing the industry's technological capabilities and supporting its overall economic growth. The construction industry in Pakistan plays a vital role in the country's economic development, contributing significantly to GDP and employment. However, the industry faces numerous challenges, including inefficiencies, inadequate infrastructure, and a lack of advanced technological integration. Despite these challenges, there has been a gradual shift towards adopting modern construction practices, including BIM and IPD, to improve project outcomes. The industry's potential for growth is substantial, particularly with ongoing investments in infrastructure and housing projects. Continued focus on improving project management practices and integrating advanced technologies is essential for the construction sector to fully realize its potential in driving Pakistan's economic growth.

1.1 IPD

In AEC organizations, IPD and BIM have grown rapidly in recent years [10]. The emphasis has recently shifted to creative project delivery techniques [11]. Due to their intrinsic qualities, traditional project management techniques like Design–Bid–Build (DBB), Design–Build (DB), or Turnkey project delivery approaches are becoming less popular [12]. IPD is a collaborative approach to project management that encourages early and ongoing involvement of all stakeholders, including owners, architects, and contractors, to maximize project outcomes. IPD, in contrast to conventional approaches like DB and DBB, which frequently result in conflicting relationships and fragmented communication, integrates all key participants from the outset. Using tools like BIM, this integration improves coordination and efficiency, addressing the inefficiencies and higher costs that are frequently associated with traditional delivery methods. By aligning stakeholders' interests through shared risk and reward mechanisms, recent research demonstrates that IPD can significantly improve project performance by reducing conflicts and promoting a more cohesive project execution [13]. By providing a comprehensive digital representation of the physical and functional characteristics of a facility, BIM significantly transforms construction industry project management. BIM, according to recent research, improves project outcomes by enhancing resource management, reducing errors, and enhancing collaboration among stakeholders throughout the project lifecycle. Real-time updates and advanced simulations are made possible by the technology's capacity to integrate various project components, such as design, construction, and operations. This contributes to increased efficiency and cost savings. BIM's role in modernizing construction practices is highlighted by these capabilities, which address many of the inefficiencies and difficulties associated with traditional project delivery methods. [14].

1.2 BIM

BIM has emerged as a fundamental tool in contemporary construction, enabling the simulation and management of the entire project lifecycle through centralized digital models. BIM integrates comprehensive information about a structure's design, construction, and operation into a centralized digital model, enhancing visualization, simulation, and analysis capabilities. This integration facilitates informed decision-making and improved project outcomes by allowing stakeholders to engage in detailed simulations that contribute to more accurate and efficient project planning. However, the successful implementation of BIM requires overcoming challenges related to data management and interoperability. Addressing these issues is crucial for fully leveraging BIM's potential to transform architectural practices [15]. BIM addresses a ground breaking methodology in the design, designing, and development (AEC) industry, zeroing in on the creation and the executives of computerized portrayals of physical and practical qualities of spots [16].

1.3 Why BIM is beneficial in the construction industry

BIM bids significant paybacks for the industry of construction by addressing various aspects of project management and execution. A key benefit of BIM is its ability to perform clash detection, enabling the early identification and resolution of conflicts among various building systems during the design stage. The mentioned practical tactic reduces the likelihood of inflated on-site modifications and delays, leading to smoother project execution. BIM also enhances communication among project stakeholders by providing a centralized platform where all parties can access and share up-to-date information, fostering more efficient and effective collaboration.

Additionally, BIM contributes to more accurate and efficient scheduling through its detailed project models. The integration of time and cost data within BIM models supports precise construction cost estimating and enables better visualization of the project during the planning and pre-construction stages. This comprehensive view aids in organizing facility management and mitigating risks by providing insights into potential issues before they arise. Furthermore, BIM enhances productivity through support for prefabrication and modular construction, which streamlines the building process by allowing for off-site fabrication of components. This results in faster construction times and improved safety on site, as the prefabricated elements are assembled with greater precision and reduced manual handling.

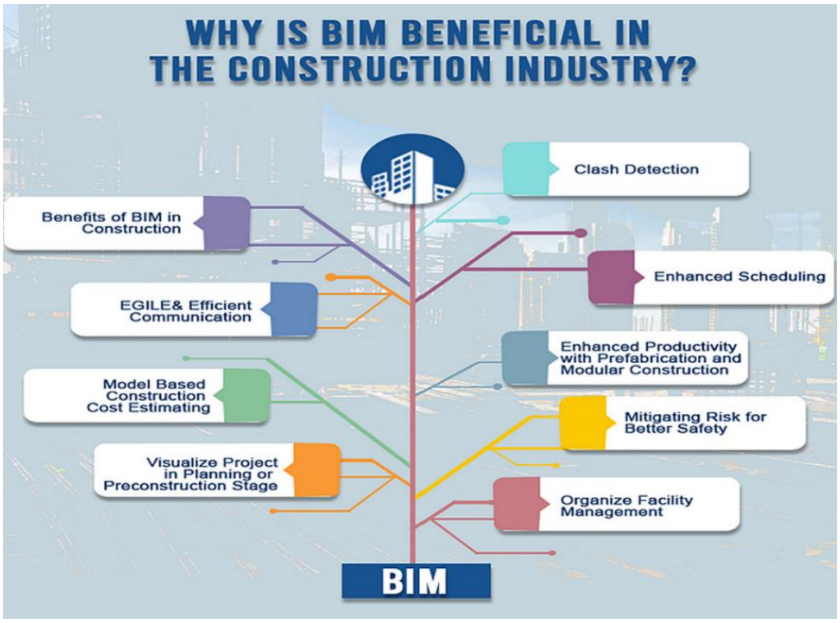


Fig. 1 Why BIM is beneficial in the construction Industry

1.4 BIM Implementation Globally

Scholars across the globe have been extensively examining the obstacles in relation with BIM implementation within the construction industry. As reported by Bhatti et al. [17], the global adoption of BIM surged from 26% in 2007 to 57% in 2016, nearly doubling within a decade. In developed nations, the progress of BIM implementation has been significantly bolstered by mandatory government policies [18]. However, in developing countries like Malaysia, the adoption rate remains low owing to the absence of national BIM guidelines, challenges in software amalgamation, competition, and hesitancy in skill transfer [19].

1.5 BIM Implementation Pakistan

Based on the research the application of BIM inside the Pakistani construction industry remains relatively underdeveloped, with an adoption rate estimated at approximately 11%. The study identifies several barriers to more widespread BIM adoption in Pakistan. These barriers include limited awareness and understanding of BIM technologies, inadequate training opportunities, and a general resistance to transitioning from traditional construction practices to new technological approaches. Despite these challenges, the research indicates a growing interest in BIM and highlights ongoing efforts to enhance its adoption through improved educational initiatives and supportive policy frameworks. The findings suggest that while BIM implementation in Pakistan is currently limited, there is significant potential for growth as awareness and infrastructure continue to evolve [20].

2. Research Methodology

This study was conducted in three distinct phases, each strategically designed to collect, process, and analyse data to evaluate the influence of BIM and IPD on construction projects in Pakistan. The research methodology was carefully selected to ensure precision, reliability, and reproducibility of the findings.

During Phase 1, a systematic literature review was undertaken to conduct a preliminary examination of the barriers hindering BIM implementation in Pakistan. Additionally, global challenges were identified to offer a broader perspective and explore common mitigation strategies.

Phase 2 involved the development and dissemination of a structured questionnaire among professionals in the Architecture, Engineering, and Construction (AEC) industry. This survey aimed to assess and prioritize the identified barriers and benefits associated with BIM adoption in Pakistan.

In Phase 3, we analysed the survey data to identify key trends and relationships. Descriptive statistics summarized the responses, while correlation and inferential tests examined the significance of the findings. This analysis helped us understand the practical impact of BIM and IPD and validated the barriers and benefits identified in the previous phases

2.1 Questionnaire Survey

Following the literature review, a structured questionnaire survey was conducted to collect primary data from professionals working in the Architecture, Engineering, and Construction (AEC) sectors in Pakistan. The survey was distributed to 19 firms, selected to represent a diverse cross-section of the industry, including engineering, architecture, and construction companies. These 19 firms were selected through purposive sampling to ensure diversity in project type, size, and geographic coverage. The questionnaire consisted of 17 questions, divided into sections that addressed the respondents' fields of operation, experience, awareness and use of BIM and IPD, and perceived benefits and barriers. For instance, respondents were asked about their company's area of expertise, years of operation, and their role within the company. Questions were also included to gauge the level of BIM and IPD adoption, with survey results showed that only 6% of the respondent firms reported actively using BIM, significantly lower than the estimated 11% national implementation rate. In contrast, 36% of firms indicated the use of IPD. This gap illustrates the variability in adoption between different firm types and regions, as also noted in previous literature [20]. Additionally, the survey explored the perceived effectiveness of these technologies in improving project outcomes, such as project documentation and communication among team members. The survey was designed to capture

both quantitative and qualitative data, allowing for a detailed analysis of the respondents' experiences and opinions regarding BIM and IPD in their respective projects.

2.2 Data Analysis

The data obtained from the questionnaire survey were examined through a combination of descriptive and inferential statistical techniques. Descriptive statistics, including mean values and percentage distributions, were employed to synthesize survey responses and highlight significant patterns and trends. For example, 79% of respondents who had used BIM or IPD reported that these tools were helpful in their work, while 63% found them beneficial for their projects. To further explore relationships between variables, cross-tabulation and correlation analysis were employed. This included examining the correlation between company size and the likelihood of BIM/IPD adoption, as well as the impact of these technologies on project success metrics such as cost, time, and quality. Inferential statistics, such as Chi-square tests, were used to determine the statistical significance of these relationships. Qualitative data from open-ended survey questions were analysed using thematic analysis, identifying common themes such as the lack of national standards, high costs, and the need for specialized training as barriers to BIM/IPD adoption. The results from this analysis were then compared with the literature review findings to identify consistencies and areas for further investigation. Throughout the analysis, all relevant data were included to guarantee the accurateness in addition to consistency of the findings.

3. Results and Discussion

The survey results indicate that most respondents are from engineering (47%) and construction (43%), with only 10% from architecture. This distribution underscores the primary roles of engineers and construction professionals in BIM and IPD adoption [21]. Additionally, 68% of respondents are familiar with BIM and IPD, reflecting the growing awareness in the industry [22]. However, the 32% who are unaware suggest that further education is needed to achieve broader adoption. These findings highlight both the current engagement and the existing gaps in knowledge across the industry.

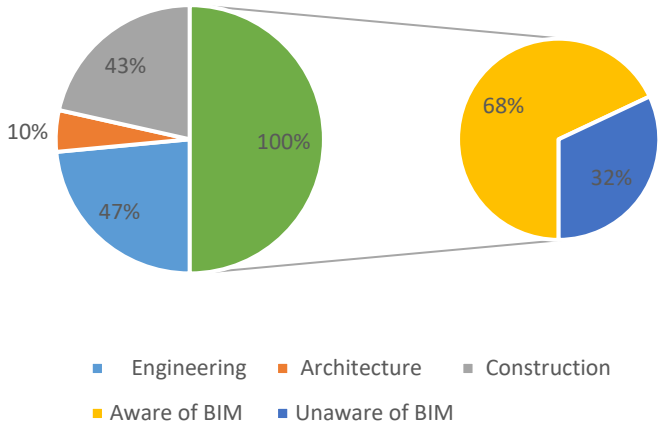
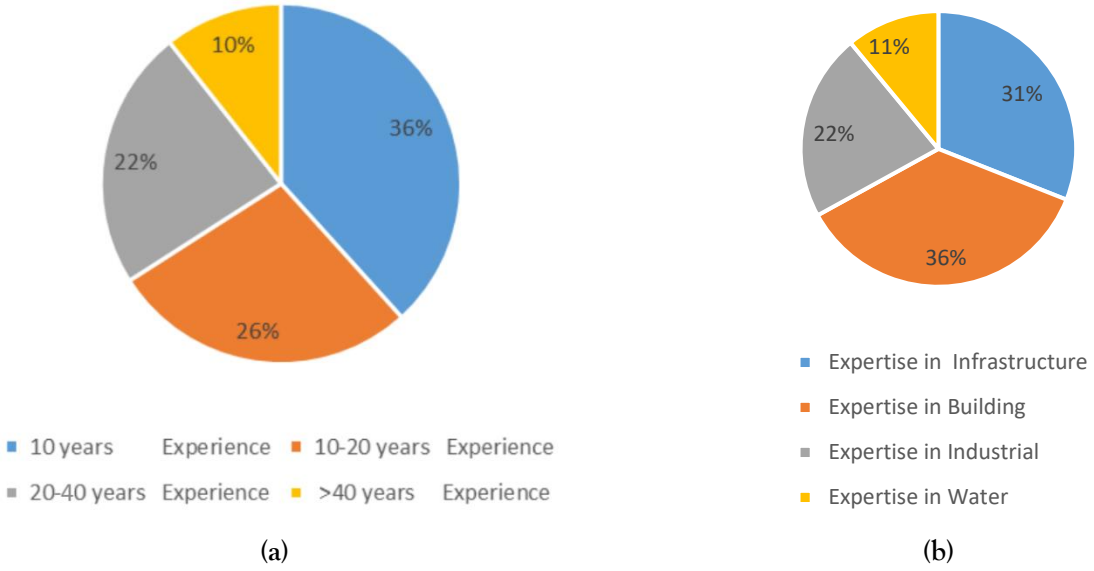


Fig. 2 BIM Awareness

Figure 3a shows that 36% of companies have been operating for 10 years, 26% for 10-20 years, 22% for 20-30 years, and 16% for over 40 years. Figure 3b indicates that 36% of these companies specialize in building construction, 31% in infrastructure, 22% in industrial projects, and 11% in water projects. This distribution highlights a strong focus on building and infrastructure, with a mix of newer and established firms across the industry, which may influence the adoption of BIM technologies, as different sectors have varying needs and challenges [22].



(a) (b)

Fig. 3 Experience and Expertise (a) Total Years of Experience; (b) Expertise in relevant field

3.1 The Role of Government in Promoting BIM and IPD

The survey results reveal a strong consensus on the government's role in advancing BIM implementation in the construction industry. Most respondents (52%) advocate for the government to assume a leading role, underscoring the expectation that government-led initiatives and policies are essential for driving the widespread adoption of BIM. Meanwhile, 26% of participants support a guiding role, indicating that while direct leadership is favoured, there is also an appreciation for the government's role in providing strategic direction and support without full control. Only 6% of respondents favour a more general, less involved approach, and 16% believe that the government should not be involved at all. These findings clearly demonstrate that most industry professionals see substantial governmental involvement as crucial for the successful implementation of BIM, with a significant emphasis on the need for strong, proactive leadership.

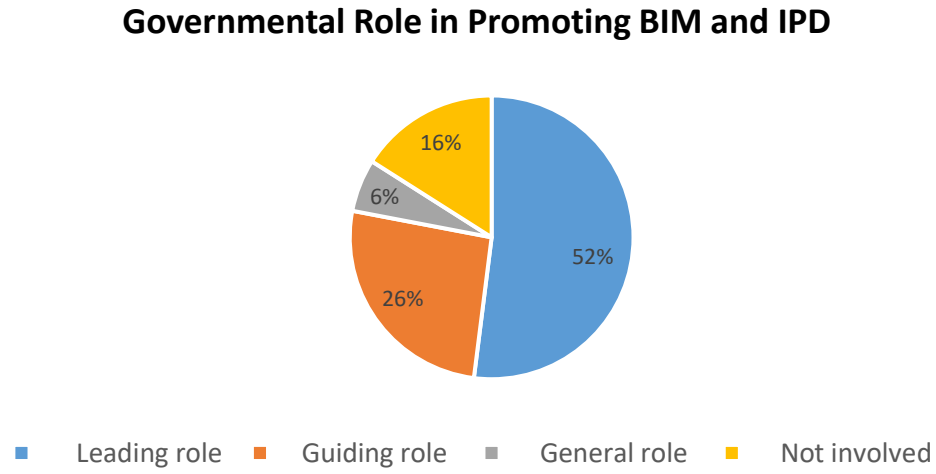


Fig..4 Role of Government in Promoting BIM and IPD

3.2 Benefits of BIM in Pakistan

BIM facilitates numerous improvements in the construction industry, enhancing various aspects of project management and execution. Quantity Estimation (79%) is significantly improved, allowing for precise predictions of material quantities needed for construction. BIM also plays a crucial role in reducing Reworks & Clashes (77%), minimizing costly revisions during the building process. Additionally, it enhances Documentation (77%), ensuring that all project information is meticulously recorded and accessible. The Design Review (74%) process benefits greatly from BIM, facilitating thorough assessments of design plans before construction begins. Communication (74%) among project team members is also strengthened through BIM's collaborative features, fostering better coordination. Although slightly less impactful, BIM aids New Staff (66%) in quickly understanding ongoing projects, and it helps in reducing Omissions & Errors (66%) during project execution. Furthermore, Client Satisfaction (64%) is positively influenced by BIM-implemented projects, indicating that the technology meets client expectations to a significant extent. The capability of generating new 3D Views (63%) and sections instantly is another advantage. BIM also assists in Planning (61%) and contributes to reducing both Construction Time (57%) and Construction Costs (57%). Lastly, BIM supports Quality Control (56%) during the project, and although it has a lower impact, it still helps to minimize Execution Problems (53%). These ratings highlight the importance of BIM as a tool for enhancing efficiency, accuracy, and collaboration in the construction industry.

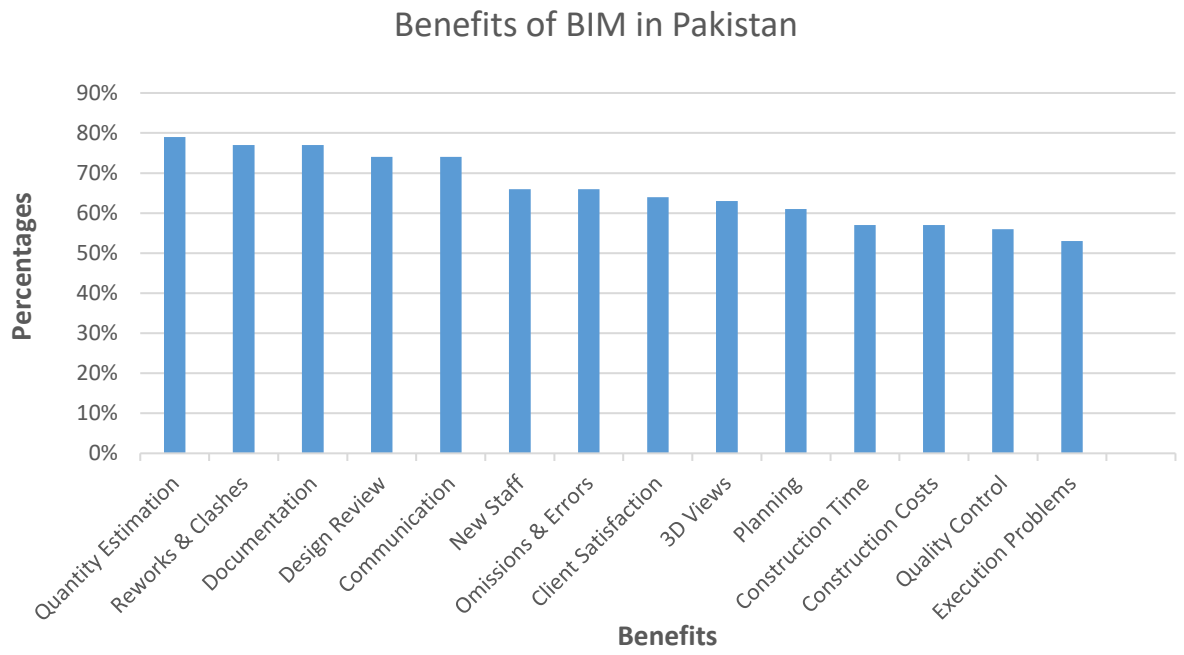


Fig. 5 Benefits of BIM in Pakistan

3.3 BIM implementation in Pakistan

The survey results highlight the primary barriers to implementing BIM within the construction industry, with the lack of professionals (27%) being the most significant challenge. This finding aligns with existing literature that emphasizes the shortage of skilled personnel as a critical hindrance to BIM adoption [23]. Following closely, the lack of information sharing in BIM (22%) and the high initial cost of software (18%) are also substantial barriers, reflecting concerns about collaboration inefficiencies and the financial burden of adopting new technologies [24]. The relatively lower percentages associated with incomplete national standards (12%), the high cost of training (11%), and the high cost of the implementation process (10%) suggest that while these factors are important, they are perceived as less prohibitive compared to the

availability of skilled professionals and information-sharing challenges. These results underscore the multifaceted nature of BIM adoption barriers, indicating that successful implementation requires addressing both technical and human resource challenges.

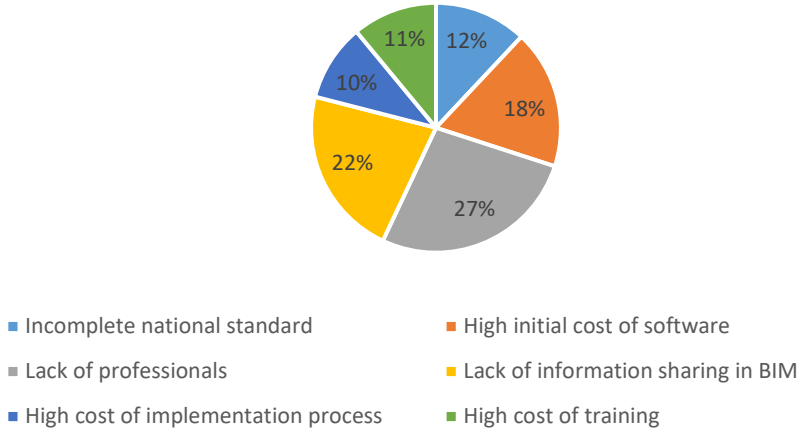


Fig. 6 BIM implementation in Pakistan

3.4 BIM implementation in other country

The implementation of BIM in various countries has been met with several significant challenges, reflecting a range of industry-specific and contextual barriers. In many developed nations, high initial costs associated with BIM software and training have been major obstacles, particularly for smaller firms and projects with limited budgets. Additionally, the lack of standardized protocols and integration frameworks often results in inconsistent BIM practices and difficulties in data interoperability. Resistance to change among traditional construction practices and insufficient support from regulatory bodies further compound these challenges. Moreover, the shortage of skilled professionals trained in BIM methodologies exacerbates implementation issues, delaying the realization of BIM's full potential. Addressing these barriers through targeted policy initiatives, enhanced training programs, and the development of standardized practices is essential for overcoming adoption hurdles and maximizing the benefits of BIM across diverse international contexts.

4. Conclusion & Recommendations

4.1 Conclusion

The analysis of BIM and IPD adoption within Pakistan's construction industry reveals a significant gap between the potential benefits of these technologies and their current level of implementation. While BIM and IPD have demonstrated their ability to improve project outcomes in developed countries, Pakistan faces several challenges that hinder widespread adoption. These challenges include a lack of skilled professionals, insufficient training opportunities, and the absence of a supportive regulatory framework. The limited adoption rate of BIM in Pakistan, currently estimated at 11%, underscores the need for targeted efforts to address these barriers. Global comparisons further emphasize the disparity in BIM adoption rates between developed and developing nations. In countries with established BIM mandates, the technology has been effectively integrated into construction practices, leading to enhanced project efficiency and reduced costs. Conversely, in Pakistan, the absence of such mandates and the reliance on traditional construction practices have slowed the adoption of BIM and IPD. Despite these challenges, there is a growing recognition of the importance of these

technologies in modernizing the construction industry. To fully realize the benefits of BIM and IPD, Pakistan must focus on enhancing educational initiatives, providing comprehensive training programs, and developing a supportive policy framework. By addressing these critical areas, the country can overcome the current barriers to adoption and leverage the full potential of BIM and IPD to drive efficiency, reduce costs, and contribute to the broader economic development of the construction industry.

4.2 Strategic Recommendations for BIM implementation in Pakistan and Other Developing Nations

To enhance the adoption of BIM in Pakistan and other countries, it is essential to implement several strategic recommendations. Firstly, governments should develop and enforce standardized BIM protocols to ensure consistency and interoperability across projects. Investing in comprehensive training programs and certification for construction professionals can bridge the skills gap and facilitate smoother transitions to BIM technologies. Financial incentives and subsidies could help mitigate the high initial costs associated with BIM software and implementation. Additionally, fostering industry-wide collaboration and knowledge sharing through forums and partnerships can address resistance to change and promote best practices. Finally, integrating BIM with national building codes and regulations can support its broader adoption and ensure alignment with local construction standards. These measures collectively aim to overcome existing barriers and accelerate the effective use of BIM across diverse contexts.

REFERENCES

[1] Ling, F.Y.Y.; Teo, P.X.; Li, S.; Zhang, Z.; Ma, Q. Adoption of Integrated Project Delivery practices for superior project performance. J. Leg. Aff. Disput. Resolut. Eng. Constr. 2020, 12, 05020014. [Google Scholar] [CrossRef]

[2] Ozorhon, B.; Karahan, U. Critical success factors of building information modeling implementation. J. Manag. Eng. 2017, 33, 04016054.

[3] Aaron Sun, W., Mollaoglu, S., Miller, V. and Manata, B. (2015). Communication Behaviors to Implement Innovations: How Do AEC Teams Communicate in IPD Projects? Project Management Journal, 46. doi: 10.1002/pmj.21478

[4] Abdirad, H. (2015). Advancing in Building Information Modeling (BIM) Contracting: Trends in the AEC/FM Industry. Proceeding of the Proceedings of the AEI Conference: Birth and Life of the Integrated Building, Milwaukee, Wisconsin, March 24-27

[5] R. Almashhour, H. Abuzaid, and S. El-Sayegh, "Creativity in Project Implementation: An Empirical Study of Project Managers," Buildings, vol. 14, no. 3, doi: 10.3390/buildings14030818.

[6] R. Kassa, I. Ogundare, B. Lines, J. B. Smithwick, N. J. Kepple, and K. T. Sullivan, "Developing a construct to measure contractor project manager performance competencies," Engineering, Construction and Architectural Management, vol. ahead-of-print, no. ahead-of-print, 2023, doi: 10.1108/ECAM-12-2022-1122.

[7] K. K. Naji, M. Gunduz, and M. Adalbi, "Analysis of Critical Project Success Factors—Sustainable Management of the Fast-Track Construction Industry," Buildings, vol. 13, no. 11, doi: 10.3390/buildings13112890.

[8] H. Turkoglu, D. Arditi, and G. Polat, "Mathematical Mult objective Optimization Model for Trade-Offs in Small-Scale Construction Projects," Journal of Construction Engineering and Management, vol. 149, no. 7, p. 04023056, 2023/07/01.

[9] Sajjad, M., Hu, A., Radu, D., Waqar, A., Almujibah, H. R., & Mateen, A. (2024). BIM implementation in project management practices for sustainable development: Partial Least square approach. Ain Shams Engineering Journal, 103048. https://doi.org/10.1016/j.asej.2024.103048

[10] Owen, R., Amor, R., Palmer, M., Dickinson, J., Tatum, C. B., Kazi, A. S., Prins, M., Kiviniemi, A., & East, B. (2010). Challenges for Integrated Design and Delivery Solutions. Architectural Engineering and Design Management, 6(4), 232–240. https://doi.org/10.3763/aedm.2010.IDDS1

[11] Pal, A., & Nassarudin, A. (2020). Integrated project delivery adoption framework for construction projects in India. IGLC 28 - 28th Annual Conference of the International Group for Lean Construction 2020. https://doi.org/10.24928/2020/0018

[12] Adamtey, S. A. (2021). A Case Study Performance Analysis of Design-Build and Integrated Project Delivery Methods. International Journal of Construction Education and Research, 17(1), 68–84. https://doi.org/10.1080/15578771.2019.1696903

[13] G. Chen, J. Chen, Y. Tang, Q. Li, and X. Luo, "Identifying Effective Collaborative Behaviors in Building Information Modeling–Enabled Construction Projects," *Journal of Construction Engineering and Management*, vol. 148, no. 6, Jun. 2022, doi:10.1061/(ASCE)CO.1943-7862.0002270

[14] T. N. Nguyen, "BIM in Construction: Benefits, Challenges, and Development Trends," International Journal of Scientific Research in Science, Engineering and Technology, vol. 12, no. 2, pp. 160–165, Mar. 2025, doi: 10.32628/IJSRSET25122140.

[15] Bredella N. Simulation and Architecture: Mapping Building Information Modeling. NTM. 2019 Dec;27(4):419-441. English. doi: 10.1007/s00048-019-00224-9. PMID: 31616955.

[16] I. Kaini, Implementation of Integrated Project Delivery (IPD) and Building Information Modelling (BIM) in the Construction Industry, M.S. thesis, Faculty of Civil Engineering, Universiti Teknologi Malaysia, Johor, Malaysia, 2013..

[17] I. A. Bhatti et al., "Implementation of Building Information Modeling (BIM) in Pakistan Construction Industry," *Engineering, Technology & Applied Science Research*, vol. 8, no. 4, pp. 3199–3202, Aug. 2018. The authors report:

[18] Bin Zakaria, Z.; Muhamed Ali, N.; Tarmizi Haron, A.; Marshall-ponting, A.J.; Abd Hamid, Z. Exploring the adoption of Building Information Modelling (BIM) in the Malaysian construction industry: A qualitative approach. Int. J. Res. Eng. Technol. 2013, 2, 384–395.

[19] Ullah, K.; Lill, I.; Witt, E. An overview of BIM adoption in the construction industry: Benefits and barriers. In Proceedings of the 10th Nordic Conference on Construction Economics and Organization, Tallinn, Estonia, 7–8 May 2019; Emerald Publishing Limited: Bingley, UK, 2019.

[20]. Khalfan, N. B. Bhatti et al., "Investigating BIM Implementation Barriers and Issues in Pakistan Construction Industry," *Applied Sciences*, vol. 10, no. 20, p. 7250, Oct. 2020, doi: 10.3390/app10207250.

[21] Eastman, C., Teicholz, P., Sacks, R., & Liston, K. (2011). BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors. John Wiley & Sons.

[22] Succar, B. (2009). Building information modelling framework: A research and delivery foundation for industry stakeholders. Automation in Construction, 18(3), 357-375

[23] Smith, D. K., & Tardif, M. (2020). Building Information Modeling: A Strategic Implementation Guide for Architects, Engineers, Constructors, and Real Estate Asset Managers. John Wiley & Sons.

[24] Azhar, S., Khalfan, M., & Maqsood, T. (2017). Building information Modeling (BIM): Now and beyond. Construction Economics and Building, 12(4), 15-28.