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An Empirical Study on Significance of BIM Adoption in Various Stages of Project Lifecycle

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Abstract: *BIM adoption can be done in different stages of the project life cycle, from the Pre-Construction phase to post-Construction phase. This paper provides an overview of BIM adoption in different stages of the project life cycle and highlights the benefits and challenges associated with each stage. The Preliminary stage is pre-construction, BIM can play a significant role in improving the accuracy and efficiency of the design and planning processes. The secondary stage is construction which involves the use of BIM for coordination, sequencing, and construction management. The final stage is post-Construction operation, where BIM can be used for operation and maintenance. The paper describes the benefits of BIM adoption, including improved project performance, reduced errors and rework, and enhanced decision-making. The study identifies the adoption of BIM in different stages of the project lifecycle, including conceptual design, detailed design, construction & Operation and maintenance & Project closure phase discusses how BIM can be applied in each stages of the project.*

Keywords: BIM-Building Information Modelling, Project lifecycle

I. INTRODUCTION

Many issues in Construction, including low productivity, poor quality, growing costs, building waste, delays, and a lack of communication among project stakeholders, plague the construction industry.By adoption of Building information modelling (BIM) in the construction project life cycle, it creates potential to address these challenges and improve construction industry performance. BIM is becoming an essential tool in the construction industry as it provides several benefits that contribute to construction projects Success. It is a significant technological advancement of the construction industry for drawing, modelling, simulation, construction management and control. It is a digital process that is transforming the building and infrastructure projects are designed, constructed, and managed. BIM provides a digital representation of the physical and functional characteristics of a building or infrastructure asset. It enables design, construction, and operations teams to collaborate effectively and make more informed decisions throughout the project life Cycle. BIM is an essential tool in the project life cycle, from the Pre-Construction stage to post-Construction phase. It allows project teams to work in a more coordinated and integrated manner, reducing errors and delays, improving productivity, and enhancing the quality of the Project. The BIM process involves the use of 3D modelling software, which allows for the creation of digital representations of buildings and structures. These models can be used to simulate and test different design options, analyse the building's performance, and communicate design intent to project stakeholders.

II. BIM ADOPTION IN PROJECT LIFECYCLE

The need of adoption of Building information modelling (BIM) in the construction project life cycle creates potential to address Construction challenges, barriers and improve construction industry performance. BIM can be applied to various stages of the project life cycle.

- **During the Pre-Construction Phase:** BIM can play a significant role in improving the accuracy and efficiency of the design and planning processes. Here are some ways BIM can be used during the pre-construction phase:

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- **Design and Visualization:** BIM software allows architects and designers to create 3D models of the building, which can be used to visualize the project and make design decisions.
- **Clash Detection:** BIM software can detect clashes or conflicts in the design between various systems, such as mechanical, electrical, and plumbing systems. This helps to identify potential issues before construction begins, saving time and reducing costly rework.
- **Cost Estimation:** BIM models can be used to generate accurate cost estimates for the project, allowing for better cost control and budget management. The software can also provide data on the amount of materials needed, labour costs, and other project expenses.
- **Schedule Optimization:** BIM can be used to create a construction schedule, identifying the critical path and highlighting potential delays. This allows for better project planning and management, reducing the risk of schedule overruns and delays.
- **During the Construction Phase:** BIM plays a crucial role in improving the efficiency, accuracy, and quality of construction projects. It provides a benefits of Clash detection, Construction sequencing, Quantity take-off and 4D simulation. BIM can be used to coordinate the work of different trades and subcontractors on a construction project. By sharing a single, up-to-date model, everyone can stay informed and work together more effectively.
- **During the Maintenance Phase:** BIM can be a useful tool in the maintenance phase of a Project life cycle. It helps to improve the efficiency and effectiveness of maintenance activities, reduce downtime and costs, and ensure the project is in good condition.
- **During the Project Closure Phase:** BIM can be a valuable tool in the project closure phase, helping to ensure that project objectives are met, and information is handed over to the owner or operator for ongoing facility management.

III. LITERATURE REVIEW

Nawaz, A., Su, X., & Nasir, I. M. (2021) - The authors used a quantitative approach to analyse data collected from project managers, engineers, and contractors. They find that BIM adoption has a positive impact on planning and scheduling in mega plan projects, leading to improved project coordination, communication, and collaboration. Overall, the study suggests that BIM adoption can be an effective strategy for improving planning and scheduling in mega plan projects and can contribute to the successful implementation of large-scale infrastructure projects. (1)

Arrotéia, A. V., &Melhado, S. B. (2020) - The authors describe the benefits of BIM in improving project planning, cost estimation, and collaboration among project stakeholders. They also discuss the challenges encountered during the implementation of BIM and provide recommendations for future use of BIM in infrastructure projects. Overall, the article highlights the potential of BIM to improve project outcomes in the pre-construction phase of infrastructure projects. (2)

Hamma-adama, M., Kouider, T., & Salman, H. (2020) -Drivers included improvements in project quality, collaboration, and communication, as well as increased productivity and efficiency. On the other hand, the main barriers to BIM adoption were found to be the lack of awareness and education about BIM, the high cost of BIM software and hardware, resistance to change, and the lack of government support and policies.The authors also found that the size of the construction company and the level of experience with BIM were significant factors in determining the level of BIM adoption. Finally, the authors recommended that more education and awareness programs about BIM be developed, and that governments and industry organizations provide more incentives and support for BIM adoption. (3)

Sinenko, S., Hanitsch, P., Aliev, S., &Volovik, M. (2020) -The authors present a case study of a construction project where BIM was implemented. The project involved the construction of a high-rise building, and the authors describe how BIM was used to manage the project and improve communication between project stakeholders. The case study illustrates the benefits of BIM, including improved collaboration, reduced errors, and improved project outcomes.The article provides a useful overview of BIM and its implementation in construction projects. (4)

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Ullah, K., Lill, I., & Witt, E. (2019, May) - The authors describe by introducing BIM and its potential benefits for the construction industry including increased efficiency, reduced costs, and improved collaboration. The article then reviews the current state of BIM adoption in the construction industry. The authors then examine the challenges that construction companies face when adopting BIM, including a lack of understanding of BIM, resistance to change, and the need for significant. (5)

Razali, M. F., Haron, N. A., Hassim, S., Alias, A. H., Harun, A. N., & Abubakar, A. S. (2019, November) -The authors highlight the benefits of using BIM throughout the lifecycle of a project, including improved collaboration and communication among stakeholders, increased efficiency in design and construction, and better data management and maintenance throughout the Project's life. The article provides a detailed overview of the BIM process, including the creation of 3D models, the incorporation of data into those models, and the use of BIM for analysis and decision-making. Overall, the article provides a comprehensive overview of the application of BIM in the building lifecycle, highlighting both the benefits and limitations of this technology. (6)

Ahmed, S. (2018) - The study begins by explaining the concept of BIM and how it can be used in the construction industry. The authors then describethe various benefits of BIM, such as improved collaboration, reduced errors, and improved project management. Despite the many benefits of BIM, the study identifies several barriers that hinder its implementation in the construction industry. These barriers include a lack of awareness of BIM, a lack of expertise in using BIM software, resistance to change, high implementation costs, and a lack of standardization. The authors conclude that addressing these barriers is essential to promote the implementation of BIM in the construction industry. (7)

Marefat, A., Toosi, H., &Hasankhanlo, R. M. (2018) -The authors also address some of the barriers to BIM implementation, including lack of standardization, insufficient training and education, and resistance to change. They propose solutions to overcome these barriers, such as developing standard BIM templates and protocols, providing adequate training and education, and creating a culture of collaboration and innovation in the construction industry.Overall, the article suggests that BIM has significant potential to improve construction safety management, but its successful implementation requires overcoming various challenges.(8)

Mesároš, P., &Mandičák, T. (2017, October) -The article emphasizes the significant potential benefits of using BIM in construction project management, while acknowledging the importance of careful planning and management to ensure successful implementation and adoption. The authors also highlight several challenges that can arise when implementing BIM in construction project management, including the need for specialized skills and training, data security and privacy concerns, and potential resistance to change from stakeholders. (9)

Hafeez, M. A., Vukovic, V., Chahrour, R., Kassem, M., & Dawood, N. (2016, March) - The authors propose a framework for implementing Project life cycle BIM processes in Qatar. The framework includes six phases: pre-construction, design, construction, handover, operation. Each phase is associated with specific BIM activities, such as clash detection during the construction phase and asset management during the operation phase. The authors describe that implementing whole life cycle BIM processes can improve project efficiency, reduce costs, and enhance collaboration among project stakeholders. They also suggest that the proposed framework can be adapted for use in other countries and regions. (10)

Vozzola, M., Cangialosi, G., & Turco, M. L. (2009, September) - The paper presents a case study of a hospital construction project where BIM was used extensively throughout the project lifecycle. The authors discuss the benefits of using BIM, such as improved communication and collaboration among stakeholders, better visualization and analysis of the building design, and more accurate cost estimation. The authors also highlight the challenges of implementing BIM, such as the need for specialized software and hardware. Finally, the paper concludes by suggesting that BIM can be a valuable tool for improving the efficiency and effectiveness of the construction process. (11)

Okakpu, A., Ghaffarianhoseini, A., Tookey, J., Haar, J., Ghaffarianhoseini, A., & Rehman, A. U. (2022)-The study was conducted using a qualitative research approach, which involved semi-structured interviews with 23 stakeholders involved in the construction projects.The study found that stakeholders perceive BIM as an effective tool for improving the efficiency and effectiveness of the project. The adoption of BIM for projects is influenced by several risk factors, including technical challenges, financial barriers, cultural resistance, and lack of BIM standards and

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guidelines. The authors conclude that the successful adoption of BIM for projects requires a coordinated approach by all stakeholders. (12)

Jaaron, A. A., Hijazi, I. H., & Musleh, K. I. Y. (2022). -The authors describe the importance of effective change management in BIM adoption, which requires a thorough understanding of the change process, the readiness of the organization, and the stakeholder engagement. The article concludes that the proposed model can serve as a framework for construction companies to systematically plan, execute and monitor BIM adoption, and to overcome potential barriers and challenges. Furthermore, the integration of ADKAR elements in the model can help change managers to better manage the change process and ensure that employees are fully engaged and committed to the adoption of BIM. (13)

Li, L., Yuan, J., Tang, M., Xu, Z., Xu, W., & Cheng, Y. (2021). -The authors describe a case scenario in which the system is used to manage the project lifecycle of a commercial office building. The system is able to provide the building owner with real-time information on energy consumption, indoor air quality, and occupancy levels, among other things. The system is also able to predict future energy consumption and identify potential maintenance issues. Overall, the article highlights the potential benefits of using BIM-enabled building lifecycle management systems for building owners, including improved building performance, reduced operating costs, and better decision-making. (14)

Quoc, T. N., Van, T. N., Ngoc, D. T., & Xuan, A. P. (2022)-The article also provides a detailed overview of the BIM process and its various stages, including design, construction, and operation. The authors highlight the importance of BIM in each stage and how it can help stakeholders achieve their goals more effectively. They also discuss the challenges of implementing BIM and offer recommendations for overcoming them.Overall, the article concludes that BIM can bring significant benefits to all stakeholders involved in construction projects, including improved project outcomes, increased productivity, and reduced costs.(15)

Al-Ashmori, Y. Y., Othman, I., Rahmawati, Y., Amran, Y. M., Sabah, S. A., Rafindadi, A. D. U., &Mikić, M. (2020)-The article also examines the current state of BIM implementation in Malaysia and identifies barriers to its adoption, such as the lack of BIM standards and guidelines, inadequate BIM training, and the high cost of BIM software and hardware.The authors conclude that BIM has the potential to transform the construction industry in Malaysia and improve project outcomes. However, its successful implementation will require a concerted effort from all stakeholders to overcome existing barriers and promote the benefits of BIM. (16)

Alasmari, E., Martinez-Vazquez, P., &Baniotopoulos, C. (2022) - The systematic literature review provides evidence that the adoption of BIM in construction projects can significantly impact the Life Cycle Cost (LCC) of the project positively. The study highlights the need for proper planning, investment in technology and human resources, and a change in the traditional construction industry's culture and mindset to achieve successful BIM adoption. (17)

Xu, X., Ma, L., & Ding, L. (2014) - The proposed framework is divided into four phases: pre-construction, construction, operation, and maintenance. Each phase involves different types of data and stakeholders, and the authors suggest specific BIM-enabled tools and strategies for managing information in each phase. The article describes the benefits of using BIM for life-cycle information management in construction projects, including improved collaboration, cost savings, and better decision-making. (18)

Jagadeesh, G. M., &Jagadisan, S. (2019) - The study found that while awareness of BIM technology is high among construction professionals in India, adoption rates are relatively low. Lack of knowledge and training, limited availability of BIM software, and resistance to change were described as the main barriers to adoption. However, the authors note that there is a growing interest in BIM technology in India, particularly among large construction firms and government agencies. The authors conclude that there is a need for greater education and training on BIM technology in India, as well as increased availability and affordability of BIM software. (19)

Salvi, S., Patil, M. A., Mhetre, M. S., Patil, M. Y., & Shinde (2018) - The authors describe the importance of sustainability in the construction industry and the need to consider the entire lifecycle of a building, from design to demolition. They suggest that BIM can be used to perform accurate and comprehensive assessments of a building's environmental impact throughout its lifecycle. The article describes the various stages of a building's lifecycle and explains how BIM can be used in each stage. For example, BIM can be used in the design stage to optimize building performance and reduce energy consumption. During construction, BIM can be used to monitor the use of materials and ensure that they are being used efficiently. The authors also discuss the use of BIM in maintenance and operations,

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where it can be used to monitor energy consumption, identify areas for improvement, and track the building's performance over time. Finally, BIM can be used in the demolitionstage to plan for the safe and efficient removal of the building and the disposal of its materials. (20)

Cepa, J. J., Pavón, R. M., Alberti, M. G., Ciccone, A., &Asprone, D. (2023) - The authors describe the importance of BIM in the entire lifecycle of infrastructure projects, including design, construction, operation, maintenance, and demolition. They suggest that BIM can improve the efficiency and effectiveness of infrastructure management and maintenance by providing accurate and timely information about the condition of infrastructure assets. The article describes the potential benefits of BIM implementation in the operation, maintenance, and transport infrastructure sector, including improved asset management, reduced maintenance costs, and increased safety. (21)

Liu, Z., Lu, Y., Nath, T., Wang, Q., Tiong, R. L. K., &Peh, L. L. C. (2022) - The study found that BIM competency & communication and collaboration had the most significant impact on BIM adoption during the construction phase. The study recommends that construction companies should focus on developing BIM competency and improving communication and collaboration among stakeholders to facilitate successful BIM adoption during construction.(22)

Bui, N., Merschbrock, C., &Munkvold, B. E. (2016) - The authors describe the potential benefits of BIM in project lifecycle in improving project management, reducing costs, and enhancing collaboration. However, they also note the limited adoption of BIM in developing countries due to various factors such as lack of awareness, infrastructure, and technical skills. The article concludes with recommendations for promoting the adoption of BIM in developing countries, including capacity building, collaboration, and government support. (23)

IV. CONCLUSION

Building Information Modelling (BIM) adoption has become increasingly popular in the construction industry due to its ability to improve project outcomes and reduce costs. BIM adoption offers several benefits, such as improved communication, increased collaboration, and better project management. BIM can be used in all phases of the project lifecycle, from initial design to construction and post-construction.The Critical success factors for benefits of BIM throughout the project life cycle were analyzed and shortlisted into various stages of project lifecycle. The factors collected from the articles and journals are analyzed qualitatively through questionnaire survey. The questionnaire survey is circulated to related professionals and monitored the data from the responses. Overall, after the completion of response collection these data are analyzed using respective software's. In conclusion, to validate the research through real time case studies

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