Benefits & Challenges 5D BIM adoption: Perception of Quantity Surveyors.

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Abstract
5D Building Information Modeling (BIM) is a technology that integrates 3D design, construction, and maintenance information with time and cost data, allowing for the creation of a dynamic model of a building or infrastructure project towards its enhanced management. The study aims to assess the perception of Nigerian Quantity Surveyors' perception of the benefits and challenges of adopting 5D BIM. The review method of data collection was used, and the data obtained were analysed using descriptive. The results highlight the potential benefits of using 5D BIM, which include improving project planning and decision-making, reducing errors and rework, and enhancing collaboration among project stakeholders. The findings also identified several challenges to the widespread adoption of 5D BIM, including the need for standardisation and interoperability, the lack of skilled users, and the high initial costs of implementing the technology. Overall, this study provides a comprehensive overview of the potential benefits of 5D BIM and the challenges affecting the facilitation of its widespread adoption in the construction industry. This implies and poses a major task for the Nigerian Institute of Quantity Surveyors to embark on a systematic and deliberate approach to BIM software training for members in construction-related themes. The result also recommends accreditation agencies and tertiary institutions review the current curriculum to incorporate the concept of 5D BIM into teaching and learning to equip students with the digital skills required for the fourth industrial revolution.

Keywords: 5D BIM, cost management; construction 4.0; digital skills; project planning; Standardisation.

Introduction

Building Information Modelling (BIM) has revolutionized the construction industry, changing the way buildings are designed, constructed, and managed(Malagnino et al., 2021). The use of BIM technology has allowed for more efficient and accurate project delivery, reducing the risk of errors and delays, and increasing collaboration among project stakeholders(Hautala et al., 2017). One of the most significant advancements in BIM technology is 5D BIM, which adds cost estimation and management capabilities to the traditional 3D model, and time scheduling to the 4D model(Abdullahi B Saka et al., 2019).

5D BIM is rapidly gaining traction in the construction industry, and many construction professionals believe that it has the potential to transform construction cost management. However, despite its potential benefits, there are still many challenges associated with the adoption and implementation of 5D BIM(Le, 2021). Quantity surveyors, who are responsible for managing construction costs, play a critical role in the adoption and implementation of 5D BIM(Seyis, 2020).

Therefore, it is essential to understand their perception of the benefits and challenges associated with adoption of 5D BIM.

This paper provides an in-depth analysis of the benefits and challenges of 5D BIM adoption from the perspective of quantity surveyors. The paper begins by providing a brief overview of BIM and its importance in the construction industry. The significance of 5D BIM in construction cost management is also highlighted. A thorough review of the literature is then presented, focusing on the definition and benefits of 5D BIM, as well as case studies of successful implementation. The research methodology is then discussed, detailing the research design. The results are presented and analyzed, discussing the benefits and challenges of 5D BIM adoption from the perspective of quantity surveyors. The paper also examines how quantity surveyors perceive the benefits of 5D BIM adoption.

The paper concludes by summarizing the key findings, implications of the study, and recommendations for future research. In conclusion, the adoption and implementation of 5D BIM in construction cost management has the potential to revolutionize the construction industry.

Research Methodology

The method of review utilized in this investigation is one that is predicated on content analysis. Because of its vast applicability and general acceptance as an effective strategy for reviewing and synthesizing literature and justifying results, this method has been widely employed in engineering and construction management. This is owing to its widespread applicability. (Li et al., 2018; Onososen & Musonda, 2022). The Scopus database was utilized to choose a number of first-tier papers linked to BIM. This was done in order to locate articles that were relevant to the aims of the study. These papers were selected from respected and authoritative academic journals in topics such as engineering and construction management, science, technology, safety, and human factors, amongst others. Figure 1 illustrates the steps that were taken to pick the articles that were used.

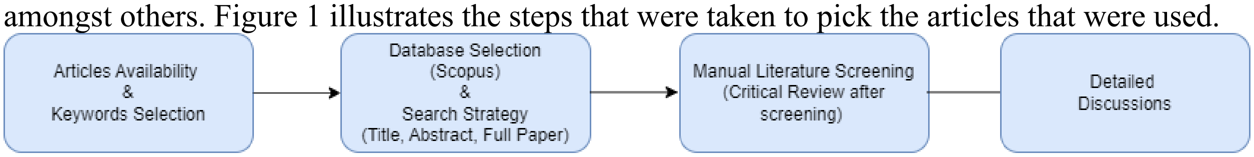

Figure 1. Research Method Process.

Discussion and Findings

Brief overview of Building Information Modelling (BIM)

Building Information Modelling (BIM) is an innovative approach to construction management that has revolutionized the construction industry by improving the efficiency, cost-effectiveness, and sustainability of construction projects (Matos et al., 2021). It is a digital process that involves the creation of a 3D model that integrates all relevant information about a building project, including design, construction, and operation data (Pereira et al., 2021). This model acts as a shared knowledge resource that facilitates collaboration and communication between all project stakeholders, including architects, engineers, contractors, and building owners(Abdullahi B. Saka & Chan, 2019).

BIM enables construction professionals to create and manage a comprehensive database of information about a building project, including its design, materials, systems, and schedules(Jalaei & Jrade, 2015). This information can be accessed and shared in real-time by all stakeholders, allowing for better communication and decision-making (Nwodo et al., 2017). By using BIM, construction professionals can create a detailed virtual model of a building that includes every aspect of the project, from the smallest details to the overall structure (Han et al., 2021). BIM is a powerful tool for improving the efficiency of construction projects, as it enables construction professionals to identify and address potential issues before they arise. By creating a detailed model of the building, BIM allows construction professionals to simulate various scenarios, such as changes in design or materials, and assess their impact on the project. This helps to minimize errors and rework, reducing project costs and increasing overall efficiency (Alizadehsalehi et al., 2020).

One of the key benefits of BIM is its ability to improve collaboration between project stakeholders. By creating a shared knowledge resource, BIM enables all stakeholders to work together more effectively, reducing the risk of misunderstandings and delays. This is particularly important in large, complex projects where multiple stakeholders are involved(Sandberg et al., 2019). BIM also helps to improve the sustainability of construction projects by providing construction professionals with the tools to assess the environmental impact of their designs(Sameer & Bringezu, 2021). By using BIM, architects and engineers can simulate the energy performance of a building and identify ways to improve its efficiency (Paneru et al., 2021). This helps to reduce the environmental impact of the building, making it more sustainable and cost-effective to operate in the long term. Another benefit of BIM is that it helps to improve the accuracy and quality of construction projects. By creating a detailed model of the building, BIM enables construction professionals to identify potential problems early in the process, allowing them to make adjustments before construction begins (Olawumi et al., 2017). This helps to reduce the risk of errors and rework, which can be costly and time-consuming. In addition to these benefits, BIM is also an effective tool for improving project scheduling and management(Chong et al., 2017). By creating a detailed model of the building, BIM enables construction professionals to accurately estimate project timelines and costs. This helps to ensure that projects are completed on time and within budget, reducing the risk of delays and cost overruns (Di Bari et al., 2019).

Despite its many benefits, the implementation of BIM can be challenging for construction professionals. One of the main challenges is the need to change traditional workflows and processes to incorporate BIM into the project management process. This can require a significant investment of time and resources, as well as a commitment to training and education. Another challenge is the need for effective collaboration between project stakeholders (Abdullahi B. Saka & Chan, 2020). BIM requires a high level of collaboration and communication between all stakeholders, which can be challenging in large, complex projects where there are multiple stakeholders involved(Davtalab et al., 2018). This requires a significant level of coordination and cooperation, as well as the use of specialized software and tools.

Importance of BIM in the construction industry

Firstly, BIM enhances project coordination and collaboration, which is crucial for the success of any construction project. In traditional construction management practices, communication between various stakeholders is often inefficient, leading to delays and rework. BIM provides a common platform for project teams to share information, work together, and make informed decisions. This ensures that everyone involved in the project is on the same page, and potential conflicts are resolved before they become problems(McNamara & Sepasgozar, 2018). Through BIM, stakeholders can access all the project information, including plans, specifications, and schedules, in real-time, from anywhere and at any time. This level of collaboration ensures that everyone has access to the latest project information, minimizing miscommunications, and reducing the likelihood of costly mistakes.

Secondly, BIM improves project visualization, which is crucial for both design and construction phases(Goulding et al., 2014). Through 3D visualization, BIM enables construction professionals to create a virtual model of the building that provides a realistic representation of the structure. This visualization helps project teams to better understand the design intent, identify potential problems, and improve the decision-making process(Wu et al., 2021). By visualizing the building in 3D, project teams can make informed decisions on materials, systems, and construction methods. Additionally, BIM provides tools for simulating various scenarios, such as construction sequencing and site logistics. These simulations help project teams to assess the feasibility and impact of different construction approaches, improving the overall efficiency of the project (Carvalho et al., 2019). Thirdly, BIM improves project efficiency and reduces errors and rework. Through BIM, construction professionals can detect and address design and construction issues early in the project lifecycle. This reduces the likelihood of errors and rework, which can be costly and time-consuming. BIM enables construction professionals to simulate and analyze different project scenarios, allowing them to optimize the design and construction processes. Additionally, BIM provides tools for estimating material quantities, construction timelines, and costs, which helps project teams to make informed decisions that reduce waste and improve efficiency. By streamlining the project lifecycle, BIM reduces construction time and cost, delivering projects more quickly and efficiently (Olowa et al., 2022).

Fourthly, BIM improves sustainability in the construction industry. Through BIM, construction professionals can assess the environmental impact of their designs and identify opportunities to improve energy efficiency, reduce waste, and minimize the carbon footprint of buildings(Kim et al., 2021). By simulating energy performance, BIM enables architects and engineers to optimize the design and identify the most effective sustainability measures. Additionally, BIM provides tools for measuring and analyzing the lifecycle environmental impact of buildings, helping to reduce the environmental footprint of the construction industry (Batarseh, 2018). Finally, BIM improves the overall quality of construction projects. BIM enables construction professionals to create a comprehensive database of information about a building project, including its design, materials, systems, and schedules. This information can be accessed and shared in real-time by all stakeholders, allowing for better communication and decision-making (Chegu Badrinath et al., 2016). By using BIM, construction professionals can create a detailed virtual model of a building that includes every aspect of the project, from the smallest details to the overall structure. This level of detail helps to minimize errors and rework, reducing project costs and increasing overall efficiency(Bernardette Soust-Verdaguer et al., 2017).

Significance of 5D BIM in construction cost management

Building Information Modelling (BIM) has been gaining popularity in the construction industry due to its ability to enhance project coordination, improve visualization, and reduce errors and rework(A.B. Saka et al., 2019). 5D BIM, which integrates cost information with the 3D model, has emerged as a crucial technology in construction cost management(Ayman et al., 2018). Firstly, 5D BIM provides accurate cost estimating, which is crucial in construction cost management. By integrating cost data into the 3D model, construction professionals can generate accurate and detailed cost estimates for the project. The 5D model enables project teams to simulate different scenarios and analyze the impact of design changes on project cost (Tahmasebinia et al., 2022). This helps to identify potential cost overruns early in the project lifecycle, enabling project teams to make informed decisions and take corrective action to stay on budget. Additionally, 5D BIM enables construction professionals to estimate material quantities accurately, reducing waste and improving efficiency.

Secondly, 5D BIM improves project scheduling, which is a critical aspect of construction cost management. By integrating cost data with the 3D model, construction professionals can generate detailed project schedules that take into account the cost implications of different design and construction approaches (Kassem et al., 2012). This helps project teams to optimize the construction process, reduce downtime, and minimize the duration of the project. Additionally, 5D BIM provides tools for simulating various project scenarios, allowing project teams to assess the impact of different scheduling approaches on project cost (El Jazzar et al., 2021). Thirdly, 5D BIM improves project control and reduces the likelihood of overruns. By integrating cost data into the 3D model, project teams can track project progress and cost in real-time. This level of project control enables project teams to identify potential cost overruns early in the project lifecycle and take corrective action to keep the project on budget. Additionally, 5D BIM enables construction professionals to generate detailed project reports that provide stakeholders with a comprehensive view of the project's cost and progress (Zimmermann et al., 2021).

Fourthly, 5D BIM enhances collaboration and communication between project stakeholders. By providing a shared platform for project information, 5D BIM improves communication and collaboration between architects, engineers, contractors, and building owners (Ahmed & Suliman, 2020). This level of collaboration ensures that everyone involved in the project is on the same page, reducing the likelihood of miscommunications and errors (Potseluyko et al., 2022). Additionally, 5D BIM enables project teams to share cost data in real-time, enabling stakeholders to make informed decisions and take corrective action to keep the project on budget. Finally, 5D BIM improves project delivery and overall project success. By improving cost estimating, project scheduling, project control, collaboration, and communication, 5D BIM helps project teams to deliver projects more efficiently and effectively. This reduces project costs, improves project quality, and increases overall project success. Additionally, 5D BIM enables construction professionals to generate detailed project reports that provide stakeholders with a comprehensive view of the project's cost and progress, increasing transparency and accountability (Alizadehsalehi & Hadavi, 2021).

Explanation of 5D BIM and its benefits

Building Information Modeling (BIM) is a digital representation of the physical and functional characteristics of a building or infrastructure. It is a 3D model that includes all the necessary information about a project, including dimensions, material specifications, and construction processes. 5D BIM takes the 3D model one step further by incorporating cost data, which allows construction professionals to create accurate project budgets and monitor project costs in real-time (Silvestre & Pyl, 2020).

5D BIM integrates the 3D model with cost data, allowing construction professionals to create detailed project budgets and monitor project costs throughout the project's lifecycle. 5D BIM uses cost data to simulate various construction scenarios, enabling project teams to make informed decisions that balance project scope, cost, and time constraints. The five dimensions of 5D BIM are:

I. 3D Model: The 3D model represents the physical characteristics of the building or infrastructure, including dimensions, geometry, and spatial relationships.

II. Time: Time refers to the construction schedule or timeline, including the sequence of construction activities, duration, and dependencies.

III. Cost: Cost data includes the cost of materials, labor, equipment, and other expenses associated with the project.

IV. Sustainability: Sustainability refers to the environmental impact of the project, including energy consumption, carbon emissions, and waste reduction.

V. Facility Management: Facility management includes the ongoing maintenance and operation of the building or infrastructure, including equipment maintenance, energy management, and occupant comfort.

The benefits of 5D BIM are numerous and significant. The following are some of the key benefits of 5D BIM:

I. Accurate Cost Estimating: 5D BIM enables construction professionals to create accurate and detailed project budgets by incorporating cost data into the 3D model. By using 5D BIM, construction professionals can estimate material quantities accurately, reducing waste and improving efficiency. Additionally, 5D BIM enables project teams to simulate different scenarios and analyze the impact of design changes on project cost. This helps to identify potential cost overruns early in the project lifecycle, enabling project teams to make informed decisions and take corrective action to stay on budget (Information, 2019).

II. Improved Project Scheduling: By integrating cost data with the 3D model, construction professionals can generate detailed project schedules that take into account the cost implications of different design and construction approaches. This helps project teams to optimize the construction process, reduce downtime, and minimize the duration of the project. Additionally, 5D BIM provides tools for simulating various project scenarios, allowing project teams to assess the impact of different scheduling approaches on project cost (Malagnino et al., 2021).

III. Enhanced Project Control: By integrating cost data into the 3D model, project teams can track project progress and cost in real-time. This level of project control enables project teams to identify potential cost overruns early in the project lifecycle and take corrective action to keep the project on budget. Additionally, 5D BIM enables construction professionals to generate detailed project reports that provide stakeholders with a comprehensive view of the project's cost and progress (Nabizadeh & Hossein, 2021).

IV. Improved Collaboration and Communication: By providing a shared platform for project information, 5D BIM improves communication and collaboration between architects, engineers, contractors, and building owners. This level of collaboration ensures that everyone involved in the project is on the same page, reducing the likelihood of miscommunications and errors. Additionally, 5D BIM enables project teams to share cost data in real-time, enabling stakeholders to make informed decisions and take corrective action to keep the project on budget (Jiang et al., 2021).

V. Increased Project Efficiency and Effectiveness: By improving cost estimating, project scheduling, project control, collaboration, and communication, 5D BIM helps project teams to deliver projects more efficiently (Azhar et al., 2011).

Advantages of 5D BIM in quantity surveying

I. Accurate Cost Estimation: One of the primary advantages of 5D BIM in quantity surveying is accurate cost estimation. Quantity surveyors use 5D BIM to generate accurate and detailed project budgets by incorporating cost data into the 3D model. This allows for accurate estimating of material quantities, reducing waste and improving efficiency. Additionally, 5D BIM enables quantity surveyors to simulate different scenarios and analyze the impact of design changes on project cost. This helps to identify potential cost overruns early in the project lifecycle, enabling quantity surveyors to make informed decisions and take corrective action to stay on budget (Malagnino et al., 2021).

II. Improved Cost Management: Another advantage of 5D BIM in quantity surveying is improved cost management. Quantity surveyors use 5D BIM to monitor project costs throughout the project's lifecycle, enabling them to track project progress and cost in real-time. This level of project control enables quantity surveyors to identify potential cost overruns early in the project lifecycle and take corrective action to keep the project on budget. Additionally, 5D BIM enables quantity surveyors to generate detailed project reports that provide stakeholders with a comprehensive view of the project's cost and progress (Nasila & Cloete, 2018).

III. Enhanced Project Control:5D BIM provides enhanced project control for quantity surveyors. By integrating cost data into the 3D model, quantity surveyors can track project progress and cost in real-time. This level of project control enables quantity surveyors to identify potential cost overruns early in the project lifecycle and take corrective action to keep the project on budget. Additionally, 5D BIM provides tools for simulating various project scenarios, allowing quantity surveyors to assess the impact of different scheduling approaches on project cost (Adam et al., 2020).

IV. Improved Collaboration and Communication: 5D BIM improves collaboration and communication between architects, engineers, contractors, and building owners. Quantity surveyors can use 5D BIM to collaborate with other project stakeholders and share cost data in real-time, enabling stakeholders to make informed decisions and take corrective action to keep the project on budget. Additionally, 5D BIM provides a shared platform for project information, improving communication and collaboration between all project stakeholders (Genova, 2019).

V. Increased Efficiency and Effectiveness:5D BIM helps quantity surveyors to deliver projects more efficiently and effectively. By improving cost estimating, cost management, project control, collaboration, and communication, 5D BIM enables quantity surveyors to deliver projects on time and within budget. Additionally, 5D BIM provides tools for analyzing project data and identifying areas for improvement, enabling quantity surveyors to optimize the construction process and improve project efficiency (B. Soust-Verdaguer et al., 2021).

VI. Improved Visualization:5D BIM allows quantity surveyors to visualize the construction process in greater detail, which enables them to make informed decisions about material quantities and construction methods. Quantity surveyors can use 5D BIM to generate detailed 3D models that provide a realistic representation of the building or infrastructure. This enables quantity surveyors to identify potential issues early in the design process, reducing the likelihood of costly errors and delays (Röck et al., 2018).

VII. Risk Mitigation:5D BIM helps quantity surveyors to mitigate project risks by providing a comprehensive view of the project's cost and progress. By tracking project costs in real-time, quantity surveyors can identify potential cost (Liu et al., 2019)

Challenges in 5D BIM adoption and implementation

I. Lack of Standardization: One of the primary challenges in 5D BIM adoption and implementation is the lack of standardization in the industry. While BIM standards have been developed in many countries, they are not consistently applied, resulting in a lack of interoperability between different BIM software platforms. This lack of standardization makes it difficult for construction teams to collaborate effectively and share project data in real-time, reducing the benefits of 5D BIM (Altohami et al., 2021).

II. Skills Gap: Another challenge in 5D BIM adoption and implementation is the skills gap among construction professionals. While BIM technology is becoming increasingly prevalent, many construction professionals lack the necessary skills and knowledge to use the technology effectively. This can result in a lack of adoption or ineffective use of 5D BIM, reducing the potential benefits of the technology (Ayman et al., 2018).

III. Integration with Existing Processes: Integrating 5D BIM with existing construction processes can be a challenge. Construction teams may be resistant to change, and integrating 5D BIM into existing processes may require significant changes to established workflows. Additionally, integrating 5D BIM with other software applications used in construction, such as project management or scheduling software, can be challenging (Sorce & Issa, 2021).

IV. Cost: The cost of implementing 5D BIM can also be a challenge for construction firms. BIM software can be expensive, and implementing the technology may require additional hardware, training, and support costs. Additionally, the cost of implementing 5D BIM may be prohibitive for smaller construction firms, reducing their ability to compete with larger firms that have already adopted the technology.

V. Data Management: Effective data management is critical for the success of 5D BIM. Construction projects generate vast amounts of data, and managing this data effectively can be a challenge. Ensuring data quality and accuracy, and managing data security and privacy are important considerations in 5D BIM implementation. Additionally, construction teams must establish protocols for sharing data and maintaining data integrity throughout the project lifecycle (Feng et al., 2020).

VI. Legal and Contractual Issues: The implementation of 5D BIM can also raise legal and contractual issues. For example, ownership of project data can be a contentious issue, particularly when multiple parties are involved in the project. Additionally, contractual issues, such as liability for errors in the 5D BIM model, must be addressed in project contracts (Babatunde et al., 2021).

VII. Resistance to Change: Resistance to change is a common challenge in any technological implementation, and 5D BIM is no exception. Construction teams may be resistant to change, particularly if they are accustomed to traditional construction methods. This resistance can manifest in a lack of adoption or ineffective use of 5D BIM, reducing the potential benefits of the technology (Chen et al., 2021).

VIII. Lack of Industry Awareness: Finally, a lack of industry awareness can also be a challenge in 5D BIM adoption and implementation. Many construction firms may not be aware of the benefits of 5D BIM, or may not understand how to effectively implement the technology. Additionally, there may be a lack of awareness among clients and stakeholders, reducing demand for 5D BIM services (Taher & Elbeltagi, 2021).

Discussion of the benefits of 5D BIM adoption in construction cost management

I. Enhanced Cost Control: One of the key benefits of 5D BIM adoption is enhanced cost control. By incorporating cost data into the BIM model, construction teams can track costs in real-time, identify cost overruns early, and take corrective action. This early identification of cost overruns can result in significant savings for construction firms, reducing the risk of project delays or cancellations (Sandberg et al., 2019).

II. Improved Collaboration: 5D BIM also improves collaboration among construction teams, reducing the risk of errors or miscommunications. Construction teams can work collaboratively on the same BIM model, allowing for real-time collaboration and problem-solving. This improved collaboration can result in more accurate cost estimates and better cost control throughout the project lifecycle (Abdullahi B Saka et al., 2019).

III. Accurate Cost Estimation: Another benefit of 5D BIM adoption is more accurate cost estimation. By incorporating cost data into the BIM model, construction teams can generate more accurate cost estimates, reducing the risk of cost overruns. Accurate cost estimation is critical in construction, as cost overruns can result in project delays, cancellations, or legal disputes (Abdullahi B. Saka et al., 2020).

IV. Improved Planning and Scheduling: 5D BIM can also improve planning and scheduling, providing construction teams with real-time data on cost and schedule performance. Construction teams can use this data to adjust the project schedule and resources, ensuring that the project is delivered on time and within budget. This improved planning and scheduling can result in significant time and cost savings for construction firms (A. O. Onososen et al., 2022).

V. Reduced Rework: Incorporating cost data into the BIM model can also reduce the risk of rework, reducing costs and improving project efficiency. By providing real-time cost analysis and management, construction teams can identify and correct errors early, reducing the need for costly rework later in the project lifecycle (Liphadzi et al., 2022).

VI. Improved Decision Making:5D BIM also improves decision-making by providing construction teams with real-time data on cost and schedule performance. This data can be used to make informed decisions about project scope, resources, and scheduling, ensuring that the project is delivered on time and within budget. This improved decision-making can result in significant cost savings for construction firms, reducing the risk of project delays or cancellations (Onososen & Musonda, 2022).

VII. Enhanced Risk Management: 5D BIM can also enhance risk management, providing construction teams with real-time data on project risks and vulnerabilities. Construction teams can use this data to identify potential risks and take corrective action early, reducing the risk of project delays or cancellations. This enhanced risk management can result in significant cost savings for construction firms, reducing the risk of legal disputes or project failure (Onososen & Musonda, 2021).

VIII. Improved Client Communication: Finally, 5D BIM can improve client communication, providing clients with real-time data on project cost and schedule performance. Clients can use this data to track project progress and make informed decisions about project scope and resources. This improved client communication can result in greater client satisfaction and repeat business for construction firms (Onososen & Musonda, 2022a).

Explanation of how quantity surveyors perceive the benefits of 5D BIM adoption.

Quantity surveyors are responsible for the management of costs and procurement of resources throughout the construction project lifecycle. They play a crucial role in ensuring that projects are delivered on time and within budget. The benefits of 5D BIM adoption are particularly relevant to quantity surveyors as they directly impact their role in construction project management.

I. Improved Cost Control: The most significant benefit of 5D BIM adoption for quantity surveyors is improved cost control. By incorporating cost data into the BIM model, construction teams can track costs in real-time, identify cost overruns early, and take corrective action. Quantity surveyors can use this real-time cost data to monitor project costs and make informed decisions about project scope and resources. This early identification of cost overruns can result in significant savings for construction firms, reducing the risk of project delays or cancellations (Santos et al., 2020).

II. Enhanced Collaboration: 5D BIM adoption also enhances collaboration among construction teams, reducing the risk of errors or miscommunications. Quantity surveyors can work collaboratively with other construction team members on the same BIM model, allowing for real-time collaboration and problem-solving. This improved collaboration can result in more accurate cost estimates and better cost control throughout the project lifecycle (Ahmed & Suliman, 2020).

III. Accurate Cost Estimation: Another benefit of 5D BIM adoption for quantity surveyors is more accurate cost estimation. By incorporating cost data into the BIM model, construction teams can generate more accurate cost estimates, reducing the risk of cost overruns. Quantity surveyors can use this data to develop more accurate cost plans and budgets, ensuring that the project is delivered on time and within budget (Naneva et al., 2020).

IV. Improved Planning and Scheduling: 5D BIM can also improve planning and scheduling, providing quantity surveyors with real-time data on cost and schedule performance. Quantity surveyors can use this data to adjust the project schedule and resources, ensuring that the project is delivered on time and within budget. This improved planning and scheduling can result in significant time and cost savings for construction firms (Sibenik & Kovacic, 2021).

V. Reduced Rework: Incorporating cost data into the BIM model can also reduce the risk of rework, reducing costs and improving project efficiency. By providing real-time cost analysis and management, construction teams can identify and correct errors early, reducing the need for costly rework later in the project lifecycle. This reduced rework can result in significant cost savings for construction firms (Nasila & Cloete, 2018).

VI. Improved Decision Making: 5D BIM also improves decision-making by providing quantity surveyors with real-time data on cost and schedule performance. This data can be used to make informed decisions about project scope, resources, and scheduling, ensuring that the project is delivered on time and within budget. This improved decision-making can result in significant cost savings for construction firms, reducing the risk of project delays or cancellations (Azhar et al., 2011).

VII. Enhanced Risk Management: 5D BIM can also enhance risk management, providing quantity surveyors with real-time data on project risks and vulnerabilities. Quantity surveyors can use this data to identify potential risks and take corrective action early, reducing the risk of project delays or cancellations. This enhanced risk management can result in significant cost savings for construction firms, reducing the risk of legal disputes or project failure (Saka et al., 2019).

Strategies

I. Change Management: One of the biggest challenges in 5D BIM adoption is change management. 5D BIM requires a significant shift in the way construction teams collaborate and manage projects. This shift can be difficult for construction teams that are used to traditional project management methods. To overcome this challenge, construction firms should invest in change management training to help their employees adapt to new workflows and processes. Change management training should focus on building a culture of collaboration and openness to new ideas, which can help ease the transition to 5D BIM (Malagnino et al., 2021).

II. Technical Expertise: Another challenge in 5D BIM adoption is the need for technical expertise. 5D BIM requires specialized software and technical skills that may not be available in-house. To overcome this challenge, construction firms should invest in hiring or training employees with the necessary technical skills. This investment in technical expertise can pay off in the long run by improving project efficiency and reducing the risk of errors (Lim et al., 2021).

III. Data Management: 5D BIM adoption also requires effective data management. The large amount of data generated by BIM models can be overwhelming, making it difficult to manage and analyze. To overcome this challenge, construction firms should invest in data management solutions that can store, analyze, and report on data generated by the BIM model. Data management solutions should be scalable, secure, and user-friendly, allowing construction teams to easily access and analyze data (Mellado et al., 2020).

IV. Cost: The cost of 5D BIM adoption can be a significant challenge for construction firms, especially smaller firms with limited resources. To overcome this challenge, construction firms should carefully evaluate the costs and benefits of 5D BIM adoption and develop a budget that includes the necessary software, hardware, and training. Construction firms should also consider partnering with other firms to share the costs of 5D BIM adoption, reducing the financial burden on any one firm.

V. Standardization: Standardization is another challenge in 5D BIM adoption. There is currently no industry-wide standard for 5D BIM, making it difficult for construction firms to collaborate effectively. To overcome this challenge, construction firms should participate in industry groups and collaborate with other firms to develop standardized BIM workflows and processes. Standardization can help reduce the risk of errors and improve collaboration among construction teams.

VI. Legal and Contractual Issues: Legal and contractual issues can also be a challenge in 5D BIM adoption. BIM models contain sensitive information that must be protected, and there may be legal and contractual issues related to ownership, liability, and intellectual property. To overcome this challenge, construction firms should work with legal experts to develop contracts that address these issues and protect the interests of all parties involved in the project.

VII. Resistance to Change: Finally, resistance to change can be a significant challenge in 5D BIM adoption. Some employees may resist the adoption of new technology or workflows, which can hinder overcoming challenges in 5D BIM adoption.

Conclusion

In conclusion, 5D BIM is an advanced level of BIM that integrates cost data into the model, providing real-time cost analysis and management throughout the project lifecycle. The benefits of 5D BIM adoption in construction cost management are numerous, including improved collaboration, increased efficiency, reduced risk of errors, and better decision-making. However, there are also several challenges that must be overcome for successful implementation, including change management, technical expertise, integration with legacy systems, data management, cost, standardization, legal and contractual issues, and resistance to change. To overcome these challenges, construction firms should invest in change management training to help their employees adapt to new workflows and processes, hire or train employees with the necessary technical skills, invest in software solutions that can integrate with legacy systems, develop scalable data management solutions, carefully evaluate the costs and benefits of 5D BIM adoption, participate in industry groups to develop standardized workflows and processes, work with legal experts to develop contracts that address legal and contractual issues, and address resistance to change through effective communication and training. The successful adoption of 5D BIM requires a comprehensive strategy that addresses these challenges and leverages the benefits of 5D BIM in construction cost management. By adopting 5D BIM, construction firms can improve their project efficiency, reduce the risk of errors, and make better-informed decisions, leading to improved project outcomes and increased profitability.

Early Introduction of BIM knowledge into the curriculum of Quantity Surveying Departmental courses for students to acquire first hand training will help to create and develop the right awareness of 5D BIM for the future generations to leverage on.

By adopting 5D BIM, Cost consultants can improve their project efficiency, reduce the risk of errors, make better-informed decisions leading to improved project outcomes and increased profitability.

It is, therefore, important for construction firms to evaluate the potential benefits and challenges of 5D BIM adoption and develop a comprehensive strategy to ensure successful implementation. As technology continues to advance, 5D BIM will become an increasingly essential tool in construction cost management, and construction firms that embrace this technology will have a competitive advantage in the industry.

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