# Assessing Building Information Modelling Usage Level in Construction Projects: Construction Professionals Perspectives

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## Abstract

Building Information Modelling (BIM) usage in the construction industry has rapidly become a game-changer in construction activities, which has revolutionised project planning, designing, construction and management, leading to significant improvements in project coordination, collaboration, efficiency, and overall project outcomes. Hence, this study aims to assess BIM usage in construction projects based on construction professionals' perspectives toward establishing its usage level for different construction activities. Structured questionnaires were distributed to construction professionals in Gauteng province, South Africa, using systematic random sampling techniques to collect data on the level of BIM usage for construction activities for projects within the construction industry. Data was collected through the quantitative approach using a questionnaire survey. A valid mean item score was determined in the study using a statistical data equation; each item was ranked with standard deviations, and Cronbach's alpha was established. The study findings indicated that project design and planning were the highest-ranked levels of BIM usage in projects in the construction industry. The study recommends that evolving BIM with other innovative technologies, such as cloud-based collaboration, digital twins, and artificial intelligence, will drive the digital transformation of construction projects, improve project delivery processes, and create value for construction stakeholders. The study concluded that the continuous usage of BIM for construction activities will play a key role in reshaping the future of activities in projects and driving digital transformation within the construction industry.

## Keywords

Building formation Modelling, Construction projects, Construction industry, Digital technology, Project design, Project planning.

## 1. Introduction

In recent years, Building Information Modelling (BIM) has emerged as a transformative technology in the construction industry, revolutionising the way projects are designed, planned, executed, and managed (Ikuabe et al., 2022; Adekunle et al., 2024;). BIM facilitates the creation of digital representations of building components and systems, enabling interdisciplinary collaboration, data-driven decision-making, and enhanced project outcomes (Bamghose et al., 2024). As construction professionals increasingly recognise the potential of BIM to streamline workflows, improve efficiency, and mitigate risks, the adoption and utilisation of BIM have become key focal points within the industry (Akinradewo et al., 2023; Owolabi et al., 2023).

Viklund Tallgren et al. (2020) established that BIM is a digital representation of a facility's physical and functional characteristics. It represents a shared knowledge resource for sharing information, forming a reliable basis for decisions during a construction project's life cycle (Georgiadou, 2019; Ogundipe et al., 2024). Currently, construction projects have complex physical and functional attributes, with technological innovation as a feature that affects the design and construction stages (Abina et al., 2023). Ondogan and Erdogan (2006) posit that the introduction of 3D Computer-Aided Design (CAD) changed labour-intensive drafts into more effective documentation. BIM is a shared knowledge platform with integrated digital models that superseded the 3D computer-aided design (Georgiadou,2019; Ogunbayo et al., 2022). Mihindu and Arayici (2008) assert that the building industry is under

pressure to provide sustainable infrastructure value for money and to reduce accidents, among others. Arayici et al. (2009) and Adekunle et al. (2022) pointed out that BIM, as a lifecycle evaluation concept, seeks to integrate processes throughout the entire lifecycle of a construction project toward sustainable construction. Abina et al. (2023) state that the construction industry has recently witnessed an increase in the widespread adoption of BIM for construction projects. This has revolutionised how construction professionals plan and manage construction activities (Gartoumi et al., 2023). Succar (2009) and Ogunbayo et al. (2021) state that BIM usage in construction projects has rapidly gained drive due to its impact on construction projects. Mesároš et al. (2020) and Alsofiani (2024) assert that while the impacts of BIM are widely recognised, there remains a need for comprehensive empirical studies to assess BIM usage in construction projects.

This study seeks to delve into the multifaceted usage of BIM among construction industry professionals, aiming to uncover the nuances of usefulness in construction project activities. Hence, this paper aims to delve into the comprehensive assessment of BIM usage levels in construction activities from the perspective of construction industry professionals. The study seeks to provide valuable insights into the construction industry's current BIM usage level in projects. Eventually, this study aims to inform and identify stages through which BIM can foster sustainable improvements in project delivery and overall construction industry performance.

## 2. Literature review

As Mesároš et al. (2020) noted, BIM is a design-based technology that provides significant value throughout the lifecycle stages of the construction project process. Renowned for its intricacies and complexity, the construction industry has witnessed a paradigm shift with the induction of BIM into the construction process (Nagy et al.,2021; Adekunle et al., 2023). Traditionally, siloed approaches and fragmented information workflows have been pervasive, leading to inefficiencies, miscommunication, and suboptimal project outcomes (Masoetsa et al., 2022; Cox et al., 2003). As a digital representation of a built assert's physical with functional characteristics, address these challenges by fostering collaboration, facilitating informed decision-making, and improving data accuracy throughout the construction project life cycle (Abanda et al., 2015; Nagy et al.,2021).

The study of Wu and Issa (2012) posits that BIM has helped construction professionals design and plan projects. Abanda et al. (2015) assert that its usage is essential in improving quality control of activities within construction projects. Aghimien et al. (2022) postulated that BIM is a tool that is used for project cost estimating in construction projects. It has helped construction professionals schedule construction sequences for construction activities (Enegbuma et al., 2015; Bambgose et al., 2024a). The study of Suermann (2009) indicated that the use of BIM among professionals in the construction industry helped in risk management and planning for construction projects. BIM usage for construction projects increases facility management and helps plan facility maintenance systems (Yan &Demian, 2008). BIM application in construction projects increases stakeholders' collaboration toward efficient production output (Wang et al., 2013). Wong and Fan (2013) maintain that BIM usage in projects guides construction professionals on risk management and reliable working procedures during construction. Abbasnejad et al. (2016) affirm that BIM usage in construction leads to safety planning for construction activities before and during construction.

Suermann (2009) signified that the degree of BIM usage for construction purposes has led to the quality of the construction process and accurate estimates. Amusan et al. (2021) and Bamgbose et al. (2024b) assert that BIM allows construction professionals to develop accurate safety planning and work schedules. BIM usage by professionals leads to efficient project designing and planning for construction projects (Wang et al., 2013). Also, the study of Oguntona et al. (2023) affirms that BIM usage for construction activities would create effective stakeholder collaboration and risk management during the planning and execution stages of projects.

As shown in the review above, the BIM usage level in projects within the construction industry needs to be detailed to establish its significance in the construction process and operation. Further, it is critical to determine the level of BIM usage in construction projects based on the perspective of professionals in the construction industry. Also, it is critical to determine the BIM usage level in construction projects as it is applied during the planning, designing, and construction stages. Hence, this study assesses BIM usage levels in construction projects based on the construction industry perspectives.

## 3. Methodology

This study was carried out within Gauteng province among construction professionals in the South African construction industry. The Gauprovince was chosen for this study because of the many ongoing BIM-aided construction projects in Gauteng province. The respondents were construction professionals, specifically from construction industries within Gauteng, South Africa. Respondents for this study were selected based on their involvement and experience with BIM usage for construction activities. Through the system random sampling method, 100 questionnaires were administered to the respondents, and 70 were retrieved. This study used the systematic random sampling method because it is more direct and eliminates the opportunity of clustering than cluster sampling, which breaks the population into diverse clusters, takes a simple random sample from each cluster (Ogunbayo et al., 2023), and covers all the elements evenly (Rea & Parker,2014). Using Strongly Disagreeing=1, Disagreeing=2, Neutral=3, Agreeing=4, and Strongly Agree=5, the questionnaire was designed on a 5-point Likert scale and recorded a 70% response rate. SPPS software was used to analyse the data for this study. The SPSS software generated the mean item score (MIS), the standard deviation (SD), Cronbach's alpha, and the ranks (R) from the Excel spreadsheet obtained from the Google form with 70 respondents (Pallant, 2020). Before analysing the data collected, the data collected were screened and cleaned to identify errors and, if possible, correct them. The respondents were asked about their highest qualifications, profession, and years of experience in the construction industry. Through the questionnaire, respondents were further asked about nine uses of BIM in construction activities and projects within the construction industry. The study conducted descriptive analysis, including percentage, frequency, mean item score, and standard deviation. This was conducted to examine the outcomes of the Likert inquiries about this research questionnaire. After computation, the BIM usage level in construction activities in projects within the construction industry was sorted from the highest to lowest. The computation was based on the weighted responses from the survey participants for each question. It was also aligned with the scores chosen by the respondents that were deemed collectively as the analytically agreed indicators of comparative significance. This helped this study assess the impacts of using BIM among professionals in the construction industry. Similarly, Cronbach's Coefficient Alpha determines the consistency, which then determines the reliability of the measuring instrument. The coefficient is most effective when the Likert scale is used, and in this study, the Likert scale is used to get responses from the relevant respondents. The Cronbach's coefficient ranges from 0 to 1, and a Cronbach's Alpha score closer to 1.00 is acceptable (Pallant, 2020; Ogunbayo et al., 2023). Hence, a Cronbach's value of 0.976 obtained in this study is suitable.

## 3. Results

The demographic information of the seventy respondents who participated in the study reveals that 17.14% (12) of the respondents have master's degrees as their highest qualification, 34.29 % (24) have bachelor's degrees, 27.14 % (19) have honour's degrees while 21.43% (15) have national diplomas as their highest qualifications. Moreover, the findings reveal that 30% (21) of the respondents were quantity surveyors as their profession,12.86% (9) were architectures, 21.43% (15) were construction managers, 17.14% (12) were construction project managers, 8.57% (6) were contractors and 10% (7) were engineers (civil mechanical and electrical) as their profession in the construction industry. Further, the findings show that 21.43% (15) had 0-5 years of experience in the construction industry, 40% (28) had 6-10 years of experience in the construction industry, 22.86% (16) had 11-15 years of experience in the construction industry, while 15.71% (11) had 16- over 20 years in the construction industry.

Table 1 below illustrates the respondents' ranking on the level of BIM usage for construction activities among professionals in the construction industry. The outcomes indicated the top and lowest levels of BIM usage for construction activities among professionals in the construction industry. The respondents were asked to identify the level of BIM usage for construction activities in the construction industry using a five-point Likert scale of 'Strongly disagree' to 'Strongly agree' on the questionnaire. According to the responses obtained from the respondents, 'Project design' was ranked first with the highest mean score of 3.50 and 1.225 standard deviations (SD); 'Project planning' was ranked second with a mean score of 3.41 and SD of 1.245; 'quality control' 'project cost estimating', and 'working scheduling', were ranked the third with the MS of 3.20 and 1.314 SD, 'risk management' was ranked number six with a mean score of 3.14 and SD of 1.266; ' facilities management and maintenance' was ranked the seventh with the MS of 3.07 and SD of 1.311; 'stakeholders collaboration' was ranked the eight with the MS of 3.01 and SD of 1.280 and lastly, ' 'Safety planning' was the least ranked and was ranked nine with the MS of 3.00 and SD of 1.263.

**Table 1.** Ranking of Building Information Modelling Level of Usage in Construction Projects

| Level of use of BIM | MIS | SD | R |
|---|---|---|---|
| Project design | 3.50 | 1.225 | 1 |
| Project planning | 3.41 | 1.245 | 2 |

| | | | |
|---|---|---|---|
| Quality control | 3.20 | 1.314 | 3 |
| Project cost estimating | 3.20 | 1.314 | 3 |
| Work scheduling | 3.20 | 1.368 | 3 |
| Risk management | 3.14 | 1.266 | 6 |
| Facilities management and maintenance | 3.07 | 1.311 | 7 |
| Stakeholders' collaboration | 3.01 | 1.280 | 8 |
| Safety planning | 3.00 | 1.263 | 9 |

## 4. Discussion of Findings

The study assessed the BIM usage level in project activities in the construction industry. The result of the study indicated that project design and project planning were the highest-ranked (1st-2nd) levels of BIM usage in projects in the construction industry. The findings align with Wu and Issa (2012) and Wang et al. (2013) that BIM usage by professionals in construction projects leads to efficient project designing and planning for construction projects. The findings imply that project design and project planning were the highest levels of usage of BIM in project activities in the construction industry activities, which indicated that the BIM tool is a technology used for construction projects, designing, and planning of construction activities to reduce wastage.

The findings also indicated that quality control, project cost estimating, work scheduling, and risk management were medium-ranked (3rd - 6th) levels of usage of BIM in projects in the construction industry. The finding is also similar to the study of Abanda et al. (2015) and Oguntona et al. (2023), which states that BIM is used for quality control of activities within construction projects. It also aligns with Agbimien et al. (2022) that BIM in the construction industry is used for construction project cost estimating. The findings also affirm the study of Enegbum et al. (2015) and Amusan et al. (2021) that BIM usage for construction projects has led to effective work schedules for construction activities during production. The findings also confirm Suermann (2009) and Wong and Fan (2013) that BIM usage increases risk management systems for construction activities in construction projects. This finding implies that quality control, project cost estimating, work schedule, and risk are part of the activities that BIM is used for during different stages of projects in the construction industry to increase the efficiency of the construction process.

Further, the findings revealed that facilities management and maintenance, stakeholders' collaboration and Safety planning were the least ranked (7th – 9th) levels of usage of BIM in projects in the construction industry. The findings support Yan and Demian (2008), who state that BIM usage helps with efficient facility management guided by predictive maintenance plans for facilities within the construction industry. The findings also concur with Wang et al. (2013) and Oguntona et al. (2023) that the usage of BIM in projects within the construction industry increases stakeholder involvement in construction activities through collaboration through available first-hand information. The findings also agree with Abbasnejad et al. (2016) that using BIM in projects within the construction industry will help create a safety plan that is monitorable and prevent future accidents on construction projects. These findings imply that BIM for construction activities creates stakeholder collaboration, which helps better inclusion in facilities management and maintenance plans for existing and proposed facilities. Its usage also helps increase safety planning for construction project activities to reduce accidents on construction sites.

## 5. Conclusion and recommendations

The study assessed the BIM usage level in activities within projects in the construction industry. It identified project design, project planning, quality control, project cost estimating, work scheduling, and risk management as the leading activities BIM is used in activities within projects in the construction industry. The study established that these activities have high levels of usage in activities within projects in the construction industry, which improves construction production and outputs.

The study findings highlight the positive contributions of BIM usage for project design and planning and its impact on construction project collaboration, coordination, and overall efficiency. The study reveals a growing recognition and adoption of BIM among construction professionals by integrating BIM into project workflows for construction activities. The study indicated that construction professionals had embraced BIM reports for various benefits, including improved project coordination, enhanced communication among stakeholders, better visualisation of project designs, reduced rework, and streamlined construction processes, and these benefits contribute to cost savings, time efficiencies, and improved project outcomes.

The study's findings also show that integrating BIM with project management practices by construction professionals for construction activities is essential for improving project control, safety planning, decision-making, resource allocation, and risk management for projects in the construction industry. The study also indicates that the

use of BIM by professionals in the construction industry will continue to expose them to activities that need attention at every construction activity stage, including designing, planning, quality control, cost estimating, schedule of work, risk identification and management, stakeholder needs, safety planning and maintenance planning during and after project lifecycle. This indicates a positive trend towards leveraging digital technologies to enhance construction project efficiency and collaboration.

Based on the study's findings, it is recommended that industry-wide standards, guidelines, and best practices for BIM implementation for construction projects be established for professionals in South Africa and developing countries' construction industries. This will ensure consistency, interoperability, and data exchangeability across construction projects and stakeholders. The study advises that there should be an increase in collaboration among the construction industry, association regulatory bodies, and standards organisations toward developing standard protocols for BIM usage in activities within the construction industry. The study recommends that professional institutions invest in training programs, skill development initiatives, and continuous learning to enhance BIM competencies among construction professionals within the construction industry. The study established that BIM training should involve technical aspects, collaborative workflows, data management practices, and industry standards. The study further recommends that evolving BIM with other innovative technologies, such as cloud-based collaboration, digital twins, and artificial intelligence, will drive the digital transformation of construction projects, improve project delivery processes, and create value for construction stakeholders. The study concluded that the continuous usage of BIM for construction activities will play a key role in reshaping the future of activities in projects and driving digital transformation within the construction industry.

The study was limited to construction professionals' perspectives within a Gauteng province in South Africa; further research should be carried out in other provinces among construction professionals to understand their level of BIM usage for construction projects within other provinces of the country. Also, future research should pursue studies on how the construction industry can maximise the benefits of BIM to drive innovation and efficiency in construction projects.

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