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Optimizing BIM adoption and utilization among Small and Medium Construction Enterprises in Luapula Province, Zambia

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ABSTRACT

Zambia's construction sector is a key driver of economic growth, with Small and Medium Enterprises (SMEs) playing a crucial role in infrastructure delivery. However, the sector faces persistent challenges, including low productivity and frequent project delays. Building Information Modelling (BIM) offers a promising solution through improved planning, coordination, and lifecycle efficiency, yet its adoption among SMEs remains limited, especially in regions like Luapula Province. This study examines the feasibility of BIM adoption and identifies strategies to enhance its effective use among SMEs in Luapula's construction sector. Data were collected via structured questionnaires targeting industry professionals to assess BIM awareness, usage patterns, adoption barriers, training needs, and organizational readiness. Results indicate that while BIM tools such as ArchiCAD are widely recognized, there is limited awareness of national policies and frameworks supporting their implementation. BIM is primarily utilized during the design and pre-construction phases, appreciated for boosting efficiency and client satisfaction, but remains underused in execution and post-construction stages. Key barriers include a shortage of skilled personnel, lack of industry standards, and minimal government support. The study also highlights strong demand for structured training to close existing capacity gaps. The findings underscore the under-utilization of BIM among SMEs in Luapula Province and point to the need for coordinated policies, targeted training, and phased integration strategies to support broader BIM adoption and accelerate the digital transformation of Zambia's construction industry.

Keywords: Building Information Modelling (BIM), BIM adoption, SME construction Sector, Digital Construction, Infrastructure Development, Zambia

INTRODUCTION

The construction industry is a key driver of economic growth in many developing countries, contributing significantly to Gross Domestic Product (GDP). In Zambia, for example, the sector accounted for approximately 6.8% of national GDP in 2019. Beyond its economic impact, it plays a vital role in infrastructure development, urbanization, and employment creation.

A large share of the industry is powered by Small and Medium-sized Enterprises (SMEs), which make up as much as 90% of construction firms in many developing economies. SMEs are central to delivering housing, roads, schools, and other essential infrastructure in both urban and rural areas. Employing over 50% of the workforce, they form the backbone of the construction sector.

Despite their critical role, SMEs face numerous challenges, including limited access to finance, outdated construction practices, and inefficiencies in project delivery. These issues constrain their capacity to execute projects effectively and competitively.

One of the most promising solutions to these challenges is the adoption of Building Information Modelling (BIM) a digital, collaborative approach that integrates architectural, engineering, and construction data into a single 3D model used throughout a project's lifecycle. BIM enhances project planning, clash detection, cost estimation, and stakeholder coordination. Although widely adopted in developed countries, BIM implementation remains limited in emerging economies, particularly among SMEs.

This study explores the status of BIM adoption among SMEs in developing countries, with a particular focus on Luapula Province located in the northern part of Zambia.

It examines current usage, identifies key barriers, and proposes strategies for effective integration. While Zambia provides the case context, the findings offer insights applicable to other low- and middle-income countries facing similar constraints.

The study is guided by the following objectives:

1. To assess the current level of BIM awareness and adoption among SMEs in the construction sectors of developing countries.

2. To identify key challenges and barriers to effective BIM adoption.

3. To propose strategies and best practices for successful BIM integration in resource-constrained settings.

4. To evaluate the potential benefits of BIM in improving SME productivity, efficiency, and competitiveness.

Numerous BIM adoption among SMEs in developing countries is hindered by several critical challenges. Financial constraints are among the most significant, as the cost of software, licenses, and necessary hardware often exceeds what small firms can afford. In addition, the lack of skilled professionals and limited access to technical training contribute to a significant skills gap, making effective BIM implementation difficult. Many SMEs also have limited awareness of BIM's full capabilities and remain cautious about investing in new technologies without clear short-term returns.

Yet, despite these barriers, the potential benefits of BIM for SMEs are substantial. The technology can enhance project efficiency, reduce design and construction errors, improve collaboration with clients and contractors, and provide better visualization for decision-making. These advantages contribute to higher-quality project outcomes, stronger client relationships, and greater competitiveness in increasingly demanding construction environments.

As infrastructure needs grow across developing countries, the construction industry must adapt to meet expectations for sustainability, cost-efficiency, and quality. For SMEs, adopting BIM is not merely a technological upgrade but represents a strategic pathway toward modernization, operational resilience, and long-term growth.

To unlock this potential, coordinated efforts are needed from governments, academic institutions, and industry stakeholders. Such collaboration should focus on increasing awareness, expanding access to training, and developing supportive policies that enable SMEs to adopt and benefit from BIM.

LITERATURE REVIEW

Overview and definition of BIM

Building Information Modeling (BIM) enables construction professionals to plan, design, and manage building projects within a 3D model (Chen et al., 2024). It serves as a digital platform that integrates various aspects of a construction project, enabling better visualization, coordination, and efficiency throughout the project lifecycle. The model contains both geometric and non-geometric data, providing a shared knowledge base for architects, engineers, contractors, and facility managers (Thaarrini, 2024). The collaborative nature of BIM ensures that multiple stakeholders can work on a shared platform, promoting better project outcomes (Yigitbas et al., 2023).

This technology-driven approach significantly impacts how construction projects are conceived, designed, and executed. BIM's potential extends beyond mere 3D modelling; it enhances cost estimation and sustainability while reducing errors and optimizing resource use (Akbari et al., 2024).

Development and Evolution of BIM

BIM's development traces back to the late 20th century, beginning with computer-aided design (CAD) systems that allowed for digital representations of building components. However, these systems lacked comprehensive data integration and interoperability. The late 1990s and early 2000s marked significant advancements in BIM technology with the introduction of parametric modelling and object-oriented design concepts. These innovations enabled the creation of intelligent 3D models that integrated both geometric and non-geometric data, laying the foundation for BIM's widespread adoption in the 2000s (Bassir et al., 2023).

Technological advancements such as cloud computing, mobile devices, and the integration of BIM with emerging technologies have further enhanced its capabilities. Today, BIM continues to evolve, with emerging technologies like artificial intelligence, machine learning, and virtual reality promising to enhance design optimization and visualization further (He, Wang, and Zhang, 2023; Shehadeh and Alshboul, 2025).

BIM's evolution can be summarized in a series of progressive phases, beginning with its Inception and Early Development (1D to 3D). Building Information Modelling originated from 2D Computer-Aided Design (CAD) systems, which advanced into 3D modeling software during the 1980s. This development enabled the creation of basic three-dimensional representations of buildings, marking a foundational shift in how architectural and engineering designs were visualized (Chen et al., 2024).

The next major advancement was the introduction of parametric modelling, often referred to as 4D BIM. Emerging in the late 1990s and early 2000s, this phase brought about the integration of geometric and non-geometric data into intelligent 3D models. Parametric modelling allowed design elements to maintain defined relationships, making it possible to automatically update dependent elements when one component was modified (Bassir et al., 2023).

By the mid-2000s, BIM had expanded to include time and cost dimensions, giving rise to what is known as 5D BIM. This phase incorporated scheduling (time) and cost estimation into the models, enabling construction professionals to simulate construction sequences and assess financial implications with greater accuracy. This multidimensional capability significantly enhanced project planning and management.

The most recent phase in BIM evolution is the integration of sustainability considerations, known as 6D BIM. This dimension supports the evaluation of environmental performance, energy efficiency, and lifecycle costing of buildings. It allows stakeholders to make informed decisions about materials, systems, and strategies aimed at reducing a project's environmental impact throughout its life span (Thaarrini, 2024.; Chen et al., 2024).

Benefits of BIM Adoption

BIM offers numerous benefits across various phases of the building lifecycle, as outlined in Table 1.

Table 1: Benefits of BIM Adoption

Phase	***Benefits of BIM use***	***Reference***
Pre-Construction	Better concept and feasibility; enhancement of energy efficiency	Eastman et al., 2011
	Effective site analysis; improved accuracy in documentation	Azhar et al., 2008b; Kjartansdottir et al., 2017
	Sustainable design; faster and more accurate cost estimation; resolve design clashes earlier	Khosrowshahi, 2017; Latiffi et al., 2016
Construction	Improved planning of resources; efficient fabrication and site utilization	Kjartansdottir et al., 2017; Eastman et al., 2011; Enshassi et al., 2018
Post-Construction	Enhanced decision-making in operations, maintenance, and asset management	Kjartansdottir et al., 2017; Husain et al., 2014; Enshassi et al., 2018

Impact of BIM

BIM's impact on construction projects is profound. It enhances project coordination by enabling real-time communication and collaboration among stakeholders, reducing the risk of costly rework and delays through early clash detection. BIM also improves cost estimation accuracy by automating quantity take-offs directly from the model, tracking material specifications, and enabling real-time assessment of design options and their cost implications (Azhar, 2011). Additionally, BIM promotes sustainability by providing tools for energy analysis, material tracking, and environmental impact assessments, helping project teams optimize building designs for energy efficiency and reduce waste during construction (Autodesk, 2012).

Challenges and Barriers to BIM Implementation

Despite its benefits, BIM adoption faces several challenges, including resistance to change, insufficient expertise, interoperability issues, and high initial investment costs (Grilo and Jardim-Goncalves, 2010). In regions like Luapula Province, Zambia, additional challenges such as limited access to technology, inadequate infrastructure, and cultural factors may further hinder BIM adoption (Chipulu, 2015). Addressing these challenges requires tailored strategies that consider the region's socio-economic realities and institutional capacities.

BIM Adoption in Africa

Saka and Chan (2019) performed a scientometric review of BIM literature in Africa. The study highlighted the continent's uneven BIM adoption, with Northern, Western, and Southern Africa showing relatively higher engagement. Key challenges include lack of awareness, skilled personnel, supportive policies, and client demand. Olanrewaju et al. (2020) explored barriers to BIM adoption in Nigeria, and major issues identified include high software cost, lack of technical expertise, low awareness among stakeholders, and limited government incentives. Achenga et al. (2022) assessed BIM awareness and uptake in Uganda, and finding indicated that while knowledge of BIM is increasing, adoption remains low due to financial, educational, and policy barriers. The study suggests stronger academic involvement to support capacity building. A study by Gondwe et al. (2023) examined the factors affecting BIM use in Malawi. Findings indicate that lack of technological infrastructure and standardization, as well as training gaps, hinder adoption. However, public projects show growing interest.

Government Initiatives and Success Factors

Government initiatives and policies play a crucial role in promoting BIM adoption. Examples from the UK, Singapore, and the US demonstrate how mandates, incentives, and training programs can drive widespread BIM adoption across the construction industry (NBS, 2019). In Zambia, the government can

support BIM adoption by establishing mandates, providing incentives, investing in training and education, and supporting research and development initiatives tailored to the Zambian construction industry (Chipulu, 2015).

Successful BIM implementation relies on factors such as supportive government policies, capacity-building and training programs, stakeholder collaboration, and investment in technology infrastructure. In Luapula Province, these factors are particularly relevant in addressing infrastructure development needs and improving construction project outcomes (Mahdjoubi et al., 2013).

THE STUDY AREA

Luapula Province is one of Zambia's ten provinces, situated in the northern part of the country and named after the Luapula River. Its capital is Mansa, and according to the 2022 Zambian census, the province had a population. of 1,519,478, accounting for 7.72% of the nation's total population.

As seen from Figure 1, Luapula is bordered by the Democratic Republic of the Congo to the north and Lake Bangweulu to the east. While the region is primarily known for its agricultural and fishing activities, it is also experiencing growth in infrastructure and construction development.

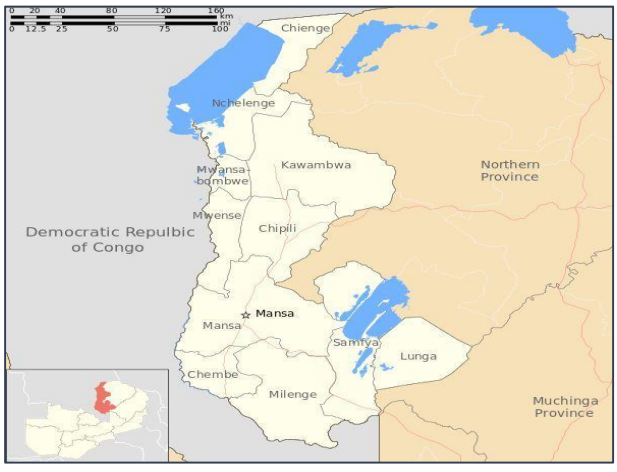

Figure 1: Map of Luapula Province, Zambia

This growth presents an opportunity to explore the adoption of advanced technologies like Building Information Modeling (BIM) in the construction industry. The focus of this research study is on the implementation of BIM in Luapula Province, assessing how it can enhance construction practices and project outcomes. Given the province's infrastructural expansion, BIM offers potential benefits such as improved project efficiency, collaboration, and resource management, making it a key area for innovation in the region's development efforts.

Despite the region's natural resources and growing infrastructure needs, Luapula Province faces significant challenges that impact the effectiveness of BIM adoption. The study area also presents an opportunity to examine how regulatory frameworks in Zambia, specifically in Luapula Province, can influence BIM adoption.

METHODOLOGY

This study adopted a mixed-methods approach, integrating both quantitative and qualitative methods to gain a comprehensive understanding of BIM adoption and its associated challenges in Luapula Province as shown in Figure 2. This approach enhances the study's validity and reliability by allowing triangulation of data sources (Creswell, 2014).

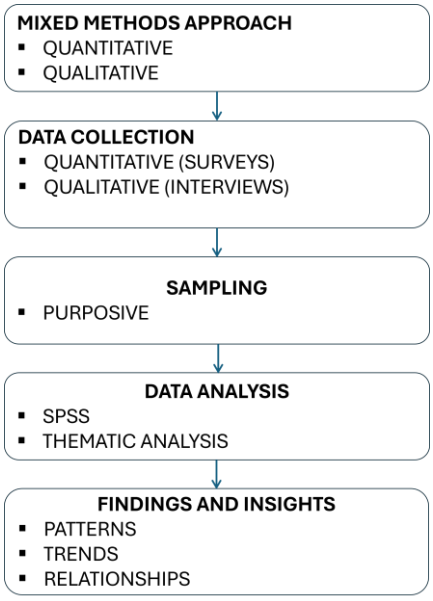

Figure 2: Flowchart for the Methodology

Data Collection involved both primary and secondary sources. Primary data were obtained through structured surveys and

semi-structured interviews, while secondary data were drawn from existing literature and official records (Flick, 2018). Surveys captured quantitative insights into BIM usage, challenges, and stakeholder views, whereas interviews explored qualitative aspects such as user experiences and perceptions (Bryman, 2016).

Sampling was done using purposive non-probability sampling, targeting SMEs involved in government-funded construction projects (Teddlie and Yu, 2007). To qualify, firms had to:

1. Be registered with the National Council for Construction (NCC).
2. Have 5–50 employees and projects valued below ZMW 1 million (Vidalakis et al., 2020).
3. Have engaged in public infrastructure projects (e.g., schools, clinics, roads) within the last three years.
4. Operate for at least three years and demonstrate basic BIM awareness among staff.

Start-ups and firms without public sector experience were excluded to maintain focus on established SMEs with relevant exposure.

Sample size was calculated using Yamane's formula, appropriate for time-constrained research and ensuring statistical validity (Yamane, 1967).

Data Analysis followed a mixed-methods framework. Quantitative data were analyzed using IBM SPSS Statistics v.27, allowing descriptive and inferential analysis (Pallant, 2020). Techniques included frequency distributions, means, Chi-square tests, and regression analyses to explore relationships between variables such as training, awareness, and BIM adoption phases. Qualitative data were analyzed using thematic analysis to identify recurring patterns and themes (Braun and Clarke, 2006).

By combining both methods, the study provided a holistic view of BIM adoption, capturing both measurable patterns and contextual experiences (Creswell and Clark, 2017).

Findings also revealed a relatively educated and experienced construction workforce in Luapula Province, which is an important factor for effective BIM implementation (see Figure 3).

FINDINGS

General Observations

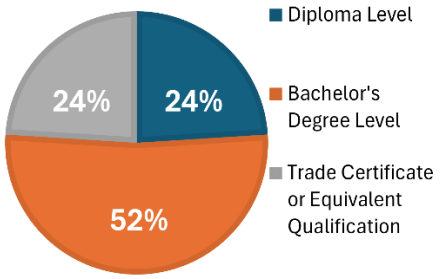

Figure 3: Level of Education of BIM Users

The sample size for this research comprised 47 stakeholders, primarily contractors actively engaged in the construction industry. Over half of the respondents (52%) hold degrees, with the remainder evenly split between diploma holders and those with trade certificates. Engineers (33%), project managers (24%), and foremen (16%) dominate the occupational landscape, indicating that leadership and decision-making in BIM processes are driven by individuals with strong technical and managerial expertise.

Despite this, Figure 4 reflects areas for improvement, with 27% of respondents having less than five years of experience and 11% unfamiliar with BIM software. The majority of respondents (70%) have more than six years of experience, suggesting a solid foundation of seasoned professionals capable of effectively leveraging BIM technologies.

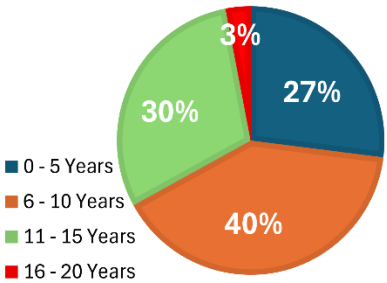

Figure 4: Years of Experience of BIM Users

Overall, the demographic and professional landscape depicts a skilled and capable workforce well-positioned to integrate and maximize the benefits of BIM in the construction industry.

Layout of Findings and Discussion

The findings are based on five factors related to the research questions and objectives:

1. BIM Awareness and Familiarity
2. BIM Usage and Implementation
3. Challenges and Barriers to BIM Adoption
4. Training and Skill Development
5. BIM Readiness

BIM Awareness and Familiarity

The research highlights a high level of BIM awareness and familiarity in the construction industry of Luapula Province, consistent with broader African trends, where BIM awareness is around 75%. Specifically, 89% of respondents are familiar with BIM software, though 11% remain unfamiliar, indicating an opportunity for growth in BIM education as seen from Figure 5.

Furthermore, ArchiCAD standout as the most widely used BIM tool, known by 54% of respondents, likely due to its accessibility, ease of use, and available training resources.

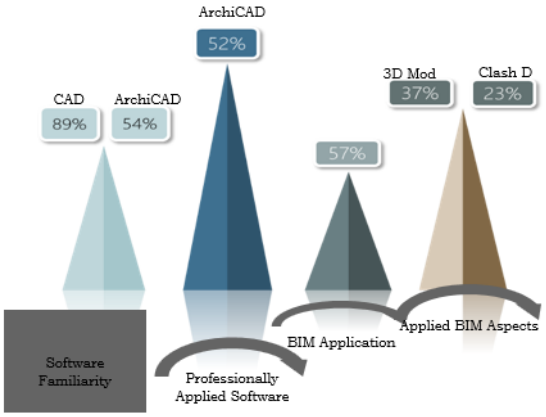

Figure 5: BIM Awareness and familiarity parameters

Revit and AutoCAD follow, used by 21% and 18%, respectively, suggesting some diversity in BIM software usage, though ArchiCAD dominates. The limited use of other BIM software (2%) and the 7% who do not use any BIM software indicate that while BIM is recognized, its application could be more varied.

The research also examines BIM application at a professional level, finding that only 8% of respondents have applied BIM extensively, while 57% have used it to some extent, and 34% have not applied it at all. This suggests that the majority of companies derive minimal benefits from BIM, highlighting a need for more extensive integration and training.

BIM is primarily used for 3D modeling and visualization, which accounts for 37% of applications. This is crucial for design and planning, enhancing communication and collaboration among stakeholders. BIM is also used for quantity take-off and cost estimation, improving budgeting accuracy and resource management. The ongoing use of BIM for 2D drafting reflects a transitional phase where traditional methods coexist with modern 3D modeling.

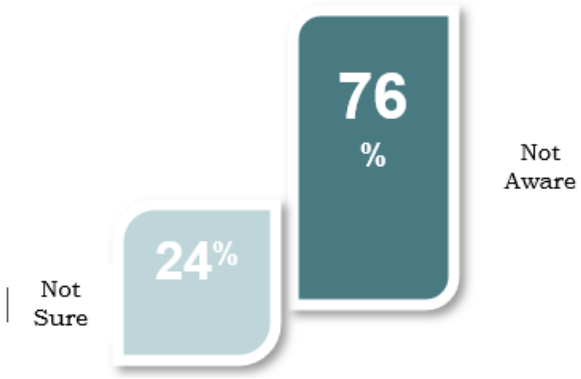

Figure 6: Awareness on government policies or initiatives supporting BIM adoption

Despite BIM's recognized importance for the future of the construction industry, Figure 6 of the research reveals a significant lack of awareness about government initiatives to support BIM adoption. None of the respondents were aware of any such initiatives, with 76% unaware of any government policies and 24% unsure, indicating a critical gap in communication and policy implementation.

BIM Usage and Implementation

The findings as shown in Figure 7 reveal that 60% of companies use BIM primarily during the pre-construction and design stages, with 40% extending its application into the construction and fabrication stages. However, none of the companies apply BIM in post-construction activities like facility management, indicating a significant missed opportunity for long-term benefits.

BIM's most valued benefit is time-saving, appreciated by 45% of respondents, followed by increased client satisfaction (34%). Cost savings (18%) and quality improvement (3%) are less valued, suggesting that while BIM's efficiency in meeting deadlines is recognized, its potential for cost efficiency and quality enhancement is underutilized.

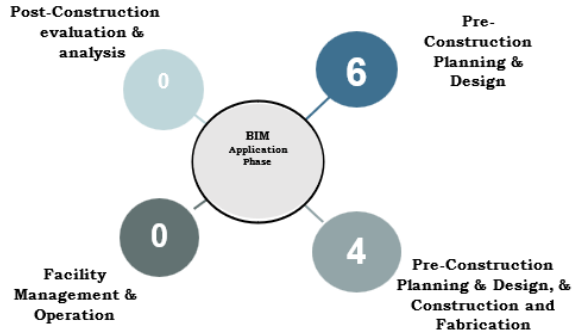

Figure 7: BIM Application Phase

Furthermore, findings shown in Figure 6 reflect a focus on immediate, tangible benefits, possibly due to limited comprehensive implementation of BIM throughout all project phases.

BIM Adoption Challenge and Barriers

Adopting BIM in the construction industry, particularly among SMEs, presents several significant challenges. High initial costs for software, hardware, and training strain SMEs financially, while a shortage of skilled professionals proficient in BIM technologies further complicates adoption. Human factors, including a lack of skilled labor (45%) and resistance to change (35%), are prominent barriers, with financial constraints affecting 20% of organizations. These challenges underscore the need for comprehensive training programs and cultural shifts within organizations to ease the transition to BIM.

At an industry level, the lack of industry-wide standards and guidelines is the major hindrance to BIM adoption, identified by 55% of respondents. This absence creates inconsistencies and hinders collaboration among stakeholders. Insufficient government support, noted by 40% of respondents, exacerbates the issue, highlighting the need for policies that mandate BIM for public projects and provide financial incentives. Additionally, the complexity and steep learning curve of BIM, though affecting only 5% of respondents, remains a notable obstacle for SMEs with limited resources.

The research also reveals significant gaps in the availability and accessibility of BIM training. Half of the respondents indicated that training opportunities are insufficiently available, while 40% were unsure about their existence, suggesting a communication gap. Moreover, 65% of respondents reported no government support for BIM adoption, emphasizing the need for governmental action to provide clear policies and frameworks. No SMEs interviewed indicated the use of BIM tools for post-construction operations such as facility management, building operation, or asset tracking. This lack indicates a significant shortfall in the lifecycle application of BIM. The concern of SMEs is primarily on design and coordination with minimal interest in using BIM for long-term building operation and maintenance, which otherwise is cost-saving and improves building longevity (Brito et al., 2021).

Training and Skill Development

The adoption of Building Information Modeling (BIM) in developing regions like Luapula Province, Zambia, is hindered by a significant skills-gap due to inadequate training programs. The research findings as seen in Figure 8 highlight a concerning absence of formal BIM training, with 70% of respondents reporting no training at all and 30% relying solely on self-learning or informal methods. This lack of structured educational opportunities poses a major barrier to the effective implementation and widespread adoption of BIM in the region.

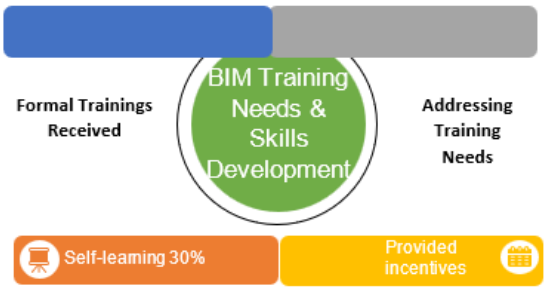

Figure 8: Formal training received

However, there is a noticeable lack of emphasis on mentorship, peer-learning, or

participation in industry events, indicating that these approaches are either undervalued or underdeveloped in the current training landscape.

The findings underscore a strong demand for structured training programs, with 75% of respondents recognizing their necessity for building BIM competencies. Additionally, 25% of respondents advocate for incentives or rewards to encourage skills development, suggesting that financial support could motivate greater investment in BIM education.

BIM Readiness

The research reveals that BIM adoption in Zambia is largely influenced by client demand and project requirements (40%), followed by government incentives or mandates (30%). Demonstrated benefits and ROI from previous BIM projects are also crucial (25%), highlighting the need for proven advantages in cost and efficiency. A small percentage (5%) were uncertain about the factors influencing BIM adoption, and none considered funding availability as a key factor, suggesting confidence or other priorities.

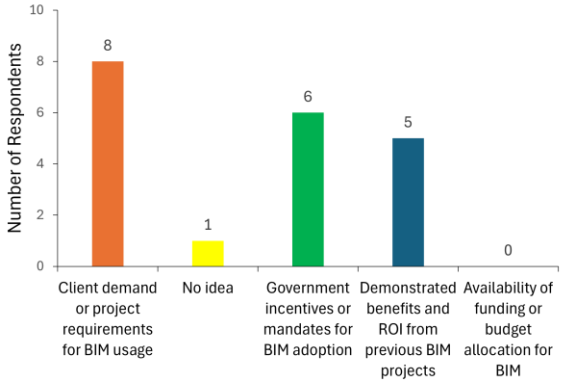

Figure 9: Factors Influencing Investment in BIM

Figure 9 reveals the objectives for adopting BIM as to improve project efficiency and productivity (40%), enhancing collaboration (20%), and reducing errors (10%). The focus on efficiency underscores the industry's need to address project delays and cost issues. The lack of emphasis on quality and the 10% uncertainty about objectives indicate a need for broader education on BIM's benefits.

DISCUSSION

BIM Awareness and Familiarity

The research highlights a strong awareness and familiarity with BIM within Luapula Province's construction industry, aligning with broader African trends. ArchiCAD emerges as the dominant software due to its accessibility and user-friendliness, although a small percentage of respondents remain unfamiliar with any BIM software, indicating an opportunity for growth. The limited application of other BIM tools suggests that while BIM is recognized, its use is somewhat narrow, with a significant reliance on ArchiCAD. The findings also reveal that only a small portion of companies are fully leveraging BIM's potential, pointing to a need for deeper integration and more comprehensive training to maximize its benefits.

Despite the high level of BIM awareness and its recognized importance for the future of the construction industry, the study uncovers a significant gap in awareness of government initiatives to support BIM adoption. With none of the respondents aware of any government efforts and a majority unsure or uninformed about relevant policies, there is a critical disconnect between government actions and industry professionals. This lack of communication and policy implementation could hinder the widespread adoption of BIM, underscoring the need for more effective government engagement and support to fully realize BIM's potential in the region.

BIM Usage & Implementation

The findings suggest that while companies in Luapula Province recognize the value of BIM during the pre-construction and design stages, they are not fully leveraging its benefits across all project phases. The focus on BIM's capabilities in visualization and coordination highlights its importance in early project planning, but the absence of BIM use in post-construction activities like facility management indicates missed opportunities for long-term efficiency and asset management.

The emphasis on time-saving (45%) and increased client satisfaction (34%) reflects the industry's prioritization of meeting deadlines and improving client relations. However, the

lower appreciation for cost savings (18%) and quality improvement (3%) suggests that these companies may not be fully exploiting BIM's potential to enhance overall project efficiency and quality. This could be due to a limited application of BIM or a focus on immediate, tangible benefits rather than a comprehensive, lifecycle approach to BIM implementation.

BIM Adoption Challenge and Barriers

The research highlights critical barriers to the adoption of Building Information Modeling (BIM) in the construction industry, particularly for SMEs. The major challenges include the high initial costs of software and training, a significant shortage of skilled professionals, and resistance to change within organizations. These issues are compounded by the lack of industry-wide standards and government support, which together create a complex and inconsistent landscape for BIM implementation. The findings underscore the urgent need for comprehensive training programs to build BIM proficiency and the development of clear, universally accepted BIM standards to facilitate collaboration and consistency.

Moreover, the lack of government support is a significant impediment, as highlighted by the 65% of respondents who reported no regulatory framework or assistance for BIM adoption. This absence not only hinders SMEs but also stymies the broader industry's progress. The research suggests that overcoming these barriers requires targeted efforts to increase education and awareness of BIM's benefits, coupled with financial incentives like subsidies and tax breaks. Such measures are crucial for encouraging buy-in from stakeholders and easing the financial burden on SMEs, thereby enabling a more widespread and effective adoption of BIM technologies.

Training and Skill Development

The findings reveal a critical gap in formal BIM training within Zambia's construction sector, with 70% of respondents receiving no training and 30% relying on self-learning, which may not suffice for comprehensive BIM proficiency. The strong demand for structured training programs, recognized by 75% of respondents, underscores the need for systematic education to build BIM skills. While 25% advocate for incentives to encourage training, there is a noticeable lack of emphasis on mentorship, peer-learning, or industry events, suggesting these approaches are undervalued or unsupported in the current training landscape. Addressing these gaps is crucial for effective BIM adoption.

BIM Readiness

The findings on BIM readiness reveal alignment with broader industry trends and underscore specific regional challenges. The primary driver for BIM adoption identified by 40% of respondents is client demand or project requirements, reflecting a growing industry trend where market needs increasingly dictate technology adoption. This aligns with the broader view that market pressures often catalyze technological shifts in construction.

Government incentives and mandates, highlighted by 30% of respondents, echo global trends where policy support is crucial for driving widespread BIM adoption. This reflects the industry's recognition that financial and regulatory support can significantly influence technology uptake.
The 25% emphasis on demonstrated benefits and ROI from previous projects aligns with the industry's focus on proving the value of new technologies through successful case studies. This trend underscores the importance of tangible proof to convince stakeholders of BIM’s benefits.

The lack of focus on funding availability suggests that financial constraints may not be as significant a barrier as previously thought, with companies potentially finding other ways to manage costs or prioritize other factors.

The objective focus on improving efficiency and productivity (40%) and enhancing collaboration (20%) reflects prevailing industry priorities, addressing key challenges such as project delays and coordination issues. The 10% uncertainty about BIM’s objectives indicates a need for increased education to better convey BIM’s multifaceted benefits, ensuring a more informed and confident adoption.
The findings by Tran et al., (2024) highlighted that although Building Information Modeling (BIM) greatly improves construction project outcomes, its widespread adoption is

hindered by technological, organizational, and cultural challenges. To fully realize BIM's benefits, a strategic approach involving innovation, education, and policy reform is essential. The research emphasizes BIM's vital role in the future of construction project management and calls for collaborative action among industry stakeholders to promote its adoption and support sustainable development in the sector.

CONCLUSION

This study examined BIM awareness and adoption among SMEs in Luapula Province, identified key challenges limiting its use, explored possible strategies to support adoption, and assessed the potential benefits of BIM for the local construction industry. The findings provide a clear picture of the current situation, showing both progress and ongoing obstacles.

Most respondents (89%) were aware of BIM tools, especially ArchiCAD. However, actual usage was moderate and mostly limited to the design and pre-construction stages. There was little use of BIM during construction and post-construction activities. The main barriers to adoption included a lack of skilled personnel, resistance to change, high costs, and limited government support and industry standards.
Although the study aimed to explore practical strategies, the findings mainly point to the need for stronger basic support. Without structured training, clear policies, and active government involvement, widespread BIM adoption among SMEs is unlikely.

The study highlights the need for a coordinated effort from government, industry, and educational institutions. Establishing national BIM guidelines, providing financial and technical support, and including BIM in formal education are necessary steps. These actions can help SMEs overcome current barriers and contribute to the wider modernization of Zambia's construction sector.

Since the study focused on SMEs in Luapula Province, the results may not fully reflect conditions in other regions or among larger firms. Future research should include other provinces and large construction companies to give a more complete view of BIM adoption in Zambia.

Overall, the findings suggest that stakeholders should prioritize developing training programs, promoting policy reforms, and offering incentives to reduce resistance and support BIM adoption. These efforts are essential for improving SME performance and advancing the digital transformation of Zambia's construction industry.

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