Reality and Prospects of Implementing Building Information Modeling Technology (BIMT) in Libya

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Abstract

Although Building Information Modeling technology (BIMT) has revolutionized the construction sector by enhancing productivity, efficiency, sustainability, and mitigating implementation challenges at all stages of architectural projects, its implementation in developing countries, particularly Libya, remains limited. This research aims to clarify the concept of (BIMT) and its application in various phases of architectural projects. It also seeks to highlight the current state of (BIMT) implementation in Libya, as well as the obstacles and challenges faced by engineers in using it. This research paper employs a descriptive-analytical methodology, incorporating both qualitative and quantitative approaches, using inductive and deductive reasoning. To achieve this, questionnaires were distributed to relevant stakeholders, and empirical statistics were applied. Most participants indicated their awareness of the benefits of (BIMT) as a more effective method for designing and managing construction projects by fostering collaboration, improving design quality by providing the ability to accurately visualize designs in (3D), and offering a platform that facilitates the exchange of information related to sustainable building design, construction, and maintenance throughout the building's lifecycle. However, the results showed that a very small percentage of engineering offices and companies in Libya utilize (BIMT). This research paper recommends encouraging and supporting efforts to raise awareness and knowledge of the benefits of (BIMT) by integrating it into the curricula of architecture departments at Libyan universities and by providing ongoing training opportunities for engineers.

Keywords: Building Information Modeling Technology (BIMT), implementation, Architectural Projects, construction sector, Libya.

المستخلص

على الرغم من أن تقنية نمذجة معلومات البناء (BIMT) قد أحدثت تحولا نوعيا في قطاع البناء من خلال تعزيز الإنتاجية والكفاءة والاستدامة، وتخفيف تحديات التنفيذ في جميع مراحل المشاريع المعمارية، إلا أن تطبيقها في الدول النامية، ولا سيما ليبيا، لا يزال محدودًا. يهدف هذا البحث إلى توضيح مفهوم (BIMT) وتطبيقه في مختلف مراحل المشاريع المعمارية. كما يسعى إلى تسليط الضوء على الوضع الراهن لتطبيق (BIMT) في ليبيا، بالإضافة إلى العقبات والتحديات التي يواجهها المهندسون في استخدامه. تستخدم هذه الورقة البحثية منهجية وصفية تحليلية، تجمع بين المنهجين النوعي والكمي، مستخدمةً الاستدلال الاستقرائي والاستنتاجي. ولتحقيق ذلك، وُزِّعت استبيانات على الجهات المعنية، وطُبِّقت الإحصاءات التجريبية. أشار معظم المشاركين إلى إدراكهم لفوائد (BIMT) باعتبارها طريقة أكثر فعالية لتصميم وإدارة مشاريع البناء من خلال تعزيز التعاون، وتحسين جودة التصميم من خلال توفير القدرة على تصور التصاميم بدقة ثلاثية الأبعاد، وتقديم منصة تسهل تبادل المعلومات المتعلقة بتصميم المباني المستدامة وبنائها وصيانتها طوال دورة حياة المبنى. ومع ذلك، أظهرت النتائج أن نسبة ضئيلة جدًا من المكاتب والشركات الهندسية في ليبيا تستخدم (BIMT). توصي هذه الورقة البحثية بتشجيع ودعم الجهود الرامية إلى رفع مستوى الوعي والمعرفة بفوائد (BIMT) من خلال دمجها في مناهج أقسام الهندسة المعمارية في الجامعات الليبية، وتوفير فرص تدريبية مستمرة للمهندسين.

الكلمات المفتاحية: تطبيق تكنولوجيا نمذجة معلومات البناء (BIMT)، المشاريع المعمارية، قطاع البناء، ليبيا.

Introduction

The construction sector in Libya is experiencing rapid growth due to population increase and rising demand for architectural projects. This growth has been accompanied by several changes in recent years regarding the use of (BIMT). (BIMT) could contribute significantly to solving the problems associated with the construction sector (Kang and Wu, 2025). Arguably, this trend can be considered a paradigm shift in procedures and technology within the construction sectors, which was initiated by Eastman under the slogan "using computers instead of drawings in building design" (Eastman, 2012). Indeed, recent advancements in computer science and information technology have globally transformed the way most construction industries operate (Chan, 2014).

(BIMT) is an enhanced process and tool that incorporates a set of virtual aspects, and systems of a building within a single environment. It involves the maintenance of an integrated digital representation of information across multiple phases (from early stages of design to building operation) of a construction project (Eastman et al., 2012; Barlich and Sullivan, 2012)

Research problem

The research problem lies in the inability of the construction sector in Developing Countries (Suleiman and Asaad, 2024) particularly Libya, to keep pace with technological and digital advancements, especially (BIMT). Despite its importance and the revolution, it has brought to the construction field, studies and research addressing the dimensions and challenges hindering the widespread adoption of this technology are extremely limited. This lack of research has contributed to a significant knowledge gap between Developed Countries (such as the US, UK and other parts of Europe) and Developing Countries particularly Libya. Therefore, this research paper seeks to address this problem by formulating research questions.

Research questions

The fundamental question guiding this research is: **To what extent has (BIMT) been implemented globally and locally in Libyan's construction sector?** This question branches into several sub-questions that this research will address as follows: What specific challenges have emerged in organizations that have implemented (BIMT)? What are the obstacles that hindering broader adoption across Libya's construction sector? Lastly, what are practical procedures that could effectively accelerate (BIMT) implementation throughout the Libyan's construction sector?

Aims and significance

This research aims to identify the current state (BIMT) adoption and application globally and locally through a comprehensive literature review and field survey. Thoroughly, this paper aims to examine current (BIMT) implementation practices in Libya. Furthermore, it also seeks to pinpoint the main obstacles and challenges hindering the expansion of this technology in the Libyan construction sector. Furthermore, the significance of this research lies in identifying several practical measures to overcome these challenges and encourage the adoption of this technology in Libya.

Research methodology

This research paper employs a descriptive-analytical methodology, incorporating both qualitative and quantitative approaches, using inductive and deductive reasoning. The research commenced with an extensive literature review on (BIMT) implementation in Developed and Developing Countries, as well as in the Middle East region. An open-ended questionnaire, for collecting quantitative data, was developed. The questionnaire consists of eighteen questions divided into six sections. These sections include data related to participants' age, specialization, and years of experience working with (BIMT), its implementation in Libya, commonly used software, project implementation methods, the (BIMT) project lifecycle, (BIMT)-related job tasks, (BIMT) training, challenges in implementing (BIMT), and the future of (BIMT) in

Libyan ‘construction industry. In order to test the questionnaire validity, a pilot study was conducted.

The research sample includes architects and engineers from various disciplines namely civil, mechanical and electrical including those who working in project management and experienced contractors in both the public and private sectors in the Libyan construction industry. They were invited by various methods including emails, LinkedIn, forums focused on (BIMT), and Google form.

Out of 140 questionnaires, 118 were successfully filled after being distributed electronically to construction professionals in Libya. Cronbach's alpha assessment performed by the Advanced Statistical Package for the Social Sciences (SPSS) software was used to assess the validity. The outcomes confirm a minimum Cronbach's alpha of 0.908, indicating the reliability. The questionnaire results also demonstrate high levels of consistency.

Literature review

This section of the paper presents the theoretical framework for a literature review on the adoption and use of (BIMT) globally, beginning with Developed Countries. The literature review then examines the adoption and use of BIM in developing countries striving to keep pace with the latest technological advancements in the construction sector. Finally, the literature review addresses the adoption and use of BIM in Arab countries, specifically those in the Middle East, with Libya being a key player in this region. As the fact that (BIMT) is important, especially in Developing Countries, it assists in avoiding expensive rework and construction delays by identifying and resolving conflicts early in the design stage. (Pachani, 2024).

Global adopting and implementing of (BIMT)

Lee (2014) indicated that the use of (BIMT) is mandatory in some Developing Countries, including North America, the UK, Germany, and France. A (BIMT) s’ report conducted by the National Bureau of Statistics (NBS) in April 2024 found that 97% of construction companies in the US had adopted and implemented (BIMT). Meanwhile, European Countries, such as Germany, France, Italy, Finland, Denmark, Norway, Holland and Sweden, are also considered world leaders in (BIMT) (Arayici, 2012). In Germany for instance, since 2022, the federal government has mandated the use of this technology in public buildings. As a government initiative, (BIMT) Deutschland was launched to provide consulting and educational support aimed at making (BIMT) a mandatory standard by the end of 2030 (Gerges, *, et al*, 2017).

Since 1997, (BIMT) has been implemented in Singapore, and it is now required in various aspects of the construction sector. An investigation conducted by Kalfa (2018) showed that 94% of the construction sector in Singapore use (BIMT). Interestingly, Singapore’s (BIMT) Fund was established to cover training and required softwares. Similarly, according to (Arayici, 2012) 87% of architects in South Korea using (BIMT).

Many Developed Countries, such as the US, UK, Canada, and Australia, have developed strategies to implement (BIMT). For example, in the US and Canada, contractor adoption of (BIMT) has been dramatically increased. In a potentially upward trend, the UK government mandated the full use of (BIMT) in public buildings (with a minimum capital cost of £5.5 million) by 2016 to reduce both time and cost overruns. (Gerges, *et al*, 2017).

Adoption and use of (BIMT) in Developing Countries

In the Continent of Africa, where the majority of Developing Countries are located, the adoption of (BIMT) in the construction sector is stumpy. For example, in Nigeria as one of the big African countries, the use of this technology is very limited. Similarly, South Africa, where its implementation encounters significant challenges due to contractual matters and a shortage of qualified staff. (Kekana *et al*., 2014), (Gerges, *, et al*, 2017).

Although (BIMT) technology is widely adopted in China, its use is concentrated almost exclusively in public buildings (Xie *et al*., 2022). Approximately half of the Chinese construction companies are implementing (BIMT) in about half of their workflow in construction projects (China Construction Industry Association, 2021). However, in public buildings in major cities (BIMT) implementation achieves 85.10% (Ministry of Housing and Urban-Rural Development, 2019). The adoption of (BIMT) in China's construction industry has been mainly driven by government directives and polices (Yang and Chou, 2018). The China Building Society (2021) reported that customer demands are the biggest motivator for construction companies to use (BIMT). Chinese regime has introduced both obligatory and motivation policies to encourage (BIMT) adoption in the construction sector (Kang, 2025).

Accordingly, the first strategy requires that public buildings with a big covered area must use (BIMT), while the second requires customers to specify appropriate additional points for applicants who commit to implementing (BIMT). However, (BIMT) development in China still suffers from a shortage of standards (Kang and Wu, 2025).

In Hong Kong, although (BIMT) is being implemented, it is still considered to be in its early stages (Chan, 2014). However, it can be argued that (BIMT) adoption in Hong Kong is progressing rapidly. This is because clients are beginning to recognize its numerous benefits, such as the ability to apply various tests to the BIM model, generate diverse design options, and detect design flaws early to minimize subsequent changes (Kang and Wu, 2025).

it can be argued that although several approaches have been proposed, such as frameworks and technology adoption to support the implementation of (BIMT), a practical mechanism for their adoption remains lacking. This is perhaps due to the contrasting status of (BIMT) in Developed Countries (where BIMT is mandatory or semi-mandatory) and Developing Countries (where BIMT is still in its early stages), highlighting the need for a more practical and applied approach to (BIMT) rather than focusing solely on its potential benefits (Gerges, *et al*, 2017).

Adopting and implementing of (BIMT) in the Middle East Countries

Several Middle Eastern Countries have placed great significance on (BIMT). For instance, the UAE, Kuwait, Saudi Arabia, Qatar, Jordan, and Egypt are among the first countries in the region to pursue its widespread implementation. The Emirate of Dubai was the first to mandate the use of (BIMT) especially in mega projects (BIMIG, 2013).

Young (2015) found that the use of (BIMT) in the Middle East is commonly narrow to 3D modelling. Moreover, Mehran (2016) argued that the lack of standards and the initial high costs, is the main barrier of implementing (BIMT) in the UAE (Gerges, *et al*, 2017).

In his empirical study, Awad (2013) reported that the Middle East region has the lowest rates of (BIMT) adoption. The general impression of (BIMT) is seen as a tool for creating a 3D model of a building. Although, a survey showed that only 25% of construction companies employ (BIMT), its use has improved planning control and overall project's efficiency. Furthermore, shortage of (BIMT) specialists is a concern, with 64%. (Gerges, et al, 2017).

Identify the research gap

An extensive review of the literature on the current status of (BIMT) practices and implementation revealed a knowledgeable gap stemming from the ambiguity surrounding (BIMT) adoption and implementation of (BIMT) in the Libyan's construction sector. Furthermore, reviewing the literature discovered a severe lack of exploratory studies and research highlighting its adoption and implementation of (BIMT) in Libya. Therefore, this research paper seeks to fill this knowledgeable gap through examining the realty of (BIMT) in Libya by exploring its adoption among stakeholders in the Libyan construction sector. Moreover, it aims to identify the obstacles that hindering broader adoption across Libya's construction sector. Ultimately, this research seeks to define practical procedures that could effectively accelerate (BIMT) implementation throughout the Libyan's construction sector.

Results

Reality of adopting and implementing (BIMT) in Libya

This section of the paper will present the results of a field survey on the use of (BIMT) technology in the Libyan construction sector. This includes identifying and measuring the level of awareness and understanding among the parties involved in this sector, including engineers and contractors. Then it presents the results of identifying and measuring the level of employment and use of (BIMT) technology. Furthermore, this section includes identifying the engineering software used locally in (BIMT). It will also address the challenges and obstacles that hinder the expansion of the use of Building Information Modelling (BIM) technology in order to determine the prospects for using (BIMT) in Libya.

Identifying and measuring the level of awareness and knowledge of (BIMT)

According to the results of a survey conducted with a sample of 118 participants from various engineering disciplines, approximately 90.5% reported having knowledge of (BIMT). This 90.5% is divided into three categories: 35.7% consider themselves beginners who understand the principles of BIM, 33.3% consider themselves intermediate, and 21.4% consider themselves advanced in (BIMT) knowledge. Only 9.5% reported having no prior knowledge of BIM, as illustrated in (Figure 1).

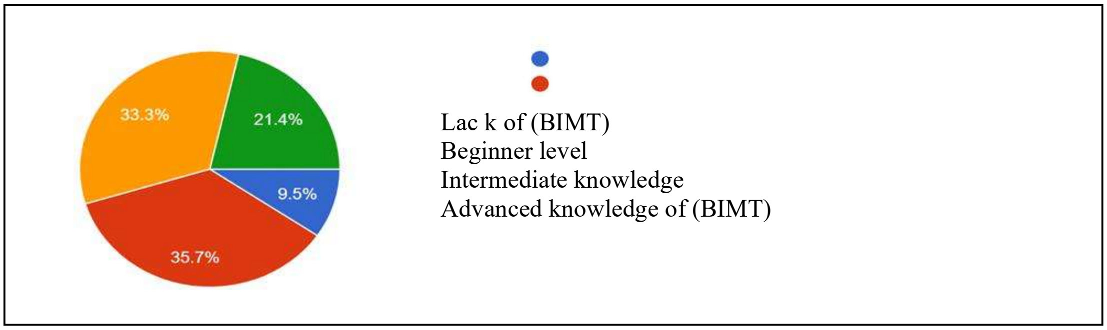

Figure 1: Illustrates the level of knowledge and awareness of respondents (BIM) technology.

The survey results showed that 90.5% of respondents with advanced knowledge of (BIMT) technology acquired their knowledge through various means. The majority (57.1%) received informal training in this field through continuous self-learning and development, while a smaller percentage (9.5%) gained their knowledge through specialized workshops. Additionally, online courses constituted a primary learning method for 45.2% of respondents, and the results also indicated that approximately 28.6% acquired their knowledge through collaboration with colleagues and knowledge sharing within the engineering work environments.

It is also worth noting that the majority of respondents (69%) with partial or full training in (BIMT) are architects, followed by civil/structural engineers (16.7%), then academics (14.3%), and finally mechanical, electrical, and plumbing (MEP) engineers (7.1%). Other complementary disciplines, such as interior design, constitute 2.4%, while engineering professionals in project management represent only 4.8%, as illustrated in (Figure 2).

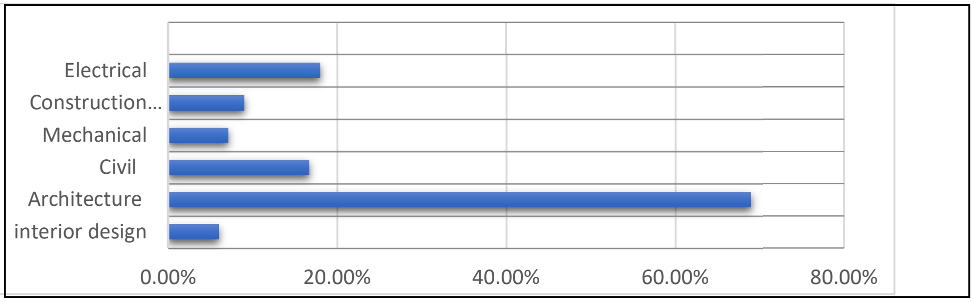

Figure 2: Shows the distribution of knowledge and expertise of the respondents.

Determining the level of experience of participants in the use of (BIMT)

The results of the survey revealed that most (BIMT) users have limited experience, indicating that they are fresh engineering graduates. 69% have been working in the field for less than three years, 11.9% for three to five years, 4.8% for five to seven years, and 4.8% for seven to ten years. Meanwhile, 9.5% have less than one year of experience, as shown in (Figure 3).

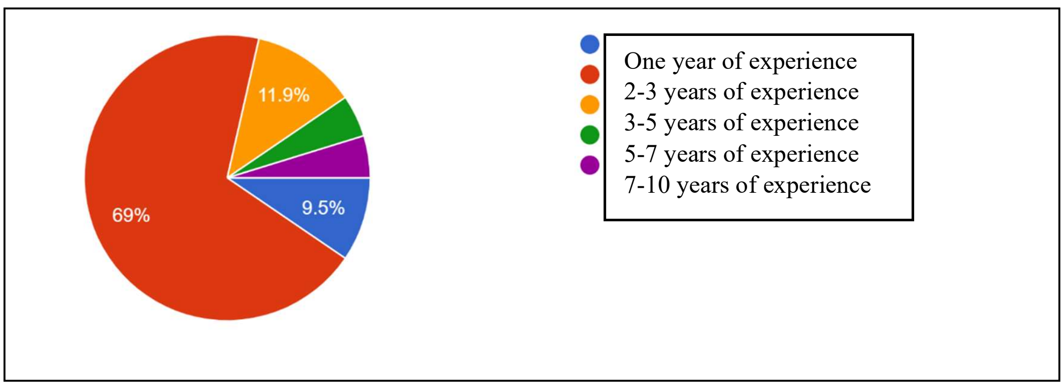

Figure 3: Illustrates the level of experience with (BIMT) among the respondents.

As illustrated in (Figure 4), the survey results also indicated that 45.2% of the experience of respondents is limited to 3D modeling software that displays the visual appearance of the project along with design details (architectural, mechanical, electrical, and plumbing). Meanwhile, 29% of respondents indicated that they use 4D modeling, and 6.5% have a database created on a shared cloud. The remaining 19.4% rely solely on 2D modelling.

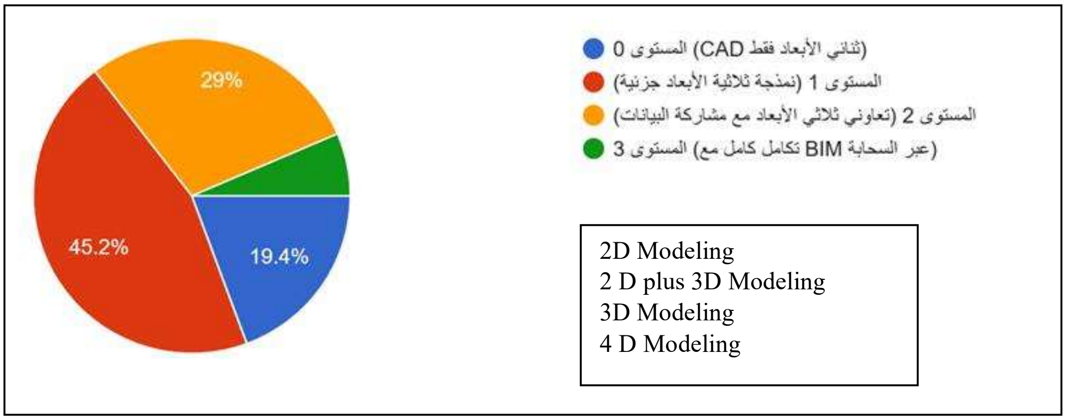

Figure 4: Shows the dimensions and level of details of the implantation of (BIMT) among respondents

Identifying the engineering software used in (BIMT)

According to (Figure 5), the most used (BIMT) softwares among the sample of participants indicate that Revit is the most used program at 81% of the total users, followed by AutoCAD at 76.2%, while the use of ArchiCAD does not exceed 9.5% due to the low usage rates of 4D and 5D applications, while Navisworks does not exceed 4.8%.

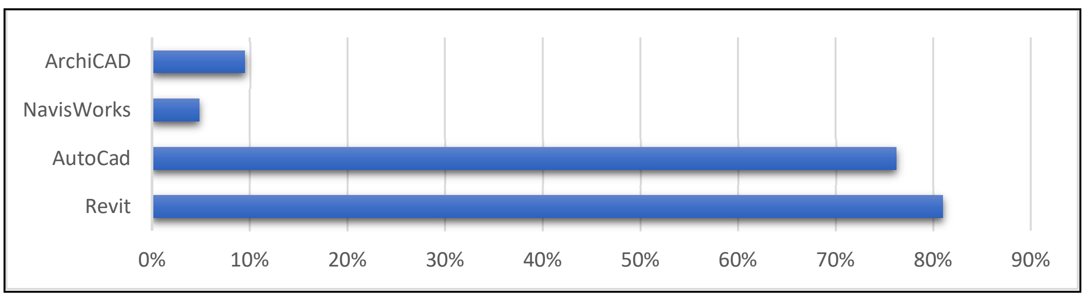

Figure 5: Illustrates the engineering software used in (BIMT)

Identifying challenges and obstacles that limit the expansion of (BIMT)

According to the survey results, as shown in (Figure 6), the most significant obstacles hindering the transition from traditional computer-aided design (CAD) software to (BIMT) are a lack of awareness regarding the importance of training (71.9% of respondents), a shortage of qualified personnel (56.3%), and resistance to change (46.9%). Other challenges cited by respondents include high costs (34.4%), the absence of regulations and legislation mandating the application of this technology (31.3%). Overcoming these obstacles is crucial to ensuring the effective implementation of BIM technology in Libya.

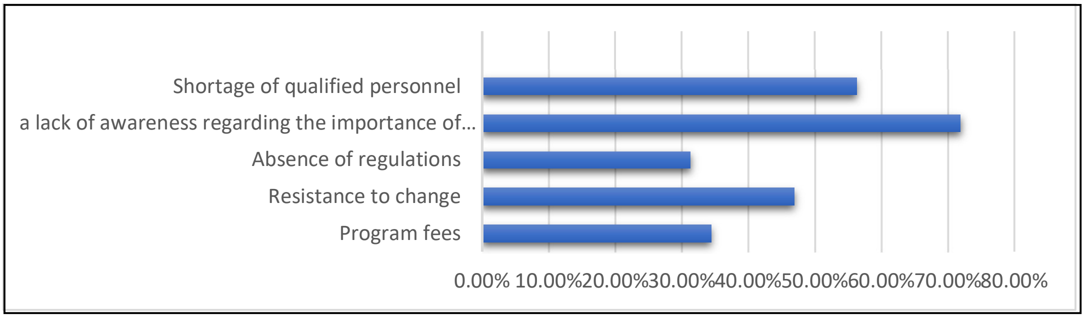

Figure 6: the main challenges and obstacles that limit the expansion (BIMT) implementation

Prospects for using (BIMT) in Libya

According to the results of the field survey, the prospects for adopting and implementing (BIMT in Libya were classified into two levels. The first focuses on establishing binding legislation and regulations for the application of (BIMT). The second focuses on identifying incentive and motivational initiatives to expand the use of BIM technology.

Enacting legislation and regulations that mandate the application of (BIMT)

As previously mentioned in the literature review, governments are obligating entities involved in the construction sector to use (BIMT), similar to practices in developed countries such as the United Kingdom and Germany. Therefore, participants were asked whether legislation and regulations should be enacted to mandate the adoption and application of (BIMT) in Libya. The majority of survey participants (70.6%) answered "yes." Another 20.6% answered "maybe," indicating a cautious openness to this proposal. Only a minority (5.9%) opposed such measures, deeming them unnecessary, while the remaining 2.9% expressed uncertainty about whether mandating (BIMT) legislation and regulations would expand the application of this technology (Figure 7).

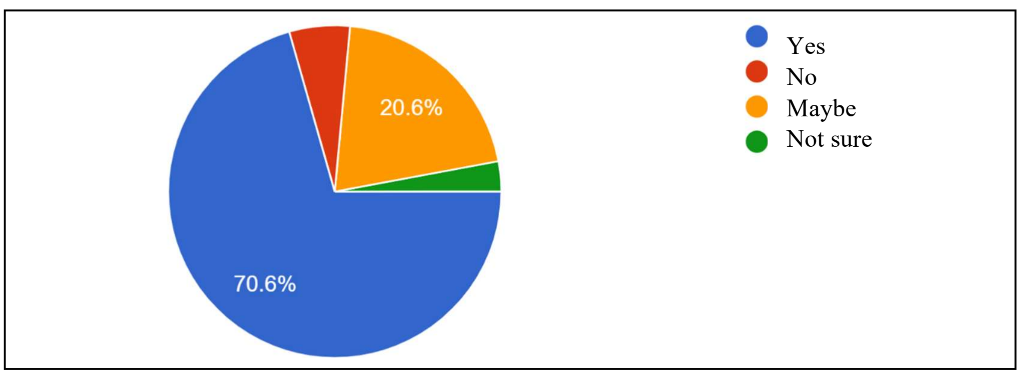

Figure 7: Respondents' views on enacting legislation and regulations mandating (BIMT)

Encouraging and motivating initiatives to expand the use (BIMT) in Libya

As illustrated in (Figure 8), the results of the survey indicated that one of the most important initiatives to encourage and motivate engineering and technical personnel involved in building design and construction to use (BIMT) in Libya is enacting legislation and regulations that would obligate all engineering and technical personnel to use (BIMT), especially in large projects. Meanwhile, 64.4% of respondents recommended that expanding the establishment of specialized programs and training in this technology additionally, 42.2% mentioned offering incentives such as granting priority in awarding design and construction contracts for public projects undertaken by the government to companies and consulting firms that rely on this technology in their work. Furthermore, 45.3% of respondents indicated the need to subsidize the cost of subscribing to (BIM) programs.

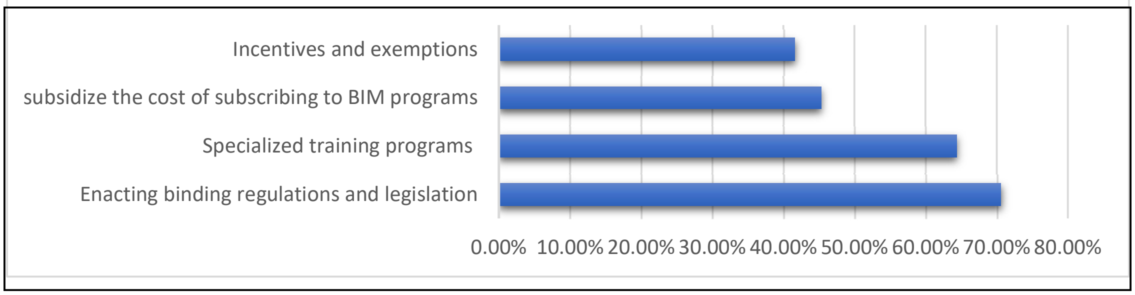

Figure 8: respondents' views on initiatives to expand the use of (BIMT)

Predicting the future adoption and use of (BIMT) in Libya

The survey results showed that most respondents anticipate a brighter future for the use of (BIMT) technology in the Libyan construction sector over the next few years (Figure 9). A majority (64.3%) indicated a high probability that this technology will be used extensively, particularly in the increasingly competitive private sector. A small minority (16.7%) expressed pessimism regarding its adoption.

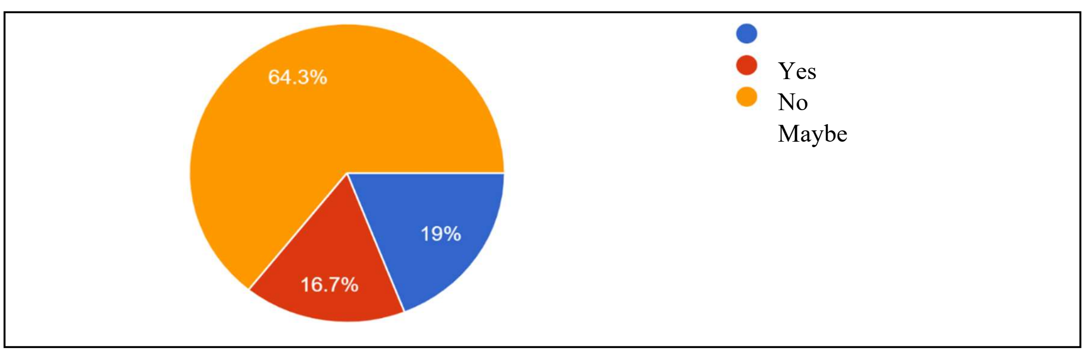

Figure 9: Shows the prediction of the future adoption and use of (BIMT).

Results discussion

Although the results showed that most respondents had a general understanding of (BIMT), the majority possessed only modest experience. Most participants reported acquiring BIM knowledge through self-learning, an independent process where they gained knowledge and skills through personal effort via educational platforms and digital courses that offered accredited certifications. This is likely due to the fact that the engineering curricula in Libyan universities do not keep pace with modern technological and digital developments. Therefore, it has become imperative to update these programs to integrate (BIMT) into architectural and engineering education at Libyan universities.

However, the adoption of (BIMT) is primarily driven by architects, with only a small percentage coming from academics, which explains why most companies only implement BIM at the design stage. While architects are at the forefront of projects, relying solely on them for BIM implementation is insufficient. The findings also revealed that the majority of (BIMT) users are fresh architecture graduates, indicating the entry of a new generation of ambitious professionals into the private sector job market and reinforcing the prediction of a promising future for this technology in Libya. This is attributed to the private sector's flexibility and eagerness to keep pace with the latest technological and digital developments. However, a very small percentage of professionals actually integrate their BIM knowledge into project workflows.The results showed that the use of (BIMT) is often limited to the design phase, where companies use 3D BIM software such as Revit to model architectural details and detect engineering conflicts.

The results also confirmed that the use of (BIMT) technology in Libya does not include other dimensions of this technology, such as the fourth dimension (4D) of scheduling, the fifth dimension (5D) of cost analysis and management, and the sixth (6D) and seventh dimensions (7D) of environmental sustainability and facilities management and maintenance, respectively. Naturally, AutoCAD remains the most widely used software, which is not a BIM program, demonstrating the dominance of two-dimensional work methods in the Libyan construction sector. Although countries like South Korea have followed suit, this step is insufficient without further improvements.

The survey results revealed a strong demand from Libya's construction sector to undermine formal governance of (BIMT), with 70.60% of participants supporting government policies that mandate the application of BIM in large project. This broad consensus reflects an understanding of the importance of central regulatory frameworks for standardizing practices, ensuring accountability, and creating a fair competitive environment. 20.60% of participants indicated that there was uncertainty due to their lack of knowledge on the subject, suggesting the need for clearer policy proposals to address the uncertainties, while the minority opposition of 8.80% highlighted the continued doubts about bureaucratic interference.

To capitalize on this momentum, the Libyan authorities should prioritize drafting legislation and regulations related to (BIMT). This also includes gradually implementation it to public projects and providing tax benefits and incentives for early entrepreneurs, in line with globally successful experiences.

As discussed above, this role is entrusted to the engineers' association, similar to what Britain and Germany did, where the German engineers' association adopted building standards and made the use of (BIMT) mandatory in all public projects about ten years ago.

Three structural obstacles dominate the construction sector's transition to (BIMT):

• **Lack of awareness and training**: The absence of local training programs and misconceptions about the complexity of (BIMT) hinder progress toward wider adoption of this technology. This necessitates holding accredited workshops and training courses, and establishing knowledge-sharing partnerships with international (BIMT) centers.

• **Trained** staff **shortage**: The severe shortage in Libya of specialists with skills in (BIMT) necessitates urgent reforms to the curricula in engineering colleges, and financial support to raise the skill level of current staff through public-private partnerships.

• **Resistance to change**: Cultural inertia towards traditional computer-aided design (CAD) practices underscores the need for change management strategies, including pilot projects demonstrating the cost and time savings of (BIMT), and similar success experiences from comparable markets.

A majority of the participant indicated a high probability that this technology will be used extensively, particularly in the increasingly competitive private sector. A small minority expressed pessimism regarding its adoption.

The majority of respondents who answered "maybe" expressed skepticism, indicating conditional optimism contingent on overcoming the aforementioned obstacles. Pessimistic responses, on the other hand, often pointed to the instability of Libya's construction sector. Nevertheless, this distribution suggests that the adoption of (BIMT) is feasible within the next three years, but only if supported by concerted efforts to achieve political and economic stability.

Conclusion

(BIMT) has become a cornerstone of the construction industry due to its broad scope of knowledge within the design, construction, and operation sectors, and its close connection to the architectural and structural engineering fields. Therefore, implementing this technology has become essential for ensuring survival and competitiveness in the construction sector. It can be said that the use and adoption of this technology is developing very slowly in the Middle East region compared to developed countries. However, the reality of (BIMT) implementation in Libya is unsatisfactory, as only 20% of architectural and construction firm use (BIMT).

The results showed that the most prominent and widely used tool of this technology in Libya is Revit. The research findings concluded that the most prominent obstacles and challenges that limit the expansion of the application of (BIMT) t lie in the resistance to change and Lack of awareness and training as well as the severe shortage of specialists. Finally, this paper recommends encouraging and supporting efforts to raise awareness and knowledge of the benefits of (BIMT) by integrating it into the curricula of architecture departments at Libyan universities and by providing ongoing training opportunities for engineers.

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