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ADVANCING BIM REGULATORY DOCUMENTS IN URBAN PLANNING AND CONSTRUCTION: GLOBAL INSIGHTS AND GAP

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Abstract

The rapid dilapidation of Malaysia's Islamic architectural heritage outpaces physical conservation, necessitating an affordable 3D digital documentation workflow requiring minimal manpower. This paper develops a cost-effective workflow through a comparative study of conventional photogrammetry and 3D Gaussian Splatting (3DGS). The methodology utilizes low-specification hardware - a consumer-grade UAV and smartphone, CPU-only processing, and open-source software. Between 150 and 200 video frames of a Masjid Sg. Chinchin roof crown replica were extracted for 3D reconstruction. Quantitative findings reveal that conventional photogrammetry effectively generates editable mesh models but yields low visual accuracy. Conversely, 3DGS produces highly accurate visual models—generating up to 723,566 splats for the UAV input, and is approximately 22% less time-consuming, although it lacks mesh editability. Furthermore, the UAV consistently outperformed the smartphone: while it produced a photogrammetry mesh with approximately 85% fewer vertices, it effectively eliminated visual noise. In the 3DGS workflow, the UAV generated 13% more splats, yielding sharper, more precise visuals. To address individual limitations, it is recommended to adopt a mixed workflow of 3D photogrammetry and 3DGS. By combining photogrammetry's structural editability with the time-efficient, high-fidelity visual accuracy of UAV-driven 3DGS, this integrated approach ensures comprehensive, fast, affordable, and replicable 3D documentation. Future research should integrate CUDA processing for accuracy and develop an interactive 3DGS web database for Malaysia's Islamic architectural heritage.

Keywords: BIM; regulations; standards; design; digitalization; Central Asia; CIS countries; BIM guidelines; IFC

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INTRODUCTION

The construction industry is one of the most profitable and capital-intensive sectors globally, with the design phase playing a critical role in determining the total cost and success of any project (Cortés et al., 2023). This phase is often complex and time-intensive, influenced by the project's type, scale, and technological readiness. In Uzbekistan's construction sector, the integration of Building Information Modeling (BIM) standards introduces both opportunities for advancement and limitations rooted in existing infrastructure and regulatory frameworks (Z.E & N.S., 2022).

Globalization continues to drive the adoption of advanced technologies in local markets, encouraging industries to align with international practices to remain competitive. However, this transition brings numerous challenges, socio-economic, technical, and regulatory that must be addressed to ensure effective implementation (S. Su et al., 2023). Understanding how design technologies like BIM intersect local and international standards is essential to overcoming these barriers and achieving consistent quality across the construction lifecycle.

Construction documentation is universally governed by both national and international standards. While local regulations reflect region-specific factors such as climate, geology, urban planning policies, and economic conditions, international standards provide uniformity in terms of symbols, measurement units, terminologies, and graphic representation (Sijakovic & Peric, 2020). Familiarity with these standards and technologies is therefore critical for aligning local design practices with global expectations (Petraite et al., 2022).

Currently, six countries the United Kingdom, Singapore, Norway, Finland, South Korea, and Denmark, have established national BIM mandates, while several others are in various stages of developing or implementing such frameworks (Jiang et al., 2022). According to a study by Jung and Lee (Jung & Lee, 2015), North America has the most extensive experience with BIM adoption, followed by Oceania, Europe, and Asia. These efforts are typically supported by top-down policies, structured guidelines, and clearly defined implementation strategies (Ganah & Lea, 2021a). As BIM adoption expands, the development and refinement of standards remain essential for managing complex data, improving collaboration, and supporting digital transformation in the construction industry (Godager et al., 2021; Obi et al., 2021).

Despite the global focus on BIM standardization, existing research has largely concentrated on developed regions, offering limited insight into underrepresented areas. Notably, previous studies have overlooked Central Asia and the Commonwealth of Independent States (CIS), where BIM adoption remains fragmented and insufficiently documented.

This study addresses this gap by identifying and comparing BIM standards, guidelines, and templates across various countries, particularly in the

emerging practices in Central Asia and CIS. By analyzing the interrelationships and gaps in existing documentation, this research contributes to the global discourse on BIM standardization and offers recommendations for policymakers and practitioners in regions seeking to align with international best practices.

LITERATURE REVIEW

The implementation and standardization of Building Information Modeling (BIM) have become central themes in the evolution of the architecture, engineering, and construction (AEC) industry. A comprehensive study by Xu et al. (Xu et al., 2014) emphasized that BIM standards significantly influence both organizational strategies and individual professionals adopting BIM. Reinforcing this, Chan et al. (Chan et al., 2019) identified the lack of standardized guidelines as one of the key barriers hindering widespread BIM adoption in the AEC sector. This sentiment is echoed in the findings of Becerik-Gerber et al. (Becerik-Gerber et al., 2011), who reported that while 71% of BIM-using firms claim to follow standards, only 35% adhere to official industry standards, with the majority relying on internally developed protocols, indicating a fragmented and inconsistent approach.

Further advancements in standardization are explored in the work of Panteli et al. (Panteli et al., 2020), who reviewed developments across EU member states. Their study found that current BIM regulations primarily address overarching concepts such as classification systems, process methodologies, data exchange mechanisms, and lifecycle information management. This indicates a trend toward harmonizing BIM processes, although standard maturity varies widely across countries.

Global BIM adoption trends reveal stark contrasts between regions. Smith (Smith, 2014) conducted a comparative analysis across countries such as North America, the UK, Scandinavia, Singapore, China, and Australia, identifying North America and parts of Europe as frontrunners, driven largely by government mandates, standardized BIM protocols, and structured education systems. Similarly, Jung and Lee (Jung & Lee, 2015) analyzed BIM maturity across six continents and noted that North America, Oceania, and Europe are rapidly progressing toward higher maturity levels, while Africa and South America remain in early development stages. Their study also highlighted the dynamic growth of BIM in Asian countries, including China, Singapore, South Korea, and India (Qi et al., 2023).

Despite the growing volume of literature, Kassem et al. (Kassem et al., 2013) noted that most seminal BIM research has focused on Western nations, particularly the US, UK, and Australia, while neglecting successful implementations in regions like Finland, Norway, and Singapore. Given the rapid

evolution of BIM practices, many earlier studies have become outdated, pointing to the need for continuous research and updates.

From a technological standpoint, Howard and Björk (Howard & Björk, 2008) examined BIM from an IT perspective, underscoring the significance of Industry Foundation Classes (IFC) in facilitating open and interoperable data exchange. Building on this, Azzran et al. (Azzran et al., 2019) advocated for the use of open BIM formats such as COBie and IFC, especially during the operational phase of building projects. Open standards ensure long-term data accessibility and multi-functional use, which Demenev et al. (Demenev et al., 2019) argue is essential for optimizing a building's lifecycle performance. Open BIM thus appears to be a critical enabler for effective data-driven facility management (Oldfield et al., 2017).

However, a recurring limitation in existing literature is the lack of classification or evaluation of BIM standards at a national level. This shortcoming is particularly relevant in post-Soviet and emerging economies, where BIM adoption is relatively nascent. Churakov et al. (2023, 2021) observed that countries in the Commonwealth of Independent States (CIS) historically developed rigid construction methodologies during the 20th century (Baydoun et al., 2024). With the global shift toward digitization, however, their regulatory systems have been adapting to incorporate BIM methodologies. Both Russia and Kazakhstan, for example, launched national BIM programs in 2014 and have since implemented strategic roadmaps to integrate BIM into state-level construction projects (Dariyadi et al., 2022).

Uzbekistan represents a more recent case of BIM integration. The country began its BIM journey following a Presidential Decree in 2018, aiming to digitize construction workflows and project management systems. According to Buronov's 2023 public survey, conducted at the Tashkent Institute of Architecture and Construction, only 13.6% of professionals reported having incorporated BIM software into their design practices. This reflects the early stage of BIM maturity in Uzbekistan and signals a need for policy and capacity-building interventions (Shakhnovich & Daurenbek, n.d.).

Meanwhile, recent scholarly efforts have expanded the boundaries of BIM research by exploring its integration into smart city development, legal infrastructures, and compliance automation. One study investigated BIM's role in supporting smart city initiatives, uncovering significant issues related to data privacy and cybersecurity that current governance frameworks fail to address. The authors call for enhanced legislation and digital policy improvements to bolster public trust and safeguard urban digital ecosystems (Gulamhusein & Bolpagni, 2022).

In the context of Kazakhstan's AECO industry, researchers explored the challenges in transitioning from basic clash detection to more sophisticated

clash avoidance methods. They found that the absence of detailed regulatory frameworks remains a primary constraint, highlighting the necessity for tailored policies to guide BIM growth in developing regions (Akhmetzhanova et al., 2022).

In parallel, efforts to combine BIM with emerging technologies such as blockchain have shown potential in advancing sustainable urban development. A bibliometric study mapped the interplay between BIM, blockchain, and City Information Management (CIM), revealing opportunities for improved environmental performance, yet acknowledging the limited number of real-world implementations (Liu et al., 2021).

Legal and contractual dimensions also significantly influence BIM integration. A qualitative analysis revealed that clearly defined roles, legal responsibilities, and dispute resolution frameworks are vital in reducing project risks and promoting collaboration among stakeholders. Without legal clarity, BIM implementation can become fragmented and conflict prone (Saad Alotaibi et al., 2024).

Lastly, advancements in artificial intelligence (AI) are transforming BIM-based regulatory compliance. A recent framework proposes integrating large language models (LLMs), deep learning, and ontological systems to automate the interpretation of complex construction codes. This AI-driven approach enhances compliance checking by minimizing human error and boosting efficiency, especially in regulatory-heavy environments (Chen et al., 2024).

STANDARDS OF BIM

Leading standardization organizations for BIM, such as the British Standards Institute, the International Organization for Standardization, and the European Committee for Standardization, have been established to develop specialized standards for BIM implementation. Their primary objective is to ensure seamless information exchange and transfer among project participants (Ganah & Lea, 2021a). Several countries have made significant efforts to develop standardized BIM methodologies and tools for documenting information requirements in the design, construction, and operation processes, as shown in Table 1 (Ganah & Lea, 2021a). This table can be expanded based on the experiences of Russia, Kazakhstan, and Uzbekistan in developing BIM methodologies and tools. This initiative is aimed at addressing inefficiencies in the architecture, engineering, and construction (AEC) industry through high-performance solutions. Streamlining processes allows all project participants to work in a unified manner, collaborate effectively, and exchange compatible models and information in the interest of the project (*SCIENTIFIC ASPECTS AND TRENDS IN THE FIELD OF SCIENTIFIC RESEARCH*, n.d.)[29].

Table 1: Adoption of BIM Standards in Different Countries

		Countries Adopting and Implementing BIM with Developed Standards															
		U S A	U K	D e m a r k	F i n l a n d	S w e d e n	N e t h e r l a n d s	S p a i n	N o r w a y	A u s t r a l i a	N e w Z e a l a n d	C h i n a	S o u t h K o r e a	H o n g K o n g	U z b e k i s t a n	K a z a k h s t a n	R u s s i a
A s s e s s m e n t C r i t e r i a	BIM Standards may have an impact on the Building Program	√	√			√	√	√	√	√	√			√	√	√	√
	BIM Standards relate to Building Codes/Regulations	√	√	√	√	√	√	√	√			√			√	√	√
	BIM Standards, Guidelines, and Templates are clear and easy to follow	√	√		√	√	√			√	√		√	√	√		√
	BIM Standards may influence the Project Cycle	√	√	√	√		√	√	√				√	√			
	BIM Standards support for 3D Working Methods			√						√	√	√		√	√	√	√
	BIM Standards support for BIM adoption in an organization	√	√					√	√				√	√		√	
	BIM Standards support for digital compliance checking					√		√		√	√						
	Standards for BIM Execution Plan	√	√			√				√				√	√	√	√
	Information Support for Facilities Management	√	√		√				√	√				√		√	√

	Countries Adopting and Implementing BIM with Developed Standards																
	U S A	U K	D e m a r k	F i n l a n d	S w e d e n	N e t h e r l a n d s	S p a i n	N o r w a y	A u s t r a l i a	N e w Z e a l a n d	C h i n a	S o u t h K o r e a	H o n g K o n g	U z b e k i s t a n	K a z a k h s t a n	R u s s i a	
BIM Standards for Digital Information Security		√															
Support for Coordinating Building Information System	√	√	√	√	√	√		√	√		√						
BIM Standards Discipline Specific	√			√		√	√	√			√	√	√				
Collaborative development (Standards developed by different disciplines and Academia)	√	√		√			√								√	√	√
BIM standards may impact Manufacturers				√					√	√	√						
BIM Standards for Energy Simulation							√	√									

According to Ganah and Leaga (Ganah & Lea, 2021a), this section highlights both the leading countries in BIM standardization and those lagging. The standards are presented by BIM work stages, serving as a valuable source of information. The United Kingdom has structured the BIM implementation process into several "levels," each representing a significant milestone (Chen et al., 2024). These levels can be described as follows:

- Level 0: Non-collaborative 2D CAD.
- Level 1: Non-collaborative 2D or 3D CAD.
- Level 2: 3D CAD with collaboration and information exchange, but not through a single shared model.
- Level 3: Full collaboration among stakeholders, working based on a single, shared model.

Although many public projects in China have sufficient resources to leverage the benefits of BIM, the Chinese government has not yet issued a comprehensive national regulatory framework mandating the use of BIM in public projects. As a result, BIM development in China over the past decade has primarily been driven by market demand. Moreover, the existing Chinese construction laws and regulations lack the necessary provisions to support a collaborative BIM process (H. Su, 2013). The European Union's recently adopted public procurement directives aimed to encourage member states to adopt BIM by 2016, creating a favourable environment for BIM implementation in France. However, if the government does not act swiftly, it may fall behind competitors in the international market (Hamma-adama & Kouider, 2019). The concrete target for BIM adoption in public sector projects was set for 2017 (Oti-Sarpong et al., 2020).

In the United States, the construction industry is regulated by the National BIM Standard – United States (NBIMS-US™). Although the NBIMS document is highly detailed, its 183-page length makes it complex to comprehend (Ginzburg & Shilov, 2016). The primary focus of NBIMS-US™ is to establish standards that facilitate the efficient management of the built environment's life cycle, supported by digital technologies (Abdulghani & Gullu, 2021). In the Russian Federation, a "Roadmap" was adopted in 2017, outlining the development of national processes for designing, constructing (reconstructing, capital repairing), operating, and demolishing capital construction projects. It also aimed to align regulatory and technical documents, as well as cost estimation norms used in construction, with the construction resources classifier (Aitbayeva & Hossain, 2020). In the following years, several decisions and regulations were developed to facilitate the implementation of BIM technologies in the industry.

In Kazakhstan, BIM implementation began in 2016 with the creation of the "Concept for the Implementation of Information Modelling Technology in Industrial and Civil Construction of the Republic of Kazakhstan." The task of developing this concept was assigned to KazSRDICA (Kazakhstan Scientific Research and Design Institute of Construction and Architecture) (Tatiana, 2020). The digitalization of the construction industry encompasses the implementation of investment construction projects throughout their entire life cycle and the transition of participants' collaboration processes into a digital format.

In the Republic of Uzbekistan, the 2021–2025 Innovation Development Strategy included a strategy for modernizing the construction sector. According to this strategy, the implementation of Building Information Modelling (BIM) technology at all stages of a construction project's life cycle was identified as a priority. As part of the strategy's execution, regulatory documents were developed to technologically regulate the introduction of BIM in the construction industry.

The aforementioned standards and regulatory frameworks represent only a portion of the documents adopted to regulate the design process. Additionally, several regulatory documents have been introduced to manage construction and operation processes (Baydoun et al., 2025).

RESEARCH METHODOLOGY

Research Design

This study adopts a desk-based qualitative research design, with a primary focus on document-based content analysis. The research involves a comparative review of BIM standards, guidelines, and templates across selected countries to identify patterns, gaps, and best practices in BIM regulatory documentation. This method ensures a structured and in-depth examination of textual data from both academic and institutional sources.

Country Selection

The selection of Russia, Kazakhstan, and Uzbekistan as case studies was guided by their shared membership in the Commonwealth of Independent States (CIS) and their distinct levels of BIM maturity and regulatory development. These countries offer strategic geographic diversity and present varying approaches to BIM adoption in post-Soviet contexts. Including them enables the study to explore the underrepresented Central Asian and Eastern European region, thus addressing a significant geographical gap in the current body of BIM research.

Data Collection

Based Data were collected from a combination of official government portals, national and international BIM regulatory documents, and industry-specific publications. Academic sources, including peer-reviewed articles and white papers, were used to provide additional context and theoretical grounding. The focus was limited to publicly available and published standards, guidelines, templates, and classification systems relevant to building design and BIM processes.

Data Analysis

A document-based content analysis was applied to identify recurring themes, structures, and inconsistencies across the selected regulatory documents. Documents were categorized based on their scope (standards, guidelines, templates), geographical origin, and implementation approach (top-down or bottom-up). A comparative matrix was then developed to visualize interrelations and regulatory coverage between the countries studied.

To strengthen the credibility and reliability of the findings, methodological triangulation was applied. This included:

- Cross-referencing regulatory documents with academic literature.
- Validating national frameworks with information from international organizations (e.g., ISO, building SMART).
- Consulting official BIM-related strategies and portals where applicable.

Scope and Limitations

The study is limited to documents available in English and Russian. While this may restrict access to certain localized standards or updates, the analysis captures the core regulatory frameworks currently influencing BIM implementation in the selected countries.

ANALYSIS AND DISCUSSION

Table The comparative analysis highlights significant regional disparities in the adoption and development of BIM standards, with a clear divide between developed countries with robust BIM mandates and emerging economies still in the process of developing fragmented regulatory frameworks. Developed countries like the United Kingdom, Singapore, and Finland have laid the groundwork for BIM adoption through centralized national roadmaps and clear execution plans, which appear to be critical success factors for early adoption. In contrast, countries such as Uzbekistan and Kazakhstan face difficulties due to the lack of a unified approach and the challenges posed by fragmented regulations and varying levels of technological preparedness.

The experiences of countries like the United States and Russia reflect the complexities of decentralized BIM efforts. While the U.S. has made significant strides in developing a wide range of BIM standards, these standards are often created at the state level, leading to fragmentation and inconsistent application. This contrasts with the UK's national-level BIM strategies, which provide a unified framework that facilitates interoperability and ensures that BIM processes are aligned across regions. Similarly, Russia's regulatory and technical framework for BIM, while comprehensive, is still in the process of evolving, with key documents outlining minimum requirements for BIM model formation but

still lacking the full integration necessary for nationwide implementation (Tatiana, 2020). This variation in approach underscores a critical point: a centralized, cohesive strategy is essential for BIM's effective implementation.

Furthermore, Europe's emphasis on cross-standard integration and lifecycle data continuity positions it ahead of other regions in digital construction practices. The European model's success can be attributed to its extensive development of standards, guidelines, and templates, along with its emphasis on ensuring seamless workflow continuity across project lifecycles. This approach contrasts sharply with that of CIS countries, where, although many technical standards are adopted at the international level, the institutional and educational gaps continue to hinder the full realization of BIM's potential. The widespread availability of interconnection documents in Europe, 5.2 times more than in Asia, demonstrates the continent's commitment to developing a harmonized BIM ecosystem, which allows for smoother collaboration and project execution across borders.

Despite the adoption of international standards such as ISO 19650, which provides a framework for BIM at a global scale, the lack of sufficient strategic planning documents in several countries remains a major obstacle. For instance, although many countries have developed BIM model standards and information requirements, such as the UK's PAS 1192-2:2013 and Singapore's focus on participant roles, there is still a significant gap in the creation of foundational project planning documents like BIM Execution Plans (BEP) and Employer's Information Requirements (EIR). Without a well-rounded set of interlinked standards that guide a project from conception to completion, the implementation of BIM can be less effective, leading to inefficiencies and project delays. This issue is particularly pronounced in emerging economies, where the focus tends to be on adopting technical standards without sufficient consideration of strategic and organizational documents that are key to ensuring successful BIM integration.

Another critical gap in BIM implementation in many countries, especially in Central Asia and the CIS region, is the lack of trained specialists and educational frameworks that can support BIM adoption. Countries such as Russia, Kazakhstan, and Uzbekistan have developed regulatory frameworks to introduce BIM technology at the state level, but these efforts have not been complemented by adequate investments in workforce development and educational initiatives. The integration of BIM requires a skilled workforce familiar with both traditional and new technologies, and without such a workforce, the full potential of BIM cannot be realized. For instance, Kazakhstan's implementation of BIM in state-funded projects, although a significant step forward, relies heavily on local companies' readiness and their ability to manage the technology efficiently, which remains a major challenge.

Similarly, Uzbekistan's plans to integrate BIM technology across the entire building lifecycle in urban planning regulations for 2024-2025 face significant hurdles in terms of specialist training and practical application (Miravalls & Pley-leclercq, 2023).

In conclusion, while BIM adoption is progressing globally, the extent and success of its implementation vary significantly depending on the country's regulatory framework, technological readiness, and workforce capacity. Countries with centralized national roadmaps, such as the UK and Singapore, have demonstrated successful models for BIM adoption that emphasize both technical and strategic integration. In contrast, countries like the United States, Russia, and those in the CIS region face challenges in achieving consistency and full implementation due to decentralized efforts, lack of coordination between standards, and gaps in educational and institutional frameworks. As it illustrates in Figure 1 The future of BIM adoption in these regions depends on overcoming these barriers through the development of unified national strategies, comprehensive training programs, and greater alignment between technical standards and strategic planning documents (Ganah & Lea, 2021b). The experience of these countries also highlights the need for international collaboration in developing BIM standards that are adaptable to local contexts, ensuring that BIM can reach its full potential as a tool for improving construction efficiency, collaboration, and sustainability across the globe. Figure 2 shows the Comparative analysis of the experiences of Russia, Kazakhstan, and Uzbekistan in developing BIM standards, guidelines, and templates.

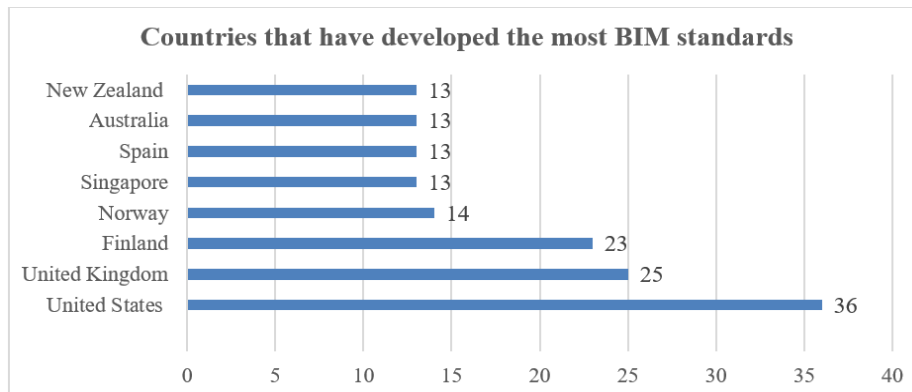


Figure 1: Comparative analysis of countries in developing BIM standard.
Source [40].

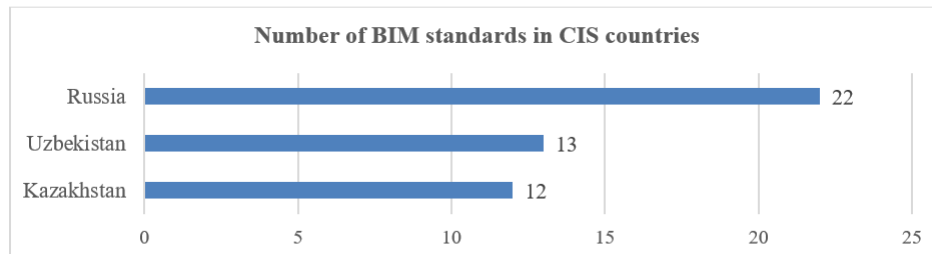


Figure 2: Comparative analysis of the experiences of Russia, Kazakhstan, and Uzbekistan in developing BIM standards, guidelines, and templates.

Source [40].

CONCLUSION

The global implementation of Building Information Modelling (BIM) standards, while technologically similar across different regions, faces significant challenges due to varying economic, technological, and regulatory environments. Countries such as the United Kingdom, Singapore, Norway, Finland, South Korea, and Denmark have set high standards for BIM adoption through national mandates, underpinned by strong governmental support, well-developed infrastructure, and a prepared workforce. However, in regions like Central Asia and the CIS countries, despite aligning with international ISO standards, the integration of BIM faces notable obstacles. These include outdated infrastructure, a lack of specialized knowledge, and an underdeveloped economic and technological environment. This discrepancy highlights that BIM adoption is not solely a matter of transposing global standards; it requires a tailored approach that addresses local conditions, both technological and managerial, as well as economic readiness.

For countries facing these challenges, it is crucial to establish a clear and structured approach to BIM integration. Policymakers should prioritize the development of a national BIM roadmap that outlines specific timelines, targets, and frameworks for implementation. This roadmap should be adaptable to the local context, ensuring that it addresses the unique regulatory, legal, and technological needs of the country. In addition, to reduce the financial burden on construction companies, governments can encourage BIM adoption by supporting pilot projects and offering tax incentives to firms investing in BIM technologies. This would not only help accelerate the transition to BIM but also create a more favourable economic environment for its widespread implementation. Furthermore, translating ISO standards into locally relevant frameworks is essential. While international standards provide a strong foundation, their application must be contextualized to account for regional

construction practices and economic conditions, making them more accessible and actionable for local stakeholders.

Addressing the workforce gap is another critical factor in ensuring the success of BIM adoption. Governments and educational institutions should invest in training and professional development programs that equip professionals with the necessary skills to utilize BIM technologies effectively. This would help address the shortage of qualified BIM experts and foster a culture of continuous learning and adaptation within the industry. The availability of skilled personnel, coupled with high-performance technological infrastructure, is essential for maximizing the potential of BIM technologies. Furthermore, the age and readiness of specialists to adapt to new technologies play a significant role in the speed of BIM adoption. Older professionals may face challenges in learning and adopting new technologies, making it imperative to focus on both younger professionals and providing ongoing support for experienced specialists.

Looking ahead, future research should focus on several key areas to further improve BIM adoption and its integration into the global construction industry. One promising avenue is the development of AI-driven tools for automating compliance checks, which could significantly reduce the time and effort required to interpret complex regulatory texts. This would enhance the efficiency and accuracy of BIM adoption, particularly in countries with evolving regulatory standards. Additionally, creating a regional BIM maturity index could provide valuable insights into the specific challenges faced by different countries or regions. Such an index would allow policymakers and industry stakeholders to assess the progress of BIM adoption, identify key gaps, and set targeted goals for improvement. Another important area for future research is the integration of BIM with smart city initiatives. As urban development increasingly focuses on sustainability and technological integration, BIM's role in managing urban infrastructure and optimizing building performance will become increasingly critical. Research in this area could provide new insights into how BIM can contribute to creating smarter, more sustainable cities.

Moreover, the future development of BIM is increasingly connected to City Information Modelling (CIM), which expands digital modelling from individual buildings to district and city-scale planning. While BIM focuses on building lifecycle management, CIM integrates urban data such as infrastructure, transportation, environment, and land use into a unified digital framework. The integration of BIM and CIM can bridge the gap between building construction and urban planning by improving coordination between architects, planners, engineers, and municipalities. This approach supports smart city development, digital twins, sustainability, and more efficient urban management. For emerging economies and CIS countries, integrating CIM with BIM could strengthen data-driven urban governance, although this will require interoperable standards,

stronger GIS-BIM integration, updated regulations, and improved digital infrastructure.

Finally, the long-term impact of BIM on the construction industry's efficiency and sustainability remains an important area for investigation. Longitudinal studies tracking BIM's effect on industry productivity, cost savings, and environmental sustainability will help demonstrate its value over time and encourage broader adoption. These studies will not only support the case for BIM but also guide future advancements in BIM technologies and their application in construction.

In conclusion, the successful integration of BIM into the construction industry requires a multifaceted approach that addresses the technological, economic, and human factors that influence adoption. By focusing on clear policy development, workforce preparedness, and targeted research efforts, countries can create a more effective environment for BIM's widespread implementation. With the right mix of governmental support, education, and research, the construction industry can unlock the full potential of BIM technologies, paving the way for more efficient, sustainable, and innovative building practices worldwide.

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