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Policy Strategy and Challenges of BIM Implementation in National-Scale Public Construction Project Procurement and Implementation

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Abstract:

The rapid digital transformation of the construction sector has positioned Building Information Modeling (BIM) as a key instrument in improving efficiency, transparency, and collaboration in public construction projects. This study explores the policy strategies and challenges of implementing BIM within national-scale public construction procurement and execution in Indonesia. The main objectives are to analyze existing national policy strategies, identify key challenges hindering implementation, and propose strategic policy recommendations. The research employs a qualitative approach using a literature study method, synthesizing findings from academic journals, government regulations, and institutional reports published between 2019 and 2025. Data were analyzed using content and thematic analysis, categorized into three main themes: policy strategy, implementation challenges, and policy recommendations. The results show that Indonesia's government has made significant progress in integrating BIM through regulatory enforcement, standardization initiatives, and capacity-building programs. However, implementation remains inconsistent due to uneven technological infrastructure, insufficient human resources, limited interoperability, and financial barriers among contractors. The study recommends developing a National BIM Roadmap, enhancing data management systems, strengthening BIM education and professional certification, and providing fiscal incentives to promote compliance. These findings highlight that effective BIM implementation requires not only regulatory support but also institutional collaboration and long-term investment in digital infrastructure and human capital.

Keywords: Building Information Modeling, Public Procurement, Policy Strategy.

Introduction

In the era of large-scale infrastructure development, digital transformation in the construction sector has become a strategic necessity. Building Information Modeling (BIM) has emerged as a crucial tool to support efficiency, transparency, and collaboration in construction projects (Alsofiani, 2024). BIM enables an integrated digital representation of geometry, schedule, cost, and maintenance data so that all

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stakeholders can access a single and consistent source of information (Kineber et al., 2023). In the context of public projects, BIM adoption is not merely a technical issue but also involves policy frameworks, national standards, and effective governance (Kuang et al., 2023). Therefore, understanding the role of public policy, regulations, and implementation strategies of BIM is essential in the realm of public construction procurement and execution.

Building Information Modeling (BIM) is an integrated approach to creating, managing, and optimizing a digital representation of the physical and functional characteristics of a building or infrastructure throughout its life cycle—from planning, design, and construction to operation and maintenance. Essentially, BIM is not merely a 3D model; it combines geometric data, technical attributes, schedules, and cost information, allowing all project stakeholders to collaborate using a single, consistent source of truth. International standards such as ISO 19650 formalize BIM information management processes to ensure structured and secure data exchange among project teams, leading to wider adoption by organizations seeking to enhance information quality and reduce the risk of data-related errors (Datta et al., 2023; ISO, 2022).

The practical benefits of BIM include early clash detection, improved multidisciplinary coordination, more accurate quantity and cost estimation (5D BIM), and better support for sustainable design decisions. Recent developments have expanded BIM's role through integration with digital twins and performance analysis for long-term building operation and energy optimization. However, full-scale implementation still faces challenges such as limited human resource capacity, software interoperability, and the need to adapt business models to manage information across an asset's lifecycle. Recent studies emphasize that implementing standardized information management frameworks (e.g., ISO 19650) and adopting robust information strategies are key to overcoming these barriers (Autodesk, 2023; Tran & Nguyen, 2024; Wang & Chen, 2023).

In many countries, the use of BIM in public procurement has become either a requirement or a strong recommendation to enhance accountability and cost control (Public Buyers Community, 2025). However, significant challenges remain, including limited stakeholder awareness, low software interoperability, and the lack of clear standards (Kineber et al., 2023). Furthermore, traditional procurement models that focus primarily on the lowest bid price often fail to support early-stage integration and collaboration facilitated by BIM (Al-Raqeb et al., 2024). Institutional barriers, such as limited human resource capacity, resistance to organizational change, and high initial investment costs, further hinder optimal BIM implementation (Alsofiani, 2024). Hence, despite BIM's high potential, its actual implementation in the field remains fragmented and inconsistent.

In the context of national public procurement, the government plays a dual role as both a policymaker and a primary user of BIM (UCL Construction Review, 2025). National policies that mandate or incentivize BIM adoption can accelerate systemic implementation (MDPI Buildings, 2023). However, policies alone are insufficient without technical guidance, training programs, and procedural adjustments (Alsofiani, 2024). Additionally, in large-scale public projects, inter-agency coordination, compliance with standards, and contract management reforms are critical for successful BIM implementation (Kuang et al., 2023). Thus, policy strategies should not only focus on regulation but also on incentives, institutional capacity building, and the modernization of procurement procedures.

Specifically in Indonesia, although digitalization efforts in the construction industry have increased, BIM implementation in national-scale public projects still faces challenges related to regulation, standardization, and local industry readiness. Substantial factors such as the lack of simplified national guidelines for public procurement, limited understanding of BIM deliverables, and logistical challenges in cross-project data integration remain major obstacles. National policy strategies specifically addressing public project implementation have rarely been examined systematically, particularly within the procurement and execution stages. Therefore, there exists a research gap in linking national policy frameworks, public procurement processes, and operational implementation of BIM in national projects.

The urgency of this research lies in the fact that national public construction projects constitute a large portion of state infrastructure spending and have broad economic, social, and environmental impacts. Successful BIM implementation in procurement and execution stages could enhance budget transparency, reduce waste, accelerate project completion, and improve the quality of public assets. However, without appropriate policy strategies and a comprehensive understanding of existing challenges, these potentials cannot be fully realized. Hence, this study is vital to provide empirical insights into policy strategies and challenges of BIM implementation in national-scale public projects.

Several previous studies have examined BIM adoption in the construction sector and the role of public policy (Alsofiani, 2024; Kineber et al., 2023; Pérez-García et al., 2021). For example, a study in Sweden found that external barriers such as regulatory constraints and public procurement requirements had greater influence than internal company barriers (Pérez-García et al., 2021). Another study in Kuwait identified that limited stakeholder awareness and traditional procurement models hindered BIM implementation in the public sector (Pérez-García et al., 2021). Nonetheless, research that specifically connects national policy strategies, public procurement mechanisms, and BIM implementation at the national level remains scarce and contextually underexplored, particularly in developing countries.

The objectives of this study are to (1) analyze national policy strategies applied to the implementation of BIM in public construction procurement and execution at the national scale, (2) identify key challenges in BIM implementation within public procurement and execution contexts, and (3) formulate policy recommendations to enhance the effectiveness of BIM implementation in national public construction projects.

Methods

This study employs a qualitative research approach with the type of research being a literature study. The qualitative approach was selected because the main purpose of the study is to gain an in-depth understanding of policy strategies and challenges in implementing Building Information Modeling (BIM) within the context of national-scale public construction procurement and execution. Qualitative research is descriptive and interpretative in nature, allowing the researcher to explore meanings, relationships, and policy implications derived from existing literature (Creswell & Poth, 2016). The literature study method enables the synthesis of theories, empirical findings, and best practices in BIM adoption across public sector projects (Snyder, 2019).

Type of Research

This research is a literature study that systematically reviews and analyzes scholarly sources related to BIM policy and its implementation in public construction. The literature study method allows researchers to integrate knowledge from various studies to develop conceptual insights into policy design and implementation frameworks. According to Booth, Sutton, and Papaioannou (2016), this method is particularly effective for identifying gaps and emerging patterns across multiple studies. It also enables the development of a comprehensive understanding of BIM's role in national construction governance systems.

Data Sources

The study utilizes secondary data sources collected from relevant and credible academic and institutional publications. These sources include peer-reviewed journal articles, academic books, government policy reports, international standards (e.g., ISO 19650), and publications by professional organizations such as BuildingSMART International and the European Commission Public Buyers Community. The literature is limited to the period between 2019 and 2025 to ensure data relevance and currency. Data were obtained from academic databases such as ScienceDirect, SpringerLink, Taylor & Francis Online, MDPI, and Google Scholar. These databases were chosen because they provide access to updated and high-quality scientific publications.

Data Collection Techniques

The data collection process was conducted through three systematic stages: identification, selection, and evaluation of documents.

1. Identification Stage – The researcher searched the literature using keywords such as "BIM policy implementation," "public procurement," "digital construction," and "BIM in national projects."
2. Selection Stage – The inclusion criteria included relevance to BIM policy or public procurement, publication within the last five years, and credibility of the publisher.
3. Evaluation Stage – Each source was critically assessed using critical appraisal techniques to evaluate content validity, consistency of findings, and contextual suitability to the scope of this research (Papaioannou et al., 2016).

This process ensured that only high-quality and contextually relevant literature was analyzed.

Data Analysis Method

The data analysis employed a content analysis method with a thematic approach. Data were categorized into three main analytical themes:

1. Policy strategies for BIM implementation,
2. Challenges and barriers in BIM adoption, and
3. Strategic recommendations for public policy development.

The analysis followed the stages of data reduction, data display, and conclusion drawing as suggested by Miles, Huberman, and Saldaña (2018). The process involved identifying recurring patterns, conceptual relationships, and cross-case comparisons

among studies (Miles et al., 2020). The validity of the findings was maintained through source triangulation and the comparison of multiple research outcomes (Snyder, 2019). The analysis aimed to generate a conceptual synthesis that deepens the understanding of policy strategies and implementation challenges of BIM in national-scale public construction projects.

Results

Analysis of National Policy Strategies for BIM Implementation

The implementation of Building Information Modeling (BIM) in national-scale public construction projects has been increasingly emphasized as part of the digital transformation in the construction sector. The Indonesian government, through regulations such as the Ministry of Public Works and Public Housing Regulation No. 22/PRT/M/2018 and the National Construction Industry Policy 2020–2024, has positioned BIM as a key instrument to improve project efficiency, transparency, and sustainability (Ministry of Public Works and Public Housing (PUPR), 2020). These policy strategies reflect the government's commitment to adopting a data-driven and integrated approach to construction management (Ullah et al., 2022). The central strategy includes the gradual enforcement of BIM standards, capacity building for human resources, and the establishment of national BIM guidelines that align with ISO 19650 standards.

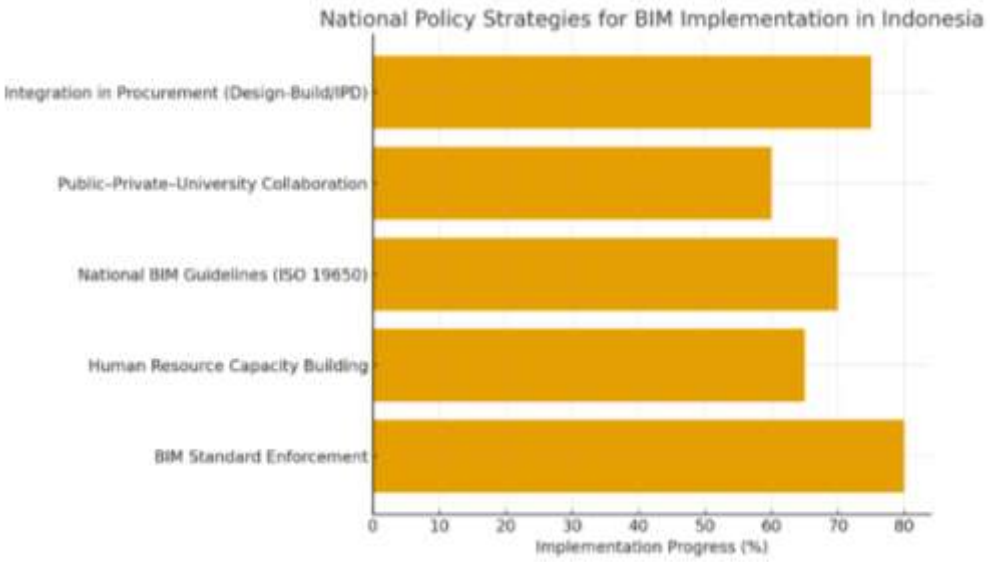

Figure 1. National Policy Strategies for IBM Implementation in Indonesia

The analysis of national policy strategies for BIM implementation in Indonesia reveals varied progress across key focus areas. The government has made the greatest advancement in enforcing BIM standards (80%), supported by regulatory frameworks such as the Ministry of PUPR Regulation No. 22/PRT/M/2018. Efforts in developing national BIM guidelines and capacity building for human resources show moderate progress, reflecting ongoing institutional and educational initiatives. Collaboration among public institutions, private sectors, and universities remains less developed (60%), indicating the need for stronger intersectoral partnerships to sustain implementation. Meanwhile, the integration of BIM into procurement processes,

particularly in Design-Build and Integrated Project Delivery projects, has achieved substantial progress (75%). Overall, while the policy framework demonstrates clear strategic direction, implementation remains uneven, influenced by regional and institutional readiness levels.

Furthermore, policy initiatives have been supported by collaborations between public institutions, universities, and private sectors in promoting BIM education and awareness. These partnerships aim to enhance technical literacy and provide institutional readiness for BIM adoption (Banawi et al., 2019). The integration of BIM into the procurement process has also become a significant policy move, ensuring that project delivery methods such as Design-Build and Integrated Project Delivery (IPD) leverage BIM as a mandatory requirement (Bolpagni, 2013; Junior et al., 2020). However, while strategic frameworks are well-designed, the implementation at the operational level remains uneven due to regional disparities and variations in organizational readiness.

Key Challenges in BIM Implementation

Despite the national policy efforts, several challenges hinder the effective implementation of BIM in public construction projects. One of the main obstacles is the limited technological infrastructure and the digital divide among public agencies and local contractors (Arayici et al., 2012; Ghaffarianhoseini et al., 2017; Kensek, 2014). Many organizations still rely on conventional 2D-based systems, leading to inefficiencies and data fragmentation. Additionally, the lack of standardized BIM execution plans and interoperability issues among different software platforms have complicated collaborative workflows (Tchouanguem Djuedja et al., 2019).

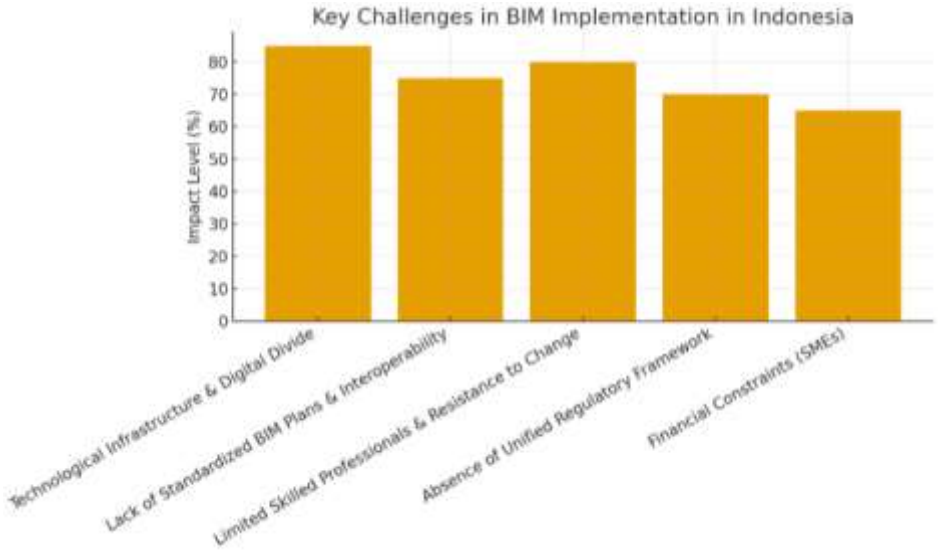

Figure 2. Key Challenges in BIM Implementation in Indonesia

The chart illustrates the key challenges affecting BIM implementation in Indonesia's public construction sector. The most significant barrier is the technological infrastructure gap and the digital divide (85%), which limit effective data integration across agencies. Human resource limitations and resistance to change also have a high impact (80%), reflecting the shortage of skilled professionals. Interoperability and lack of standardized BIM plans (75%) further disrupt collaboration, while the absence of a

unified regulatory framework (70%) hampers coordination among institutions. Lastly, financial constraints faced by SMEs (65%) remain a considerable obstacle to broader BIM adoption.

Another critical challenge is human resource capacity. The shortage of skilled professionals with adequate BIM knowledge, combined with resistance to change among project stakeholders, has slowed down adoption (Naji et al., 2024). From a regulatory perspective, the absence of a unified national BIM framework with clearly defined roles, responsibilities, and data-sharing protocols further weakens coordination between ministries, agencies, and private sector actors. Financial constraints, particularly in small and medium-sized enterprises (SMEs), also pose significant barriers, as BIM implementation requires investment in hardware, software, and training (Banawi, 2017).

Policy Recommendations for Effective BIM

1. Develop a National BIM Roadmap outlining implementation phases, standardization, and coordination mechanisms.
2. Establish centralized BIM data management systems to enhance interoperability, transparency, and data security.
3. Strengthen BIM education and professional certification programs to build technical capacity.
4. Integrate BIM courses into university and vocational curricula to prepare future professionals.
5. Provide fiscal incentives (tax reductions, grants) for BIM-compliant contractors.
6. Promote public-private partnerships (PPPs) and international collaborations for technology transfer and innovation.
7. Implement performance indicators to monitor and evaluate BIM adoption progress.

This study reveals that while Indonesia's policy strategies for BIM implementation demonstrate progressive intent, practical challenges persist due to gaps in governance, digital infrastructure, and human resources. The findings emphasize that successful BIM adoption requires not only regulatory enforcement but also cultural and institutional transformation. A multi-dimensional approach—combining policy alignment, capacity building, financial incentives, and technological innovation—is crucial for the long-term sustainability of BIM-driven public construction.

Conclusion

This study concludes that BIM implementation in national-scale public construction projects in Indonesia has progressed through policy support, regulatory frameworks, and pilot applications. However, persistent challenges such as fragmented governance, limited technological capacity, and inadequate human resource readiness continue to hinder effective adoption. The findings indicate that sustainable BIM implementation depends on a combination of coherent policy design, institutional collaboration, and capacity development at multiple levels.

For policymakers, the study highlights the importance of establishing a clear national BIM roadmap and promoting cross-sector collaboration. Practitioners in the construction industry should invest in BIM training, digital infrastructure, and

collaborative workflows to align with national standards. Integrating BIM education into university curricula and promoting public-private partnerships can accelerate adoption and innovation.

Future studies should employ empirical or mixed-method approaches by collecting primary data from policymakers, contractors, and project managers. Comparative studies between different countries or between public and private projects can also provide a broader understanding of policy effectiveness. Further research on the economic and sustainability impacts of BIM implementation in Indonesia would enhance policy formulation and practical application.

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