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A Qualitative Analysis of the Phenomenon of Lonely BIM in Infrastructure Projects

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Abstract

The integration of Building Information Modeling (BIM) in construction faces challenges due to differing approaches from stakeholders. This study emphasizes the need for practical improvements in BIM implementation in Indonesia, particularly in managerial aspects. By identifying the factors causing isolated BIM usage ('Lonely BIM'), this research provides actionable strategies to promote better collaboration, enhance stakeholder coordination, and streamline BIM processes in infrastructure projects. These insights aim to improve efficiency, reduce project delays, and encourage wider adoption of BIM, ensuring more consistent and integrated digital construction practices across the industry. Using qualitative methods, interviews and project data were analyzed with ATLAS.ti software. The factors identified include organizational culture, with the top rank being workplace culture, software/hardware investment with the top rank being software/hardware procurement, human resources factors with the top rank being the lack of human resources and support, skill disparity factors with the top rank being stakeholder BIM capability, technological gaps among stakeholders, communication constraints with the top rank being the effectiveness of coordination and communication methods, and the factor of owner demands, where the majority do not require BIM. These results identify important factors influencing BIM isolation and offer insights for the construction industry to overcome these barriers.

Keywords: Lonely BIM; Infrastructure Projects; Stakeholder Coordination; BIM Adoption; Organizational Culture

1. Introduction

The adoption of Building Information Modeling (BIM) has revolutionized the global construction industry, offering improvements in project visualization, coordination, and overall efficiency. The theoretical promises of Building Information Modelling (BIM) have been extensively studied in the construction sector (Ozorhon & Karahan, 2017). One of the most promising digital solutions in the construction sector is Building Information Modeling (BIM) (Azhar, 2011). BIM in Indonesia began gaining recognition in 2013 with the publication of the first article describing the implementation experience of BIM in several construction projects in Indonesia (Telaga, 2018).

The concept of BIM was officially introduced by the Ministry of Public Works and Housing in 2017, along with the launch of the BIM Roadmap in Indonesia. Then, in 2018, Ministerial Regulation No. 22 was issued, regulating the implementation of BIM in the construction of state building projects. In 2021, Ministerial Regulation No. 9 on guidelines for sustainable construction implementation and Government Regulation No. 16 on the Implementation of Law No. 28 of 2002 concerning Buildings were issued (Sopaheluwakan & Adi, 2020).

Lonely BIM is a term used to describe the practice of an organization, project team, or the entire market where the BIM models produced are not exchanged among project team members (Li et al., 2019). However, despite its potential, the phenomenon of 'Lonely BIM' remains a significant challenge, particularly in infrastructure projects. Lonely BIM refers to the limited integration and sharing of BIM models between stakeholders, leading to inefficient collaboration and fragmented data exchange. This issue is exacerbated in countries like Indonesia, where BIM maturity levels remain low, and adoption is hindered by organizational culture, skill disparities, and insufficient technological infrastructure (Kuiper & Holzer, 2013). Engaging in this level of BIM can provide internal efficiency benefits, build capabilities, and develop BIM processes, which is a good position for small companies or micro-organizations aspiring to reach the next level, level 2 (Abbasnejad & Izadi Moud, 2013).

The greatest reward from the practice of Lonely BIM, it can be said, lies in two things: first, making a significant paradigm shift from representing

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conventional buildings using 2D drawings without any information to creating virtual models that not only embed valuable performance-related information, specifications, etc. And second, forming BIM workflows and processes that help bring efficiency and prepare for the next level of BIM. Despite efforts to promote BIM through government regulations, such as the BIM Roadmap and the issuance of Ministerial Regulation No. 22 in 2018, BIM utilization has not fully achieved the intended collaborative benefits. As a result, BIM models often remain isolated within individual disciplines, undermining their capacity to streamline project delivery and asset management.

This research seeks to address the gap in understanding the root causes of Lonely BIM in Indonesia and to develop strategies that encourage more integrated and collaborative BIM practices. While previous studies have focused on the general benefits and challenges of BIM implementation (Abbasnejad & Izadi Moud, 2013; Azhar, 2011), there is limited research specifically examining the factors that lead to Lonely BIM and how to overcome them in infrastructure projects. This study aims to fill this gap by providing insights into the cultural, technical, and organizational barriers contributing to BIM isolation and proposing actionable solutions to improve BIM collaboration across stakeholders. This research is needed as it addresses the importance of developing the use of BIM technology in Indonesia for the future, ensuring more effective and efficient implementation, not just limited to technical issues but already a managerial consumption.

2. Research Method

This research focuses on large-scale infrastructure projects implementing Building Information Modeling (BIM) to assess the phenomenon of Lonely BIM. Projects were selected based on specific criteria, including a minimum project budget of 50 billion IDR and the use of BIM technology. Both government-owned and privately-owned projects were considered to ensure a comprehensive analysis of BIM implementation across various project types. The respondents for this study were chosen based on their direct responsibility in the implementation of BIM within the selected projects. Key personnel such as BIM Managers, BIM Coordinators, and Project Managers were prioritized, as these individuals play a critical role in managing and overseeing BIM processes. This targeted selection ensures that the data gathered reflects the perspectives of those with deep involvement in BIM implementation and decision-making.

Data will include interviews and project-related information, analyzed using Qualitative Research due to its project-specific nature and focus on understanding lonely BIM factors and strategies. This methodology is chosen for its suitability in analyzing interview data to accurately identify these factors. The method utilized for data processing and analysis is qualitative in nature, thus conducting an in-depth analysis of the acquired data. The following are the steps involved in data processing and analysis (Fig. 1).

1. Processing Project Data including infrastructure type, project location, project owner, initial contract value, project start and end dates, duration of project execution (in days), maintenance period (in days), funding source, contract nature, contract type, scope of work, contractors, consultants, and other relevant details.
2. Project Data Analysis to extract project data characteristics, distribution of project owners, project location distribution, and contract value distribution.
3. Processing Respondent Data involving respondent names, birthplace and date, job positions, formal education (educational level, field of study, university, year of education), work experience (position, business unit/department, projects, workplace).
4. Respondent Data Analysis to obtain respondent age distribution, educational background distribution, respondent experience distribution, and BIM proficiency level distribution.
5. Conducting interviews with 46 projects and 52 respondents.
6. Interview transcription.
7. Analysis of interview transcriptions using Atlas.ti.
8. Analysis of coded results in Excel.
9. Drawing conclusions and providing recommendations

To ensure the reliability and validity of the data, triangulation was employed. This method involved cross-verifying information from multiple sources, including project documents, interview transcripts, observation notes, and online news articles related to the projects. By comparing data from these various sources, the research was able to corroborate findings and provide a more robust understanding of the factors influencing Lonely BIM in infrastructure projects. Finally, conclusions can be drawn regarding the factors contributing to phenomenon lonely BIM in the implementation of BIM, along with recommendations for strategies to address.

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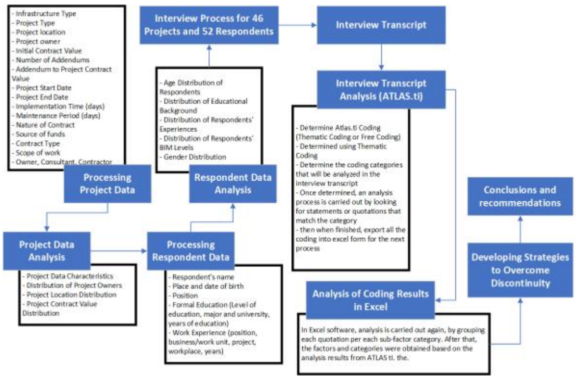

Fig.1. The method of data processing and analysis

3. Result and Discussion

3.1 Analysis of Project Data and Respondent Data

We analyzed project data extensively, focusing on Building Information Modeling (BIM) implementation, project owner distribution, and contract values. This analysis aims to highlight project variations. Additionally, we examine respondent profiles, including age, education, experience, job titles, for a deeper understanding of BIM implementation contributors' roles. Our study involved 52 respondents across 46 infrastructure projects.

We analyze project characteristics to understand factors influencing BIM implementation in infrastructure projects. Key aspects include contract value, project type, location, and ownership. This provides insights into project variations and their impact on BIM implementation in Indonesia. Among 46 projects studied, 87% are government-owned, and 13% are private, the majority of projects in this study are government-owned because the contractors we studied are state-owned enterprises (SOEs). Project contract value indicates project scale and complexity, crucial for BIM implementation. Analyzing contract value distribution offers insights into project variations (Fig. 2).

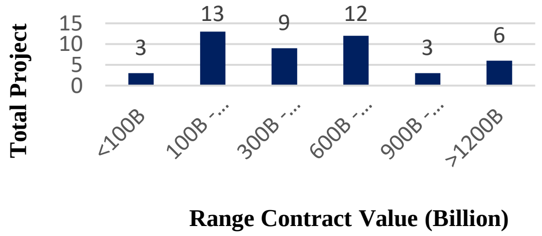

Fig.2. Distribution of Project Contract Values

Through an analysis of the project location distribution, our objective is to gain a deeper understanding of the geographic spread of infrastructure projects utilizing BIM in Indonesia. We will outline various project locations under scrutiny, aiding us in identifying patterns within the geographical distribution of projects associated with BIM implementation (Table 1).

Table 1. Project Location Distribution

Province	Number of Projects	Province	Number of Project
DKI Jakarta	4	Kalimantan	3
Jawa	13	Jambi	1
Bali	2	Riau	1
Sulawesi	4	Nusa Tenggara	2
Sumatera	13	Lampung	1
		Maluku	2
		Total	**46**

Education is crucial for understanding individuals' knowledge and skills in implementing Building Information Modeling (BIM) in Indonesian infrastructure projects. By analyzing respondents' educational backgrounds, we gain insights into their levels of education. The majority, 72% of 52 respondents, hold an undergraduate degree (Bachelor's degree), as shown in Table 2. This variation helps assess the relationship between education level and readiness to adopt BIM. Work experience is crucial for expertise in implementing Building Information Modeling (BIM) in Indonesian infrastructure projects. Analyzing respondents' years of experience provides insights into their expertise levels. The majority, 45% of 52 respondents, have 1-5 years of experience, as indicated in Table 2. This variation helps assess how experience influences BIM understanding and application.

Analyzing respondents' positions in BIM implementation provides insights into their roles and responsibilities. The majority, 38% of 52 respondents, hold the position of BIM Engineer, as shown in Table 2. This variation helps assess the relationship between job positions and contributions to BIM success.

Table 2. Results of Respondent Characteristics

Educational Background		**Year of Work Experience**		**Job Titles**	
Bachelor	72 %	1-5 Years	45%	BIM Engineer	20
Vocational High School	16 %	6-10 Years	41%	Site Engineering & Standardization Officer	17
Diploma 3	6%	11-15 Years	8%	Drafter BIM	5
Diploma 4	4%	16-20 Years	4%	BIM Coordinator	4
General High School	2%	26-30 Years	2%	BIM Expert	3
				Site Engineerin	2

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Educational Background		Year of Work Experience		Job Titles	
				g & Standardization Manager Junior Expert	
				Site Engineering	1
Total	**100 %**	**Total**	**100 %**	**Total**	**52**

3.2 Analysis of Factors Causing Lonely BIM

This subsection delves into the analysis of factors causing lonely BIM in the implementation of BIM in infrastructure projects. We have conducted interviews with 46 infrastructure projects involving 52 respondents. This analysis aims to identify the factors leading to lonely BIM in the BIM cycle within these projects. The interview results are processed using ATLAS.ti to identify the factors causing lonely BIM among stakeholders in the transition from BIM implementation to asset management. From these interviews, seven factors contributing to lonely BIM have been identified: 1) Culture; 2) Skill disparity; 3) Software hardware investment; 4) Communication barriers; 5) Owner's request; 6) Human resources; 7) Technological gap.

The factors were derived from interview findings and analyzed using the ATLAS.ti software. Each factor corresponds to the number of quotations (Table 3):

Table 3. Total Quotation Lonely BIM Factor

No.	Lonely BIM Factor	Total Quotation
1	Culture	82
2	Skill Disparity	110
3	Software Hardware Investment	92
4	Communication Barriers	57
5	Owner's Request	65
6	Human Resources	106
7	Technological Gap	69

The analysis of Lonely BIM factors highlights several key challenges in BIM implementation in Indonesia, particularly cultural resistance and skill disparities. These factors are deeply rooted in the organizational structures and technological adoption patterns within the country. Cultural resistance, for instance, reflects a preference for traditional methods, as senior stakeholders often prioritize paper-based workflows over digital solutions. This resistance is aligned with previous findings, which emphasize that the transition from conventional to digital construction is frequently met with hesitation, particularly among senior professionals who may perceive BIM as overly complex or time-consuming [11]. In Indonesia, where many project owners and consultants remain unfamiliar with BIM's full capabilities, this resistance can significantly impede collaboration and data sharing, further exacerbating the Lonely BIM phenomenon.

Similarly, skill disparities between stakeholders are critical in explaining why BIM implementation remains fragmented. While many contractors and younger professionals have embraced BIM, a significant gap remains between project teams with varying levels of BIM proficiency. This issue is particularly pronounced in Indonesia, where BIM adoption is still in its early stages. Comparable studies from other regions, such as Australia and Malaysia, also identify skill gaps as a major barrier to successful BIM integration, but the Indonesian context is unique due to the lack of formalized BIM training and limited government support [1][12].

Moreover, software and hardware limitations are another significant barrier in Indonesia. Many projects lack the necessary investment in high-performance technology, which is essential for managing large BIM files and facilitating collaboration between stakeholders. This challenge is consistent with international findings but is especially relevant in developing countries like Indonesia, where budget constraints and the high cost of BIM technology prevent widespread adoption [15].

3.2.1. Cultural Analysis

This section discusses the cultural analysis of BIM implementation in infrastructure projects. This analysis aims to provide an in-depth insight into the culture that exists in these projects. The results of the analysis show that the cultural sub-factors can be ranked based on their influence on the overall cultural factors. (Table 4)

Table 4. Rangking of Cultural Sub-Factors

No.	BIM Culture	Rank
1	Stakeholder culture (Technology) - speeding up or slowing down?	5
2	Senior Culture	4
3	Work method culture	2
4	Work environment culture	1
5	Open-minded Digital Construction vs Socialization	3
6	Management support	6

The analysis of stakeholder culture in technology highlights a preference for traditional methods among many owners and consultants, with senior stakeholders often favoring printed drawings over digital tools (Alankarage et al., 2023). While some resist technology due to the learning curve, others recognize the benefits of BIM for 3D modeling, prompting investments in new software and hardware. Effective BIM adoption requires alignment of organizational values and strategic approaches to bridge cultural gaps (Knobel et al., 2021; Ogwueleka, 2015).

Senior professionals' involvement is crucial, with varying responses to BIM; some resist due to complexity, while others support gradual adoption

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(Čuš Babič & Rebolj, 2016). BIM changes work methods, with some stakeholders sticking to manual processes while others embrace instant results through BIM (Salwati Ibrahim et al., 2019). The shift to a digital work environment requires broad stakeholder support, although resistance persists due to perceived inconvenience (Wu et al., 2018).

Successful digital construction depends heavily on management support, which facilitates BIM implementation and socialization. Without it, adoption can be difficult, particularly if upper management is resistant. Corporate-level managers play a key role in integrating innovations, making strategic steps essential for transitioning from traditional methods to BIM (Zahrizan et al., 2013). Summary of findings of cultural sub-factors can be seen in the Table 5.

Table 5. Summary of Findings of Cultural Sub Factors

Sub-Factor	Findings	Sub-Factor	Findings	Sub-Factor	Findings
Stakeholder Culture (Technology) - Speed up or slow down?	The owner still uses conventional methods, so they are still not used to paperless, for example using CDE to collaborate digitally, but the owner or consultant does not understand.	**Work Method Culture**	There are still those who use conventional methods from the stakeholders, such as entering numbers one by one, even though if you use BIM, you can directly export and immediately become.	**Senior Culture**	There is resistance to the application of BIM technology because people who are older feel complicated, have to learn software, sometimes the field team also does not want to bother.
	Digitalization in the field already uses tablets or iPads to coordinate the field, but from the owner or senior consultants it is better if they directly hold the drawings.		The method carried out if the owner has used BIM is the approval process of shop drawings by cloud using BIM 360.		There are also seniors who have high enthusiasm because they feel facilitated by BIM.
	From the owner or consultant after being shown the results using BIM by the contractor. So, they feel helped, one example is being able to directly see the 3d model so that it facilitates discussion. So that they are also provoked to provide hardware and software to support BIM.		The BIM Method function is used by the owner for the monitoring process because it is more visually pleasing.		There are those who fully support the application of this BIM technology, and also those who are open-minded to digital transformation, and those seniors are willing to be taught slowly.
	Many people think that technology has slowed them down, because it feels more complicated (such as CDE that is notification in email, while they are used to using WhatsApp) and still have to learn something new, especially field people who have to pursue project targets.		The owner and consultant have not implemented BIM, although they have not implemented BIM, they are actually helped by this BIM.		There are also seniors who prefer to scribble on paper and are even confused when looking at 3D, most of the consultants are also elders

3.2.2. Analysis of Skill Disparity Forms

This subchapter discusses the analysis of forms of skills gaps in the application of BIM to infrastructure projects. We will analyze data that identifies skills gaps that arise in the use of BIM, both within the project team and between the parties involved. This analysis provides insight into the challenges and gaps that need to be addressed to achieve a successful BIM implementation. The analysis of the forms of skill gaps was carried out using ATLAS.ti software to code the interview results in several indicators of gap factors in the implementation of the BIM cycle, one of which is the skill gap, it turns out that there are various forms of skill gaps that hinder the implementation of ideal BIM. The findings are ranked based on the form of skill disparity that most hinders the implementation of BIM in Table 6.

Table 6. Ranking of Skill Disparity Form

No.	Form Skill Disparity	Rank
1	BIM Technical Capabilities	2
2	Understanding BIM influences management decision making	5
3	Central BIM Human Resources VS Project BIM Human Resources	7
4	BIM Training Intensity affects skills	4
5	Understanding BIM for project seniors influences skills	3
6	BIM Capability Stakeholder	1
7	Contractor's Internal BIM Capabilities	6
8	Intensity of BIM Socialization	8

3.2.3. Factor Analysis of Hardware and Software Investment

This subchapter analyzes hardware and software investments in BIM implementation within infrastructure projects, using Atlas.ti for interview analysis. The key finding is that procurement significantly influences these investments, with BIM inclusion in contracts varying by project, which can complicate procurement. BIM software's reliance on 3D models requires robust hardware due to the large file sizes (Siyi & Yongfeng, 2018). Even when BIM use is mandated by the contractor, inadequate hardware can cause delays, as low-spec devices may lag during 3D modeling, leading to inefficiencies and rework. Additional inhibiting factors are detailed in Table 7.

Table 7. Ranking Software Hardware Investment Category

No.	Software Hardware Investment Category	Rank
1	Limitations of licensed account software	6
2	Hardware Software Procurement (available or not in Contract Documents & Specifications)	1
3	BIM Prioritization Scale	4
4	Low specifications that hinder work	2
5	Management Support Procurement of hardware software	5
6	Maximize existing software and hardware	3

3.2.4. Factor Analysis of Communication Barriers

This sub-chapter discusses the factors of communication constraints in the application of BIM in infrastructure projects between stakeholders, then analyzed using Atlas.ti software based on the results of interviews with respondents, it is found that the category in the most influential communication constraints factor is the method of coordination and communication in the project is effective or not, which occurs in the project, the coordination method has not used the CDE platform effectively, so it has not fully realized how the coordination process should use the BIM method in the project, other sub-factors can be ranked based on the factors that cause the most communication constraints in Table 8 below.

Table 8. Ranking of Categories of Communication Barriers

No.	Communication Barrier Factors	Rank
1	External Communication	3
2	CDE (Common Data Environment) communication vs WhatsApp communication	4
3	Signal constraints in the field	2
4	Coordination and Communication Methods	1
5	Senior Communication with technology	5

3.2.5. Owner Demand Factor Analysis

This subsection discusses the factors related to the owner's demand for BIM implementation in infrastructure projects. We analyzed the data using Atlas.ti software and identified several categories relevant to the owner's demand. The most influential factor in whether BIM is implemented or not comes from the owner. The results show that the majority of owners do not require BIM implementation, making it a contractor-initiated effort. Consequently, several sub-factors have been identified and will be ranked based on their impact in Table 9 below.

Table 9. Ranking of Owner Request Category

No.	Owner Demand Factor	Rank
1	Owner does not request but internal mandatory	3
2	Owner did not Request BIM (not mentioned in the contract document)	1
3	One vision and mission between stakeholders in implementing BIM	4
4	Owner requires BIM	2

3.2.6. Factor Analysis of Human Resources (HR)

This sub-chapter discusses the human resources factor. The analysis was conducted using Atlas.ti software, based on interviews with respondents in infrastructure projects. The main category that hinders the implementation of BIM in the field is the lack of skilled human resources and minimal support for these personnel. On average, in the projects I studied, there were only 1-2 BIM personnel per project, which means it was limited (Babatunde et al., 2020; Salwati Ibrahim et al., 2019). They also have to perform other tasks, resulting in insufficient support for developing their skills. Other factors can be ranked based on their level of hindrance to BIM implementation in Table 10 below.

Table 10. Ranking of Human Resources Category

No.	Human Resource Factors	Rank
1	Human Resources is given a double jobdesk (BIM and non-BIM)	4
2	Lack of Human Resources and Lack of Support	1
3	Lack of understanding and mastery of human resources regarding BIM	2
4	Human Resources formation and Human Resources support	3

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3.2.7. Technological Gap Factor Analysis

This sub-chapter discusses the analysis of lonely factors in the form of technological gaps, the analysis was carried out using ATLAS.ti software, based on the results of interviews with respondents in infrastructure projects, the occurrence of technological gaps between stakeholders is one of the important factors in the lonely BIM factor. Based on the results of the analysis, it is found that what happens in the field by stakeholders is different technology, so that the integration of documents, data, or BIM models is not well conveyed. For example, the contractor already has hardware and software that supports this BIM method, such as a high spec laptop or survey tools such as a total station or software used for CDE such as Autodesk Construction Cloud and so on, but the owner or consultant does not have qualified hardware or software for integration because it tends to be expensive and lacks human resources who can operate it. Changes in technology, including the integration and upgrading of software and hardware systems, frequently occur when BIM is adopted and implemented (Khosrowshahi & Arayici, 2012). (Ezeokoli et al., 2016) discovered that the availability of BIM technology and frameworks significantly influences the adoption of BIM.

In comparison to studies conducted in more developed BIM markets, such as the UK and Australia, the novelty of these findings lies in the unique combination of cultural, technological, and organizational challenges faced by Indonesia (Alankarage et al., 2023; Babatunde et al., 2020). While similar issues have been observed globally, the severity of these barriers in Indonesia underscores the need for tailored strategies that address local conditions. For instance, greater emphasis on BIM education and training, as well as government-mandated BIM integration in public projects, could help bridge the gap between policy and practice (Roy & Firdaus, 2020). This study contributes to the growing body of knowledge on BIM adoption by providing insights specific to the Indonesian construction sector, offering strategies for overcoming these localized barriers. The final findings on the factors causing the phenomenon of lonely BIM have been explicitly detailed based on the top-ranked factors and others. It has been concluded that these factors significantly influence how BIM methods are implemented. These findings can serve as a crucial reference to anticipate and prevent the occurrence of lonely BIM in projects, and they are important for advancing digital construction practices in Indonesia.

4. Conclusion

Based on the analysis and discussions conducted, this research identifies several key insights regarding the implementation of Building Information Modeling (BIM) in infrastructure projects. One of the primary challenges highlighted is the occurrence of isolation or "loneliness" in BIM adoption, driven by various factors. These include differences in organizational culture, which can create barriers to seamless integration; investment constraints, which may limit the resources available for proper implementation; communication issues that arise from a lack of alignment between stakeholders; and differing expectations from project owners, which can lead to inconsistencies in how BIM is utilized across projects. For policymakers, the results emphasize the need for stronger regulations to expand BIM implementation in public projects and support BIM training to address the skills gap. Industry stakeholders need to increase investment in hardware and software, and encourage a culture that supports digital transformation. BIM practitioners should actively improve technical skills and encourage cross-team collaboration. Limitations of this study include limited access to all stakeholders, including project owners, consultants, and subcontractors. For future research, it is recommended to analyze the implementation of BIM across all layers of stakeholders to evaluate whether there are discontinuities in BIM implementation, especially between project owners and consultants.

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