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Study of Factors Influencing the Implementation Building Information Modelling (BIM) in Construction Project

Ari Syaiful Rahman Arifin[1*], Ulfah Zakiyyah[2], M. Giatman[3], Faisal Ashar[4]
[1,2,3,4] Civil Engineering, Universitas Negeri Padang, Indonesia
*Corresponding Author: arianto41@ft.unp.ac.id

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ABSTRACT

Building Information Modelling (BIM) has become a major trend in the global construction industry. In Indonesia, socialization on BIM has been carried out, but its implementation has not been fully implemented. Therefore, it is necessary to study the factors that influence the application of BIM in construction projects. The purpose of this research is to identify the factors that influence the implementation of BIM in construction projects in the city of Padang, Indonesia. This research was conducted on construction service providers and used a descriptive research design with a quantitative approach. The research sample consisted of 28 companies with a total of 84 respondents using a purposive sampling technique. Primary data collection methods include questionnaires and interviews. The results of this study are Barrier factors and strategic factors in BIM implementation. The barrier factors in BIM implementation on construction projects according to ranking, namely (1) limited Human Resources (22%), (2) Lack of Standards and Guidelines (21%), (3) Lack of Support from Stakeholders (20%), (4) Cost (19%) and (5) Limited Infrastructure and Technology (18%). The strategic factors in BIM implementation on construction projects, according to ranking, are (1) Technical and Technology (21%), (2) Human Resources (20%), (3) Management (20%), (4) Stakeholders and Regulations (20%) and (5) Organization (19%). This study highlights the dominant factors influencing BIM implementation in the construction industry and provides valuable insights for stakeholders to enhance and accelerate BIM implementation in the region.

Keywords: *BIM, Project Digitization, Barrier, Strategic*

INTRODUCTION

Building Information Modelling (BIM) is a sharing platform that can present 3D parametric models with various project information in the form of digital displays [1]. In recent years, BIM adoption has increased globally as the Architecture, Engineering, and Construction (AEC) industries have recognized its benefits [1]. BIM is a new approach applied in construction projects to manage building design and project data digitally throughout the building life cycle. This approach enables the exchange and interoperability of information among various stakeholders [2]. The strength of its benefits in reducing costs and time, as well as increasing productivity and efficiency, has encouraged construction actors to widely adopt BIM and apply it in various fields[2].

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BIM has brought about enormous and necessary changes in the industry, resulting in more comprehensive collaboration between project professionals [3]. In its development, Building Information Modelling (BIM) has shown that it is not only useful for the geometric modeling of building performance but can also assist in construction project management (Bryde et al., 2013). Currently, BIM has become an information technology that can understand buildings without having to directly build them first [4].

Figure 1: BIM Dimensions

Building Information Modeling, commonly known as BIM, has revolutionized the construction industry. With its numerous benefits and applications, BIM has become an indispensable tool for architects, engineers, contractors, and other stakeholders involved in the construction process[5]. From improved project cost control to conflict reduction, BIM has proven its worth and has been widely adopted in many countries to enhance the productivity of construction projects.

One of the key advantages of BIM lies in its ability to improve project cost control. Traditionally, cost estimation in construction projects has been a challenging task, often leading to budget overruns and delays. However, BIM offers a more accurate and efficient approach to cost estimation. By creating a virtual 3D model of the building, BIM allows stakeholders to visualize the project in its entirety, enabling them to identify potential cost-saving opportunities and make informed decisions. This not only helps in controlling costs but also minimizes the risk of unexpected expenses during the construction phase.

In addition to cost control, BIM also plays a vital role in conflict reduction. In any construction project, conflicts and clashes between different building systems and components are common occurrences[6]. These conflicts can lead to delays, rework, and additional costs. However, BIM mitigates these issues by facilitating clash detection and resolution. Through its advanced clash detection algorithms, BIM identifies potential clashes between various building elements, such as structural components, mechanical systems, and electrical systems. This allows stakeholders to address these conflicts in the virtual environment before they become costly and time-consuming problems on the construction site[7].

Moreover, BIM promotes collaboration and coordination among different project participants. Traditionally, the construction process involves multiple teams working in silos, which often leads to miscommunication and coordination gaps. However, BIM breaks down these barriers by providing a centralized platform where all stakeholders can collaborate and share information in real time. This allows for better coordination between architects, engineers, contractors, and subcontractors, resulting in improved project efficiency and reduced errors.

Despite the benefits of Building Information Modelling (BIM), the adoption level of BIM remains much lower than expected. Construction companies should appraise the existing condition in the BIM aim[8]. The substantial expansion of construction projects in Indonesia in recent years has underscored the critical need for effective project management. Given the government's emphasis on infrastructure development, it is anticipated that investment in construction projects will continue to grow significantly[9]. However, it remains essential to ensure the timely completion of these projects to avoid both delays and budget overruns.
Project performance in Indonesia has displayed varying outcomes. Statistics reveal that a substantial portion of projects experienced delays, while a significant percentage were completed within the established timeframes[10]. A smaller fraction even managed to conclude ahead of schedule. These statistics collectively indicate the potential for enhancing project management practices within the country.

One of the main reasons project owners focus more on budget overruns than time delays is that the direct impact of a delayed project may not be immediately apparent. However, in the context of infrastructure projects, the consequences of delays are not limited to financial implications. They also have a significant impact on the construction site and the surrounding area. The development of BIM has been successful in developed countries[11]. but in developing countries like Indonesia, the development of BIM is still a question that encourages researchers to analyze how BIM is implemented in Indonesia and the obstacles in construction projects.

Padang, the capital of Indonesia's West Sumatra province, lies on Sumatra's west coast, which is one of the economic and development centers and has witnessed rapid growth in the construction sector. However, in this increasingly complex context, the application of Building Information Modeling (BIM), a revolutionary approach to construction project management, has not yet reached its full potential. Despite the enormous opportunities offered by BIM to increase efficiency, reduce costs, and improve the quality of construction projects, the City of Padang, like many other regions in Indonesia, still faces several obstacles in adopting BIM effectively. These obstacles need to be researched to find out the factors that influence the implementation of BIM, both barrier and driving factors.

This research aims to identify the main problems that cause BIM to not be implemented properly in construction projects in Padang City, West Sumatra, as well as provide the necessary insights for stakeholders in this region. By understanding the inhibiting and driving factors, it is hoped that the necessary actions can be taken to facilitate a more effective implementation of BIM in the construction industry in Padang City, which in turn will support economic growth and sustainable development in this city.

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MATERIALS AND METHODS

The method used in this research is a descriptive method with a quantitative approach. This research uses questionnaires and interviews as a way to collect the desired data. This research was carried out at a construction services company consisting of contractors and planning consultants located in Padang City, West Sumatra. Sampling in this research used the Probability Sampling method with a simple random sampling type. The research sample consisted of 28 construction companies with a total of 84 respondents who are members of the associations GAPENSI, GAPEKSINDO, AKAINDO, AKSI, and GABPEKNAS. The instrument was designed in consultation with experts (expert judgment). The validity of the instrument uses the Pearson product-moment statistical test. The reliability test uses Cronbach's Alpha formula. Data analysis techniques resulting from research questionnaires were processed using the SPSS program. The analysis requirements test consists of a normality test using the Shapiro-Wilk test model and a homogeneity test using the Levene test method.

Table 1: Respondent Characteristic

No	Respondent Characteristics	Category	Total	Percentage
1	Gender	Male	59	70%
		Female	25	30%
2	Age Range	<25 years	6	7%
		25-35 years	24	29%
		35-50 years	39	46%
		>50 years	15	18%
3	Formal Education	High School	5	6%
		Associate	21	25%
		Bachelor	58	69%
		Master	0	0%
		Doctoral	0	0%
4	Scope of work	Structures	47	56%
		Architecture	17	20%
		Electrical, Mechanical & Plumbing	5	6%
		Cost Estimator	15	18%
5	Working life	<1 years	0	0%
		1-5 years	16	19%
		6-10 years	50	60%
		>10 years	18	21%

RESULTS AND DISCUSSION

The results of the descriptive analysis (mean and standard deviation) obtained by grouping from top to bottom the ranks of variables barrier factors in BIM implementations at construction projects can be seen in Table 2 below:

Table 2: Ranking of Barrier factors in BIM implementation

Barrier factors	**Analysis Results**			
	Mean	Deviation Standard	Ranking	Percentage
Limited Human Resources (SDM)	3.8611	0.7676	1	22%

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Lack of Standards and Guidelines	3.6904	0.85	2	21%
Cost	3.3651	0.9098	4	19%
Infrastructure and Technology Limitations	3.2678	0.8795	5	18%
Lack of support from stakeholders	3.5198	0.7578	3	20%

Visual explanations of the barriers and factors to implementing BIM in construction projects can be seen in Figure 2 below. This graph provides a clear representation of the obstacles and challenges that are encountered during the implementation of Building Information Modeling (BIM) in construction.

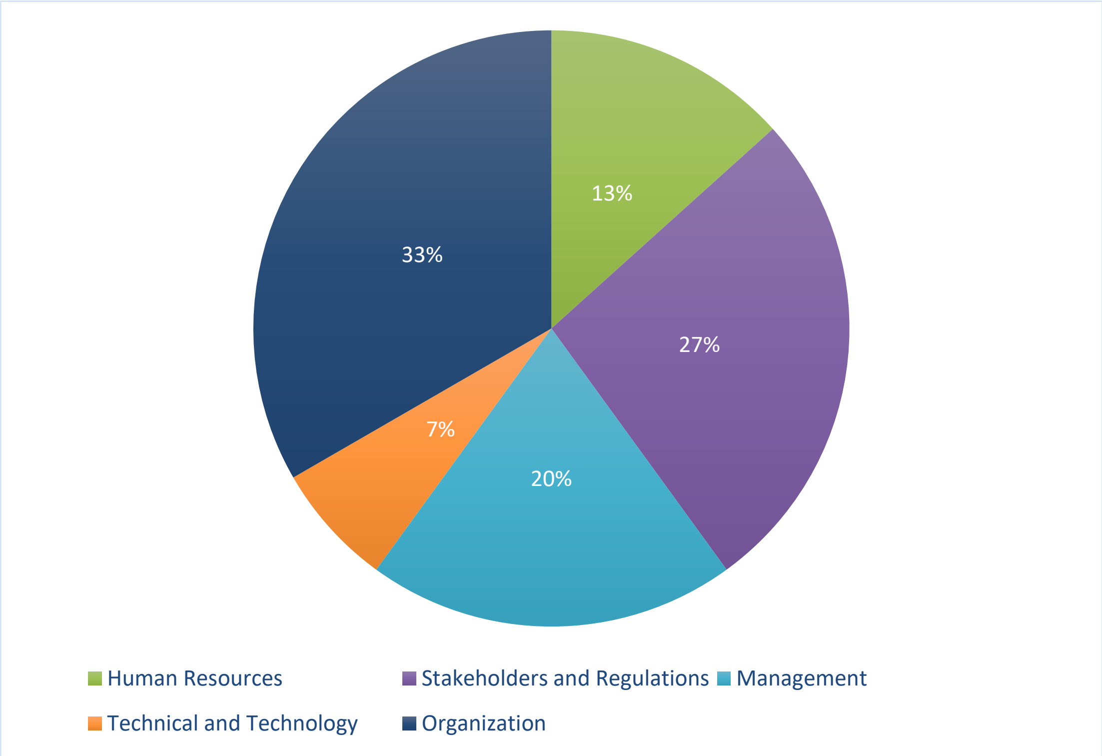

Figure 2: Percentage Graph of Barrier factors in BIM implementation

The results of the descriptive analysis (mean and standard deviation) obtained by grouping the top-to-bottom ranks of strategic factors in BIM Implementation at construction projects can be seen in Table 3 below:

Table 3: Ranking of Strategic factors in BIM implementation

Strategic Factor	**Analysis Results**			
	Mean	Deviation Standard	Ranking	Percentage
Human Resources	3.5714	0.6979	2	20%
Stakeholder and Regulation	3.4841	0.7929	4	20%
Management	3.5	0.8358	3	20%
Technical and Technological	3.7083	0.8164	1	21%
Organization	3.4048	0.8796	5	19%

Visual insights into the supporting factors for the successful implementation of BIM in construction projects can be seen in Figure 3 below. This graphical representation offers a comprehensive view of the elements that facilitate the effective utilization of Building Information Modeling (BIM) in construction endeavors.

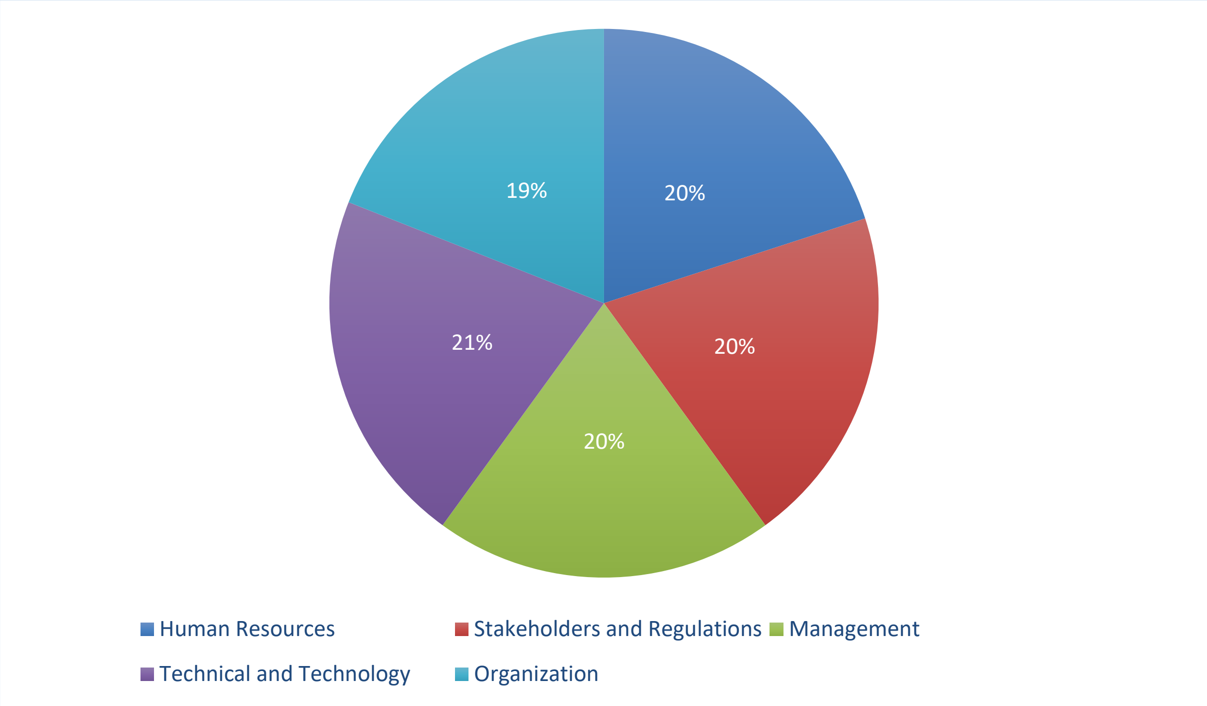

Figure 3: Percentage Value Graph Strategic factors in BIM implementation

CONCLUSION

Based on the results of the analysis that has been done, several conclusions can be drawn, as follows:

1. The dominant barrier factors in BIM implementation on construction projects according to the ranking are (1) Limited Human Resources (HR), (2) Lack of Standards and Guidelines, (3) Lack of Support from Stakeholders, (4) Cost, (5) Infrastructure and Technology Limitations.
2. The dominant Strategic factors in BIM implementation on construction projects according to ranking are (1) Engineering and Technology, (2) Human Resources, (3) Management, (4) Stakeholders and Regulations, (5) Organization.
3. Identifying the dominant factors influencing BIM implementation in the construction industry can provide valuable knowledge and insight for stakeholders to improve and accelerate BIM implementation in the region.

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