BIS ENERGY AND ENGINEERING

Volume 2 2025 | DOI: 10.31603/biseeng.360
6th Borobudur International Symposium on Science and Technology (BIS-STE) 2024

UNIMMA PRESS
Universitas Muhammadiyah Magelang

Evaluation of the building information modelling (BIM) implementation in construction projects on Lombok Island using analytical hierarchy process (AHP) and SWOT analysis

Nurdin[1], Hariyadi[1*], Ngudiyono[1]

[1] University of Mataram, Mataram, Indonesia
[*] Corresponding author email: hariyadi@unram.ac.id

Abstract

Building Information Modelling (BIM) is a breakthrough in the construction world. BIM facilitates data validity with excellent visualization. In addition, data accuracy is also a major advantage of BIM applications for construction work. In this study, an evaluation of the implementation of BIM in construction work on Lombok Island was conducted. The evaluation resulted in strategies that can be applied to overcome obstacles to using BIM in the field. The data were obtained by giving questionnaires to 30 respondents spread across 4 large construction projects on Lombok Island. Furthermore, data processing was carried out by utilizing the Analytical Hierarchy Process (AHP) as a determinant of variables that influence the obstacles to the use of BIM and SWOT analysis to compile a method that is expected to be able to solve problems based on existing variables. Based on the data processing results, 21 variables were obtained, and six aspects were considered obstacles in the application of BIM. By ranking using AHP, 12 variables were obtained as a reference in determining strategies using SWOT. Then, seven strategies were obtained that can be applied to resolve the obstacles to applying BIM, as follows: Carrying out training activities to obtain a certificate of expertise; carrying out routine briefings to improve understanding of the duties and functions in BIM operations; improving the quality of human resources to overcome planning conventionally; procuring hardware following the regulatory standards of each application; procuring application licenses; recruiting BIM experts; and recruiting human resources to meet the requirements in BIM.

Published:
May 31, 2025

Selection and Peer-review under the responsibility of the 6th BIS-STE 2024 Committee

Keywords

BIM, Obstacles, AHP, Strategies, SWOT

Introduction

Building Information Modeling (BIM) is a system that integrates various software functions into one. One of the advantages of BIM is that it is paperless. During its journey, the system will limit the printing of documents for revision purposes, only

printing them for approval and other urgent needs. In other words, the system will utilize existing software to carry out frequent revision activities. This will significantly contribute to saving energy and supporting the greening of the earth program.

The existence of supporting software has shown very real benefits in the development world. With various types and uses, supporting software has become necessary to accelerate development. So in this era, mastering software is an added value as an engineer [4].

While BIM offers convenience, its use necessitates consideration of several factors. BIM has a high model complexity, along with high training costs. Moreover, BIM integrates with non-free software, necessitating its purchase [1]. The involvement of BIM engineers is essential in implementing projects with BIM and can facilitate the implementation of Design Build Project Delivery [6]. BIM also has other advantages, such as allowing partial calculations, recalculations, and design changes during the production stage. BIM operations significantly reduce negligence and errors in cost estimation [13].

Compared to other countries in Southeast Asia, Indonesia's implementation of Building Information Modeling (BIM) in the construction sector remains relatively low [2]. Additionally, Indonesia is currently in the process of adopting BIM, preparing standards, and developing a curriculum. Indonesia still needs to learn and explore the process of implementing BIM [8]. Then, although the implementation of BIM in the construction sector has proven to be able to provide various benefits and answer problems that often occur in projects, the adoption of BIM into projects is not free from obstacles [3]. Table 1 describes the AHP hierarchy.

Table 1. Hierarchy of AHP

Aspects		Criteria	Alternatives
Government Regulation Aspects	1	BIM Usage Regulations	Alternative 1
	2	Formation of Special Institutions	Alternative 2
	3	Law enforcement	Alternative 3
Human Resource Aspects	1	Training	Alternative 4
	2	Certificate of Expertise	Alternative 5
Economic Aspects	1	Procurement of licenses	Alternative 6
	2	Human Resources Procurement	Alternative 7
	3	Implementation of training	Alternative 8
	4	Procurement of equipment	Alternative 9
Technical Aspects	1	Planners don't use BIM	Alternative 10
	2	Miscommunication	Alternative 11
	3	Changes in Work Culture	Alternative 12
	4	Process Complexity	Alternative 13
Technology Aspects	1	Ease of getting	Alternative 14
	2	Ease of understanding	Alternative 15
	3	Hardware Specifications	Alternative 16

Aspects		Criteria	Alternatives
	4	Interoperability	Alternative 17
	5	Software is not compatible	Alternative 18
Management Aspects	1	Participatory role	Alternative 19
	2	Internal Communication Failure	Alternative 20
	3	Clarity of BIM targets by the company	Alternative 21
	4	Market Demand	Alternative 22

Lombok Island, located in West Nusa Tenggara Province, is currently in the spotlight for infrastructure development. The island has carried out numerous strategic developments. Among them are the construction of the Mandalika Circuit, the construction of the Mandalika National Tourism Strategic Area infrastructure, the construction of Gili Mas Pier, the construction of hotels, and so on. Moreover, Lombok is a government priority for building a tourist area with all its infrastructure.

Given the availability of supporting human resources and equipment, Indonesia is highly likely to implement BIM in its operations. Both parties are responsible for carrying out the work from the planning stage to the implementation phase. Of course, there are several obstacles in implementing its utilization that prevent BIM from being fully applied. On the other hand, creating an appropriate and targeted strategy is crucial to foster interest in using BIM and ensure transparency in fieldwork. Therefore, it is crucial to review the implementation and application of BIM.

This study identifies the factors that influence the application of BIM in the field, identifies the primary obstacles based on AHP, analyzes the impact of BIM application in construction work, and proposes strategies to maximize BIM utilization based on SWOT analysis.

Method

All science is founded on observation [5][10]. This research was conducted using 4 objects of work that have been ongoing on the island of Lombok, namely: construction of the Mandalika Circuit, the Mandalika Urban Tourism Infrastructure Project, construction of the Meninting Dam, and construction of the Gili Mas Lembar Cruise and Container Terminal Pier.

This study primarily uses a questionnaire. To capture variables to be compared in the AHP process, the questionnaire was given to 30 respondents with a level of choice and/or opinion >50%. After the variables are obtained, the next step is to compare the variables using AHP.

Table 2. Pairwise comparison scale [9]

Scale	Meaning	Explanation
1	Both elements are equally important. (equal importance)	The two elements under comparison contribute equally to the achievement of the goal.

3	One element is slightly more important than the other element. (moderate importance)	Experience and judgment slightly favor one element over another.
5	One element is more important than the other elements. (essential/ strong importance)	Experience and judgment strongly favor one element over another.
7	One element is much more important than the other elements. (very strong importance)	An element that is preferred over other elements, its dominance is clearly visible in actual circumstances.
9	One element is absolutely more important than the other elements. (extreme importance)	An absolute element is more strongly preferred than the others and is at the highest level.
2, 4, 6, 8	It is a compromise figure between the above assessments.	When a compromise is required between two considerations/assessments.

In the process of implementing AHP, 30 respondents were used, spread across 4 research objects. Table 2 serves as a reference parameter for the comparison process.

Repeating interviews with a number of respondents at the same time is sometimes necessary if the degree of inconsistency or deviation from consistency is considered large. The consistency index expresses deviation from consistency using the following formula and Figure 1 shows the consistency of the ratio of each aspect.

$$\mathrm{CI} = \frac{(\boldsymbol{\lambda max - n})}{\boldsymbol{n-1}} \qquad (1)$$

With

λ max = Maximum eigenvalue

n = Matrix size

Next, to obtain a problem-solving strategy from the constraint variables generated in the AHP process, the SWOT strategy is applied with the following steps [7][11][12]:

a. Classify internal or external factors. Internal factors are divided into 2, namely strengths and weaknesses. External factors consist of opportunities and threats.

b. Describe the results of the calculations of the four factors in a SWOT diagram.

c. Determine the implementation strategy of the selected model for BIM sustainability. After knowing its position in the SWOT diagram, the implementation strategy that must be used by BIM utilization can be determined. The strategies are the SO strategy, the ST strategy, and the WT or WO strategy.

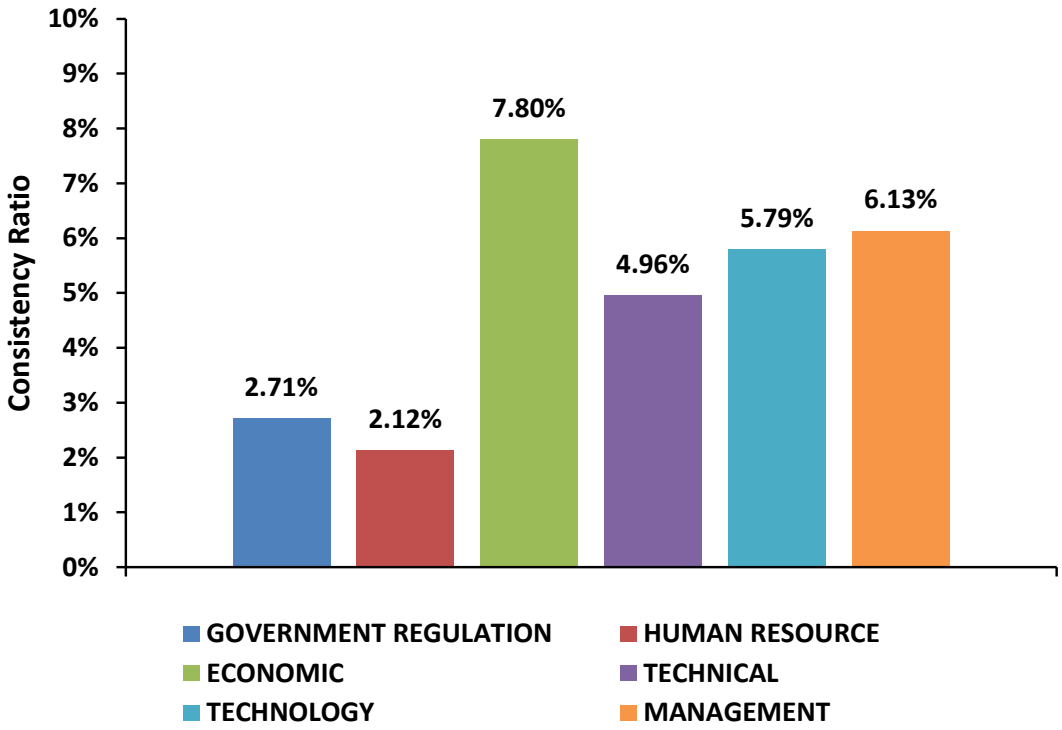

Figure 1. Consistency of the ratio of each aspect

Results and Discussion

Determination of selected variables

The respondent's recapitulation results indicate that the AHP analysis will use 21 variables for data processing, including BIM Usage Regulations, Establishment of Special Institutions, Law Enforcement, Training, Certificate of Expertise, License Procurement, HR Procurement, Training Implementation, and Equipment Procurement. Planners do not use BIM, Miss Communication, Changes in Work Culture, Process Complexity, Ease of Obtaining, Ease of Understanding, Hardware Specifications, Interoperability, Incompatible Software, Participatory Roles, Internal Miss Communication, Clarity of BIM Targets by the Company, Market Demand.

The ranking for each criterion in each aspect is arranged based on the priority vector value. Here is the ranking of each criterion for each aspect: Next, the ranking for each criterion in each aspect is arranged based on the priority vector value. The ranking of each criterion for each aspect is shown in Table 3.

Table 3. Ranking of variables in each aspect

Criteria	Priority vector	Ranking
Government Regulation Aspects		
BIM Usage Regulations	0.69	1
Law enforcement	0.31	2
Human Resource Aspects		
Lack of skills and understanding	0.12	3

Training	0.57	1
Certificate of Expertise	0.31	2
Economic Aspects		
Procurement of licenses	0.51	1
Human Resources Procurement	0.25	2
Implementation of training	0.13	3
Procurement of equipment	0.10	4
Technical Aspects		
Planners don't use BIM	0.45	1
Lack of Coordination	0.34	2
Changes in Work Culture	0.14	3
Process Complexity	0.08	4
Technology Aspects		
Ease of getting	0.08	4
Ease of understanding	0.16	2
Hardware Specifications	0.54	1
Interoperability	0.14	3
Software is not compatible	0.08	5
Management Aspects		
Participatory role	0.25	2
Internal Communication Failure	0.08	4
Clarity of BIM targets by the company	0.15	3
Market Demand	0.52	1

Discussion

In each aspect of the variable, the CR value <10% is obtained, so it can be said that the results of the questionnaire on 30 respondents can be used. In the same way, a comparison is made between the criteria in each aspect that will be an alternative solution to the problem in this study.

SWOT analysis

All respondents' AHP data processing results yield internal and external factors, and variables for determining problem-solving strategies using SWOT analysis. Table 4 displays these factors.

Then, based on the factors that have been determined, problem-solving strategies are defined using the SWOT matrix table as shown in Table 5.

Table 4. Internal and external factors of SWOT

Internal Factors	External Factors
Strength	**Opportunity**
Certificate of Expertise	Ease of Understanding
BIM Usage Regulations	Training
Weakness	**Threat**
Market Demand	Hardware Specification
Participatory role	Procurement of licenses
Planners don't use BIM	Human Resources Procurement
Lack of Coordination	Law enforcement

Table 5. SWOT analysis

SWOT Matrix		**Strength - S**		**Weakness - W**	
		1	Certificate of Expertise	1	Market Demand
		2	BIM Usage Regulations	2	Participatory role
				3	Planners don't use BIM
				4	Lack of Coordination
Opportunities - O		**Strategies S-O**		**Strategies W-O**	
1	Ease of Understanding	1	Carrying out training activities to obtain a certificate of expertise (S1, S2, O1, O2)	1	Conducting routine briefings to improve understanding of duties and functions in BIM operations (W1, W2, W4, O1, O2)
2	Training			2	Improving the quality of human resources to overcome planning in conventional ways (S1, S2, W3)
Threat - T		**Strategies S-T**		**Strategies W-T**	
1	Hardware Specification	1	Conduct hardware procurement in accordance with regulatory standards for each application (S1, T1)	1	Conducting Human Resource recruitment to meet BIM requirements (W1, W2, W3, T3)
2	Procurement of licenses	2	Conducting application licensing procurement (S2, T2)		
3	Human Resources Procurement	3	Recruiting for BIM experts (S3, T2)		
4	Law enforcement				

Conclusion

Based on the analysis that has been carried out on the Evaluation of BIM Implementation in Government Projects on Lombok Island Using AHP and SWOT, the following conclusions can be drawn:

a. There are 6 main aspects of BIM application in the field, namely: government policy, human resources, economics, technical, technology, and management aspects.

b. The main factors that are obstacles to BIM application in the field are: Certificate of expertise, Ease of understanding, BIM usage regulations, Training, Market demand, Hardware specifications, Participation role, License procurement, Planners do not use BIM, Human resource procurement, Lack of coordination, and Law enforcement.

c. BIM application greatly influences the implementation of development in the field. Its application can speed up work in various ways.

d. Strategies that can be applied based on the evaluation results are:

   1. Carrying out training activities to obtain a certificate of expertise (S1, S2, O1, O2),
   2. Carrying out routine briefings to improve understanding of the main tasks and functions in BIM operations (W1, W2, W4, O1, O2),
   3. Improving the quality of human resources to handle planning in a conventional manner (S1, S2, W3),
   4. Procuring hardware in accordance with the regulatory standards of each application (S1, T1),
   5. Procuring application licenses (S2, T2),
   6. Recruiting BIM experts (S3, T2),
   7. Recruiting human resources to meet the requirements in BIM (W1, W2, W3, T3).

Suggestions for further study:

a. Research can be conducted in a wider scope.

b. Research should also be conducted at the planning stage.

c. A larger number of respondents will produce more opinions.

References

[1] Bosdriesz, Yvar. 2018. Towards a Reference Architecture to BIM Integration in Construction Industry. Faculty of Electrical Engineering. University of Twente, Enschede, Netherland.

[2] Gegana, Gregorius & Widjanarso, Tony H. (2015). BIM Course Development and Its Future Integration at University of Indonesia and Institute Of Technology Bandung, Indonesia. 9th BIM Academic Symposium & Job Task Analysis Review, Washington, DC, 7-8 April 2015.

[3] Johartiming, Evelyn Fedora. 2021. Investigation of Building Information Modeling Implementation in the Construction Sector in Surabaya. Petra Christian University. Surabaya.

[4] Kartika, Destiar U.A. 2022. Study of the Role of Building Information Modeling (BIM) in Construction Services Business. Master of Civil Engineering, University of Mataram. Mataram.

[5] Nasution, S. 1988. Qualitative Naturalistic Research Methods. Tarsiti Bandung

[6] Pratama, A. dkk. 2024. BIM Study of Building Information Modeling Implementation in Indonesia Based on Construction Executor's Perspective (Case Study: BUMN Contractor Project). Jurnal Teoretis dan Terapan Bidang Rekayasa Sipil. Institut Teknologi Bandung. Bandung.
[7] Rangkuti F., 2015. SWOT Analysis Business Case Dissection Technique, Jakarta: PT. Gramedia Pustaka Utama.
[8] Rusyanti, S.H. 2018. Comparative Study of Building Information Modeling (BIM) Implementation in Singapore and the UK Reviewed from Institutional Aspects. Direktorat Rumah Susun.
[9] Saaty, T.L., 1993, Decision Making for Leaders: An Analytical Hierarchy Process for Decision Making in Complex Situations, Seri Manajemen No.134. Cetakan Kedua, Jakarta: PT. Gramedia.
[10] Sugiyono. 2015. Educational Research Methods Quantitative, Qualitative, and R&D Approaches. Bandung: Alfabeta.
[11] Virgia, Srihayati Baiq. 2022. Sustainability and Feasibility Study of 3R TPS Using AHP and SWOT Methods in Central Lombok Regency. Master of Civil Engineering, University of Mataram. Mataram.
[12] Wibowo, Ary. 2021. Evaluation of BIM Implementation in Construction Projects in Indonesia. Master of Civil Engineering, Universitas Islam Sultan Agung. Semarang.
[13] Wook, W.S. dkk. 2016. Information Modeling (BIM) for Project Value: Quantity Take-Off of Building Frame Approach. International Journal of Applied Engineering Research ISSN 0973-4562 Volume 11, Number 12 (2016) pp 7749-7757.