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The Comparation of Building Information Modelling and Conventional Method in Planning Multi-storey Building Structure

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Abstract
The construction sector in Indonesia is experiencing rapid development so that Architectural, Engineering Construction (AEC) companies compete with each other and adopt technology that significantly increases the efficiency and effectiveness of construction project implementation. This study is aimed to compare the implementation of BIM with conventional method based on the duration of process, the number of personnel needed and the budget of implementation. Research data are data and information obtained through questionnaires and interviews with 3 (three) AEC companies in Padang city, either implementing BIM or conventional method. Based on the result, it was concluded that conventional method requires longer time in planning structural work compared to BIM method with reducing time 76.4% in the design process, 33.3% in the number of personnel and 16.11% in salary costs compared with BIM method. By efficiency and sustainable benefits considered, it is necessary to encourage AEC companies in Padang city to implement BIM method in their business processes.

INTRODUCTION

Nowadays, the construction sector in Indonesia is experiencing rapid development. Therefore, construction stakeholders compete to create and adopt technology that can significantly support the efficiency and effectiveness of business processes. A technology that is popular and widely used by stakeholders is Building Information Modeling (BIM). According to the Regulation of the Ministry of PUPR No. 22 / PRT / M / 2018 requires the adoption of BIM for buildings with an area exceeding 2000 m^2 (Muhsin et al, 2021).

The implementation of BIM concept provides great benefits in improving collaboration and efficiency throughout the entire life cycle of construction projects. In several Southeast Asian countries, such as Vietnam and Malaysia, the adoption of BIM has begun to be carried out although there are still shortcomings in implementing it (Nugrahini & Permana, 2020). However, in Indonesia, the development of BIM adoption is still relatively slow. There are few studies discuss about implementation of BIM in Architectural, Engineering and Construction (AEC) companies. BIM is a set of technologies, policy processes that all processes run in an integrated digital model, which is then translated as 3D model. Technology is also the process of generating and managing data for a construction during its life cycle. BIM uses 3D, real-time, and dynamic modeling software to increase productivity in building design and construction (PUPR, 2018). The following levels of BIM development can be seen in Figure 1.

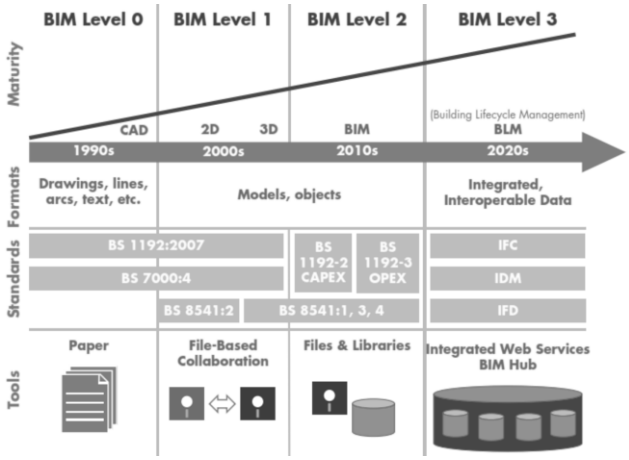

Figure 1. Level of Development BIM

The BIM concept in Indonesia has modeling from 3D to 7D or Level of Development abbreviated as LOD from LOD 300 to LOD 700. LOD 300 covers object-based parametric modeling in 3D dimensions, LOD 400 covers job and material scheduling, LOD 500 covers cost estimation, LOD 600 covers energy analysis in sustainability aspects and whereas, LOD 700 covers more economical facility management by providing relevant information for maintenance after facility built.

BIM is more widely used by state-owned companies, while private ones have not fully adopted the BIM concept (Fuad S et al 2022). Most private AEC companies in Indonesia still use conventional method that have not been integrated with each other such as AutoCAD used for drawing design, SAP for structural analysis, Microsoft Excel for quantity and cost calculations, and Microsoft Project for project scheduling (Berlian et al, 2016; Rizqi et al, 2021). Several previous studies tried to compare conventional methods with BIM in terms of time and cost (Muhsin et al, 2021) and quality (Rizqi et al, 2021), human resources needed (Berlian et al, 2016), in terms of calculating the bill of quantity of concrete work (Megawati & Purwanto, 2020; Suwarni, 2021) and estimated cost of concrete work (Rahmani, 2020; Tama et al, 2023).

The implementation of BIM method in the Indonesian construction industry still faces challenges by AEC companies in adopting new technologies in the overall implementation of BIM. BIM Implementation is still quite low when viewed from the availability of legal aspects and the implementation of integrated standards. This means that there needs to be government involvement in determining the legal aspects related to the use of BIM. In addition, the importance of the involvement of the entire supply chain in construction to develop the Information and Communication Technology (ICT) sector, such as consultants, stakeholders, and others, in order to facilitate the implementation of BIM (Pratama, A et al 2023). According to previous studies, obstacles in the implementation of BIM in construction projects are the need for significant investment, lack of stakeholder awareness of the importance of BIM, the need for continuous training, rejection of the adoption of new technology, lack of government support, lack of management participation in providing motivation and supervision set by the company, communication between divisions within the organization, availability of BIM specialists, the transition of work culture from conventional methods to BIM, low demand from clients, the difficulties of operational procedures (Hutama, Sekarsari, 2004; Fitriani et al, 2019; Mieslenna, CS et al 2019; Pantiga, J et al 2021; Pratama, A et al 2023). The development of BIM in Indonesia needs to be further encouraged so that project stakeholders can utilize technology in increasing efficiency, collaboration, and accuracy in project development. The study aims to compare between the implementation of BIM and conventional method based on the duration of process, the number of personnel needed and the cost of implementation. This study is expected to encourage AEC companies in Padang city to adopt BIM methods in their business process.

RESEARCH METHODS

This study is exploratory research by exploring the differences in conventional method that use Auto Cad software with Autodesk Revit as BIM application software based on the design process, the number of personnel needed and implementation costs. The data collection was conducted through surveys, questionnaires and interviews with several respondents of AEC companies in Padang city, who use conventional methods and to begin to adopt BIM for obtaining information to identify the duration of the design process and the budget needed as well as the number of BIM personnel.

The research procedure includes several stages, including: (1) Literature study. Review previous studies related to the study of BIM implementation adoption, usage of BIM software, development of 3D BIM models in project planning, benefits and constraints of BIM application and comparison of conventional and BIM methods that have been carried out by previous researchers. (2) Establish problem statements and research objectives. At least or almost no AEC companies in Padang city have adopted BIM in carrying out project planning which in fact mostly still uses conventional methods, requires comparison between conventional methods and BIM and this is the purpose of this research. (3) Data collection. Finding information and data as factors compared between conventional and BIM method was conducted through surveys and interviews to three respondents of AEC companies in Padang city. (4) Conclusions and recommendation. Summing up the results and findings of the research and recommending several points for future research development.

RESULTS AND DISCUSSION

The duration of structural work plan

Based on the results of the survey and interviews, the differences in duration were obtained in the planning work of multi-storey building structures between BIM and conventional methods carried out by PT. A, PT, B and PT. C (as an AEC company in Padang city) which can be seen in table 1.

Table 1. The comparison of duration of structural work plan

No	Activities	Method	The Duration of Structural Work Planning						Average
			PT. A		PT. B		PT. C		
			(Hours, minutes)						
1	Initial Setting	BIM	6	Minutes	10	Minutes	7	Minutes	18 Minutes
		Conventional	8	Minutes	10	Minutes	10	Minutes	21 Minutes
2	Layout Setting	BIM	30	Minutes	1	Hours	2	Hours	2 Hours 15 Minutes
		Conventional	40	Minutes	3	Hours	4	Hours	2 Hours 50 Minutes
3	Make a planning of foundation sloofs, columns, beams and slab	BIM	15	Minutes	2	Hours	8	Hours	3 Hours 41 Minutes
		Conventional	2	Hours	5	Hours	10	Hours	5 Hours 6 Minutes
4	Draw the details	BIM	1	Minutes	8	Hours	1	Minutes	2 Hours 6 Minutes
		Conventional	30	Minutes	10	Hours	8	Hours	6 Hours 16 Minutes
5	Draw the details of foundations, sloof, columns and slab	BIM	1	Minutes	3	Hours	3	Hours	2 Hours 5 Minutes
		Conventional	30	Minutes	8	Hours	4	Hours	4 Hours 16 Minutes

No	Activities	Method	The Duration of Structural Work Planning PT. A (Hours, minutes)	PT. B	PT. C	Average
6	Draw the details of steel reinforcing	BIM	2 Minutes	4 Hours	4 Hours	2 Hours 6 Minutes
		Conventional	30 Minutes	10 Hours	5 Hours	5 Hours 16 Minutes
7	Draw the changes of shop drawing	BIM	30 Minutes	1 Hours	2 Hours	1 Hours 16 Minutes
		Conventional	2 Hours	3 Hours	4 Hours	3 Hours
8	Draw 3D drawing design	BIM	-	5 Minutes	-	5 Minutes
		Conventional	30 Minutes	8 Hours	40 Hours	16 Hours 16 Minutes
9	Estimate Bill of Quantities (BoQ)	BIM	5 Minutes	15 Minutes	5 Minutes	8 Minutes
		Conventional	20 Hours	24 Hours	16 Hours	20 Hours
10	Estimate project budget plan	BIM	20 Hours	15 Minutes	5 Minutes	6 Hours 7 Minutes
		Conventional	40 Hours	20 Hours	20 Hours	26 Hours 6 Minutes
Total		BIM	21 Hours 30 Minutes	19 Hours 45 Minutes	19 Hours 18 Minutes	20 Hours 18 Minutes (21 Hours)
		Conventional	66 Hours 40 Minutes	91.10 Hours/Minutes	111.10 Hours/Minutes	89 Hours 6 Minutes (89 Hours)

The numbers of personnel

Based on the interview results, the differences in the number of personnel needed in planning of multi-storey building structures between BIM and conventional methods carried out by PT. A, PT, B and PT. C (as an AEC company in Padang city), which can be seen in table 2.

Table 2. The comparison of the numbers of personnel

No	Personnel	Method	The Numbers of Personnel PT. A (person, people)	PT. B	PT. C	Average
1	Team Leader	BIM	1	1	1	1
		Conventional	1	1	1	1
2	Surveyor	BIM	1	1	1	1
		Conventional	1	1	1	1
3	Geotechnical Engineer	BIM	1	1	1	1
		Conventional	1	1	1	1
4	Structural Engineer	BIM	-	-	-	-
		Conventional	1	1	1	1
5	Cost Estimator	BIM	1	1	1	1
		Conventional	1	1	1	1
6	BIM Structural Engineer	BIM	1	-	1	1
		Conventional	-	1	-	1
7	Surveyor assistant	BIM	1	1	1	1
		Conventional	3	4	3	4
8	BIM Manager	BIM	1	1	1	1
		Conventional	-	-	-	-
9	Drafter	BIM	-	-	-	-
		Conventional	3	4	4	4

No	Personnel	Method	PT. A	PT. B	PT. C	Average
			(person, people)			
10	BIM Modeller	BIM	1	1	1	1
		Conventional	-	-	-	-
11	BIM Engineer	BIM	1	1	1	1
		Conventional	-	-	-	-
12	Administrator	BIM	1	1	2	2
		Conventional	3	2	2	3
Total		BIM	10	9	11	10
		Conventional	14	16	14	15

The implementation budget

Based on the results of the survey and interviews, the difference in the amount of the budget covering the cost of installing software, hardware, training and personnel salaries in the planning of high-rise buildings between the implementation of BIM and conventional methods carried out by PT. A, PT, B and PT. C (as an AEC company in Padang city), can be seen in table 3, table 4, table 5 and table 6.

Table 3. The comparison of cost of software installation

No	The list of Software	The cost of software installation PT. A	PT. B	PT. C	Average
		Price (IDR)			
BIM					
1	Autodesk Revit 2023	35,000,000.00	20,000,000.00	35,000,000.00	30,000,000.00
2	Tekla	35,000,000.00	20,000,000.00	35,000,000.00	30,000,000.00
3	Bentley	30,000,000.00	20,000,000.00	5,000,000.00	18,300,000.00
Total		100,000,000.00	60,000,000.00	75,000,000.00	78,300,000.00
Conventional					
1	Autocad	4,000,000.00	500,000.00	250,000.00	1,583,000.00
2	Sketchup	3,000,000.00	500,000.00	250,000.00	1,250,000.00
Total		7,000,000.00	1,000,000.00	500,000.00	2,833,000.00

Table 4. The comparison of cost of hardware installation

No	The list of hardwares	The cost of hardware installation PT. A	PT. B	PT. C	Average
		Price (IDR)			
BIM					
1	Desktop	10,000,000.00	16,000,000.00	20,000,000.00	15,300,000.00
2	Laptop	20,000,000.00	30,000,000.00	25,000,000.00	25,000,000.00
Total		30,000,000.00	46,000,000.00	45,000,000.00	40,300,000.00
Conventional					
1	Desktop	7,000,000.00	10,000,000.00	12,000,000.00	9,600,000.00
2	Laptop	10.000,000.00	20,000,000.00	15,000,000.00	15,000,000.00
Total		17,000,000.00	30,000,000.00	27,000,000.00	24,600,000.00

Table 5. The comparison of training fee

No	Type of training	The training fee			
		PT. A	PT. B	PT. C	Average
		Price (IDR)			
BIM					
	The training fee (3 days for one batch)	3,000,000.00	15,000,000.00	7,500,000,00	8,500,000.00
Total		3000,000.00	15,000,000.00	7,500,000.00	8,500,000.00
Conventional					
	The training fee (3 days for one batch)	600,000.00	1,500,000.00	2,000,000.00	1,366,000.00
Total		600,000.00	1500,000.00	2000,000.00	1,366,000.00

Table 6. The comparison of salaries of personnel

No	Personnel	Method	The salaries of personnel IDR/work day			
			PT. A	PT. B	PT. C	Average
1	Team Leader	BIM	1,000,000.00	700,000.00	700,000.00	800,000.00
		Conventional	1,000,000.00	700,000.00	700,000.00	800,000.00
2	Surveyor	BIM	150,000.00	300,000.00	200,000.00	216,000.00
		Conventional	150,000.00	300,000.00	200,000.00	216,000.00
3	Geotechnical Engineer	BIM	1,000,000.00	500,000.00	350,000.00	616,000.00
		Conventional	1,000,000.00	500,000.00	350,000.00	616,000.00
4	Structural Engineer	BIM	-	-	-	-
		Conventional	1,000,000.00	1,000,000.00	300,000.00	766,000.00
5	Cost Estimator	BIM	1,000,000.00	300,000.00	300,000.00	533,000.00
		Conventional	1,000,000.00	300,000.00	300,000.00	533,000.00
6	BIM Structural Engineer	BIM	1,000,000.00	1,000,000.00	400,000.00	800,000.00
		Conventional	-	-	-	-
7	Surveyor Assistant	BIM	100,000.00	200,000.0	175,000.0	158,000.00
		Conventional	300,000.00	800,000.00	525,000.00	541,000.00
8	Drafter	BIM	-	-	-	-
		Conventional	600,000.00	1,600,000.00	1,000,000.00	1,066,000.00
9	BIM Modeler	BIM	300,000.00	500,000.00	300,000.00	366,000.00
		Conventional	-	-	-	-
10	BIM Engineer	BIM	1000,000.00	500,000.00	300,000.00	600,000.00
		Conventional	-	-	-	-
11	Administrator	BIM	500,000.00	300,000.00	400,000.00	400,000.00
		Conventional	1,500,000.00	600,000.00	400,000.00	833,000.00
	Total	BIM	6,050,000.00	4,100,000.00	3,125,000.00	4,425,000.00
		Conventional	6,250.000.00	5,800,000.00	3,775,000.00	5,275,000.00

Based on the analysis of questionnaires and interviews from respondents, the average duration needed in making design drawing and the calculation of the project cost using the BIM method is 21 hours, whereas the conventional method needs 89 hours with a difference in duration of 68 hours and the time reduction of 76.40%. The number of personnel needed for implementing BIM method is 10 personnel whereas the conventional method requires 15 personnel and the reduction in personnel of 33.3%. Meanwhile, BIM implementation costs which include, the cost of software and hardware installation, training cost, and personnel salaries are relatively greater than the costs of conventional method. BIM software installation cost is 96.38% more expensive, BIM hardware installation cost is 38.96% more expensive, and training cost is 83.93% more expensive, but the total salaries of BIM personnel are 16.11% more efficient than conventional method.

Some of the advantages of implementing BIM methods identified in previous studies such as interoperability, clash detection, time reduction, cost and the number of personnel needed (Gunawan et al, 2021).

Interoperability cannot be done in conventional methods because it uses some software such as SAP for structural strength analysis, AutoCAD for drawings, and Microsoft Project for quantities calculation and scheduling and they cannot be integrated and operated by exchanging data automatically. However, by using BIM software, all these activities can be operated and exchanged data in one BIM software template that can be executed by one personnel. Clash detection occurs due to a mismatch between the architect's design, structure, and MEP which allows each party to have different software to complete the design work. However, with the BIM method this issue can be avoided and identified errors in size, shape or other design elements by each part so as to minimize design errors that occur before the execution of construction activities. In addition, the design process with BIM software is faster than conventional methods. The implementation of the conventional method requires more experts to do their respective parts. Meanwhile, with the implementation of BIM, resource can be minimized because some work can be executed by one person only.

In addition, another advantage of implementing BIM is that design duration and salaries required are more efficient than conventional method. Some of the disadvantages of BIM implementation identified in the study are the high cost of software installation, large hardware specifications and the cost of installing hardware is more expensive and BIM is also less able to perform detail images on a fairly small scale below 1:20 (Berlian et al, 2016; Gunawan et al, 2021).

CONCLUSION

The AEC companies in Padang that use conventional method take longer to complete design work compared to those that adopt BIM method with the reduction in duration of 76.4%, the reduction of the number of personnel 33.3% and the reduction in salary cost of 16.11%. The adoption of BIM method is relatively efficient compared to conventional method based on aspects of the design process and the number of personnel but investment cost such as the cost of installing licensed software, installing hardware and BIM training cost are quite high. By considering efficiency benefit, it is necessary to encourage AEC companies in the city of Padang to implement BIM method to their business processes.

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