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Implementation of Building Information Modeling (BIM) Method on the Effectiveness of Construction Building Management Execution

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Abstract
This research aims to quantitatively analyze the effect of the implementation of Building Information Modelling (BIM) on the effectiveness of building implementation management in the construction industry. BIM has become a significant method in the construction industry with the potential to enhance collaboration, coordination, and management of information in the execution of building projects. Quantitative research methods were used in this study by collecting data through the research method uses linear regression analysis with data from construction professional respondents. The results showed that the implementation of BIM had a significant and positive influence on the effectiveness of building construction implementation management, indicated by a t value of 12.217. The coefficient of determination (R square) of 0.749 or 74.9% indicates that 74.9% of the variation in the effectiveness of building construction management can be explained by BIM implementation. These findings confirm the importance of using BIM to improve management effectiveness in building construction in the construction industry. The implications of this research provide a basis for encouraging the adoption of BIM as an effective tool in construction project management.

Keywords—*Building Information Modelling (BIM); Effectiveness; Implementation; Effectiveness; Building Construction Projects*

I. Introduction

The rapid advancement of technology in the field of construction is progressing swiftly, bringing about significant transformations in the building construction sector. Generally, coordination issues in construction development projects are commonly encountered challenges in the construction industry, (Arayici, Kiviniemi, et al., 2011).

The construction industry has undergone a paradigm shift to improve: productivity, efficiency, infrastructure value, quality and sustainability, reduction of life cycle costs, lead times and duplication through effective collaboration and communication. With rapid development, contractors as construction service providers must be able to utilize their time efficiently and produce high quality products at near minimal costs. Therefore, contractors must be able to imagine installation concept patterns that enable effective and efficient construction from planning to the construction stage. On the other hand, almost all distribution centers are in early operations. Due to reported bugs, it will not be implemented, (Nelson & Tamtana, 2019)

BIM can be viewed as a virtual process that involves the integration of all aspects, disciplines and building systems into one model. All design team members, including owners, designers, engineers, contractors,

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subcontractors, and suppliers, can work collaboratively with more accuracy and efficiency than traditional methods, (Azhar, 2011; Purnomo et al., 2022).

The use of BIM applications or BIM adoption has also become mandatory in several countries since the beginning of the 2000s, in the United States, around 50% of the construction services industry has adopted BIM since 2007, and this figure increased to 75% in 2009 In the Asian region, the implementation of BIM only started in early 2010 by several countries such as China, South Korea, Singapore, Vietnam and Malaysia. Singapore, in particular, was mentioned in a 2015 UK Government Report, (Heryanto et al., 2020), that using BIM can result in savings of up to 50% in design requirements, reduce construction work by 33%, and save operational costs by 20%. Collaboration is a key factor in implementing BIM for all parties involved in industrial construction. BIM is a digital construction development process. Although BIM has been around for more than 20 years, new building owners are starting to realize that it has the power to improve efficiency, design quality and building operations, (Arayici, Coates, et al., 2011; Purnomo et al., 2022)

With technological innovation through the application of Building Information Modeling (BIM) in construction activities, BIM is a method or system that is able to increase effectiveness and efficiency in construction work. According to (Pantiga & Soekiman, 2021) Building Information Modeling is a digital representation of the physical and functional attributes of a facility. BIM includes its solution capabilities. Deliver this information to users in a simple and easy format

According to (Yudi et al., 2020) Building Information Modeling (BIM), also known as "Integrated Project Delivery" (IPD), models the design, design and delivery of buildings through collaboration, integration and productive team organization of implementation management systems project. BIM models are useful tools for planning, designing, constructing and managing building structures. According to (Liu et al., 2017)the project manager is responsible for the physical construction which can be supported by the coordinator by facilitating virtual construction and assisting the team before and during construction. The project manager as a controlling role seeks to build and maintain good sources of information, in order to create high quality, BIM coordinator as a supporting role facilitates project management, improves information and communication between projects

According to (Sarju et al., 2022) BIM implementation can help in overcoming the problem of fragmented delivery processes and reliance on paper-based documentation in the construction industry. Implementing BIM can increase the effectiveness of building construction project implementation by speeding up the construction process, optimizing resource use, and reducing project work costs.

According to (Fikri & Septiropa, 2022)Effectiveness emphasizes the results or effects in achieving goals, while efficiency tends to be on the process or method of achieving goals.

According to (Nainggolan, 2021; Silalahi et al., 2022; Oei, F. J et al., 2023) Effectiveness is the ability to achieve predetermined goals by using available resources effectively and efficiently in the context of organizational communication.

According to (Aliran & Progo, 2011) The effectiveness of building implementation management is the level of success in achieving the goals set in the building construction process. Effectiveness can be seen from the aspects of cost, time and quality in achieving predetermined goals/ targets.

II. RESEARCH METHODOLOGY

This research uses a quantitative approach method based on the philosophy of positivism. The quantitative approach allows statistical testing of hypotheses using empirical data obtained through data collection through measurement. In this research, quantitative research methods are used to test the established hypotheses. The hypothesis in this research is as follows:

H0: There is no significant influence between BIM implementation and the effectiveness of building implementation management in the construction industry.

Ha: There is a significant influence between the implementation of BIM and the effectiveness of building implementation management in the construction industry.

In this research, primary and secondary data were used. explains that primary data refers to data sources obtained and collected directly from the object being researched. For primary data collection, a questionnaire technique was used which was filled out by contractor companies that had the potential to use Building Information Modeling (BIM) in the Construction Industry. By using this technique, primary data is obtained indirectly through questionnaires delivered to respondents. The total population obtained was 52 samples of contractor companies as determined by the researcher using a simple random sampling technique and had fulfilled the requirements of the simple linear regression test with classical assumptions that are usually carried out, namely the normality test, heteroscedasticity and linearity test.
Decision making criteria in the t test by looking at the Sig t value as shown in Table 1:

Table 1. T Test Decision Making Criteria (partial test)

Value *Sig* t	Information
If the significance value t <0.05	H_0 is rejected and H_a is accepted
If the significance value t> 0,05	H_0 is accepted and H_a is rejected

Table 2. T Test Decision Making Criteria (partial test)

Calculated t and t table values	Information
If the calculated t value is more than the table t value	H_0 is rejected and H_a is accepted
If the calculated t value is less than the table t value	H_0 is accepted and H_a is rejected

Research variable
1. Independent Variable: BIM Implementation
2. Dependent Variable: Effectiveness of Building Construction Implementation Management.

III. RESULT AND DISCUSSION

1. Validity Test

Validity tests are used to evaluate the extent to which a measurement instrument can measure the desired variable. If the calculated r value obtained is greater than the table r value, then the measurement instrument is considered valid. Validity test results indicate that the measurement instrument is reliable for measuring interest rates. A research tool is considered accurate for research if the correlation coefficient value is greater than or equal to 0.3 and vice versa, if the correlation coefficient value is less than 0.3 then the search tool is useless. . To determine item reliability, this study used the Pearson product-moment correlation coefficient using SPSS V26. The product – moment correlation formula is as follows:

$$r_{xy} = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{(n\sum x^2 - (\sum x^2)(n\sum y^2 - (\sum y)^2}}$$

rxy is the result which is then compared with the price r in the critical price table of r product moment. If rxy≥rtabel then the question item is declared valid (α;n or df = n-2) n = number of samples. In this case the number of respondents is 52, so to determine whether the question items are declared valid, you can calculate (α;n or df=52-2)=50, so the r table for the 52 respondents used in this study was 0.279.

Conclusions from the validity test results using SPSS V 26 can be seen in Table 3.

Table 3. Conclusion of Validity Test Results for Variable “X”

NO	Rx calculated	R Table	Requirement: Rx hitung > R Table	Information
1	0,728	0.279	OK	Valid

2	0,751	0.279	OK	Valid
3	0,632	0.279	OK	Valid
4	0,657	0.279	OK	Valid
5	0,841	0.279	OK	Valid
6	0,782	0.279	OK	Valid
7	0,808	0.279	OK	Valid
8	0,749	0.279	OK	Valid
9	0,783	0.279	OK	Valid
10	0,768	0.279	OK	Valid
11	0,827	0.279	OK	Valid
12	0,761	0.279	OK	Valid
13	0,563	0.279	OK	Valid
14	0,512	0.279	OK	Valid
15	0,649	0.279	OK	Valid
16	0,721	0.279	OK	Valid
17	0,733	0.279	OK	Valid
18	0,468	0.279	OK	Valid
19	0,474	0.279	OK	Valid

Based on the conclusions from the test results in Table 3 above, there are 19 questionnaires containing variable X which have been filled in by 52 respondents. One way to determine which questionnaires are valid and invalid is to first look for the r table value. The formula used for the r table is df = N-2, where N is the number of respondents (52) so df = 52 - 2 = 50. From this calculation, the r table value is 0.279. Based on the results of the validity calculations in the table above, it can be seen that the calculated r value > r table, so there are 19 questionnaires that can be declared as valid.

Table 4. Conclusion of Validity Test Results for Variable "Y"

NO	Rx calculated	R Table	Requirement: R calculated > R Table	Valid
1	0,551	0,279	OK	Valid
2	0,608	0,279	OK	Valid
3	0,698	0,279	OK	Valid
4	0,487	0,279	OK	Valid
5	0,779	0,279	OK	Valid
6	0,714	0,279	OK	Valid
7	0,845	0,279	OK	Valid
8	0,679	0,279	OK	Valid
9	0,737	0,279	OK	Valid
10	0,760	0,279	OK	Valid
11	0,792	0,279	OK	Valid
12	0,725	0,279	OK	Valid
13	0,780	0,279	OK	Valid
14	0,824	0,279	OK	Valid
15	0,646	0,279	OK	Valid
16	0,759	0,279	OK	Valid
17	0,647	0,279	OK	Valid
18	0,583	0,279	OK	Valid
19	0,623	0,279	OK	Valid
20	0,810	0,279	OK	Valid
21	0,747	0,279	OK	Valid

Based on the conclusions from the test results in Table 5 above, there are 21 questionnaires containing variable Y which have been filled in by 52 respondents. One way to determine which questionnaires are valid and invalid is to first look for the r table value. The formula used for the r table is df = N-2, where N is the number of respondents (52) so df = 52 - 2 = 50. From this calculation, the r table value is 0.279. Based on the results of the validity calculations in the table above, it can be seen that the calculated r value > r table, so there are 21 questionnaires that can be declared as valid

2. Reliability Test

Every statement that has been proven valid, in this research, aims to ensure that the instrument used is consistent as a measuring tool. This is important so that the level of instrument reliability can show consistent results. The number of respondents in this study was 52 people, and reliability testing can be carried out using the SPSS V26 program. Reliability testing in this research uses the internal consistency method, where the instrument is tested once and measured using the Cronbach's alpha coefficient. If the alpha coefficient value is greater than 0.70, then the instrument used in this research is considered reliable. The results of the reliability test for Variables X and Y are as shown in Table 5. and Table 6.

Table 5. Reliability Test for Variable "X"

Reliability Statistics	
Cronbach's Alpha	N of Items
.935	19

The output of Table 5 above is the result of the reliability analysis of variable X using the Cronbach Alpha technique. It is known that the number of items (N) is 19 question items. Cronbach Alpha value is 0.935 > 0.70. Based on these data, it can be concluded that variable Y is classified as a very good reliability category.

Table 6. Reliability Test for Variable "Y"

Reliability Statistics	
Cronbach's Alpha	N of Items
.945	21

The output in Table 6 above is the result of reliability analysis using the Cronbach Alpha technique. It is known that the number of items (N) is 21 question items. Cronbach Alpha value 0.945 > 0.70 Based on these data, it can be concluded that variable Y is classified in the very good reliability category.

3. Simple Linear Analysis

Statistical analysis in this research uses simple linear regression analysis. The simple linear test, or also known as simple linear regression, is a statistical method used to evaluate the relationship between two variables: the independent variable (x) and the dependent variable (y). This test aims to determine whether there is a linear relationship between the independent variable and the dependent variable, as well as to measure the strength and significance of this relationship.
The variables to be correlated are the independent variable (X) and the dependent variable (X). The simple linear regression equation is as follows:
$Y = a + bX$

Table 7 Simple Linear Analysis

Coefficients[a]						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	11.420	6.295		1.814	.076
	Implementasi *BIM*	.954	.078	.865	12.217	.000

a. Dependent Variable: Effectiveness of Building Implementation Management

The Coefficient Model in Table 7. above shows that the simple linear regression equation is Y = 11.420 + 0.954. This is based on the Coefficients table above the numbers used in column B where constant indicates the constant value (a). Meanwhile, variable X shows the value of the regression coefficient (b). Based on the simple linear regression equation from the given test, Y = 11.420 + 0.954, it can be concluded that every one unit increase in the independent variable (X) will cause an increase of 0.954 in the dependent variable (Y). This shows that variable X has a positive influence on variable Y.

4. T test (Partial Test)

The Coefficients Model in Table 8 above shows that testing with SPSS V26 shows that the influence of BIM on the effectiveness of building construction implementation management shows that the t count is 12.217 which is greater than the t table = 2.00856 with a significance of 0.000 which is smaller than 0.05 comparing the t count with the t table This can be stated that there is a partially significant influence between the implementation of BIM and the effectiveness of building implementation management in the construction industry, H0 is rejected and Ha is accepted, which can be seen in Table 1 and Table 2.

5. Test of the Coefficient of Determination R^2

The coefficient of determination R2 basically measures the extent to which the model can explain variations in the independent variables. The coefficient of determination value is between zero and one. A small R2 value means that the ability of the explanatory variable to explain the variance of the explanatory variable provides almost all the information needed to predict the variance of the explanatory variable. The coefficient of determination (R2) is used to measure the extent to which changes in the independent variable can explain its effect on the dependent variable. The higher the value of the coefficient of determination, the better the independent variable explains the variance of the dependent variable. When conducting a t-test, the following formula is used:
D = R2 x 100%
R = Correlation Value
100% = Percentage
The results of the coefficient of determination test are shown in Table 8.

Table 8. Test of the Coefficient of Determination R^2

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.865[a]	.749	.744	5.777

a. Predictors: (Constant), Implementasi BIM

The Model Summary in Table 9 shows the results of the Coefficient of Determination Test. Based on the SPSS output above, the value of Adjuste R2 is 0.744 or 74.4%. The remaining 25.6% is influenced by other factors not included in the model. The coefficient of determination shows that the ability of the simple linear regression model used is quite good in explaining the relationship between the independent variable X and the dependent variable Y.

IV. CONCLUSION

The implementation of BIM (Building Information Modeling) has a significant influence on the effectiveness of building project implementation in the construction industry. In this research, factors influencing the success of BIM implementation have been identified. Supporting factors that influence the success of BIM implementation include the availability of human resources skilled in BIM, the use of appropriate and latest technology, as well as good cooperation and coordination between related parties. On the other hand, there are inhibiting factors that can influence BIM implementation, including a lack of understanding about BIM, high implementation costs, the need for training about BIM, and lack of support from management. Therefore, to ensure optimal effectiveness of BIM use in the construction industry, BIM implementation needs to be done well and continuously improved. These supporting and inhibiting factors need to be considered and overcome so that BIM implementation can run successfully.

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