Analysis of The Success of Construction Projects Based on Labor Productivity

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Abstract. The success of a construction project is often achieved when it meets the set targets with various limitations in cost, time, and quality. To achieve and sustain project success, companies must acknowledge the significance of human or labor resources as factors directly linked to labor productivity have a direct impact on project success. The purpose of this study is to analyze the relationship between labor productivity and the success of construction projects. The population for this study consists of contractor companies in Banda Aceh City that are members of the GAPENSI association. The total population was determined to be 30 contractor companies, each with a sample of one Project Manager (PM) from the respective company. The research method is quantitative, with primary and secondary data sources. Data gathering involved the distribution of closed questionnaires to the participant. Data analysis technique using multiple linear regression analysis method. The results showed the magnitude of the influence of labor productivity with a coefficient of determination (R2) of 0.911. This means that labor productivity can account for approximately 91.1% of the variation in project success, while other variables outside the variables of this study explain the remaining 0.9%.

1 Introduction

Project activity is a temporary activity within a limited time to produce a product from various specific resources and has well-defined quality standards. According to planning, construction projects are expected to have good quality [1]. The success of a construction project is often interpreted as achieving the set targets with various limitations in cost, time, and quality [2][3]. The success of a project is when the project can be completed at a competitive cost, at the right time, and with the right quality [4]. To achieve and sustain project success, companies must acknowledge the significance of human resources and ensure they are appropriately positioned [5].

Effective human resource management is regarded as a valuable asset within the company and plays a pivotal role in project success [5]. One of the key factors that contribute to project success is the management of human resources or labor, as factors directly linked to labor productivity have a direct impact on project success [6][7].

Labor productivity is one of the dominating aspects in the construction industry because it encourages cost savings and effective workforce utilization[8]. The higher the labor

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productivity on the project, the higher the project's success rate. Conversely, low labor productivity will impact the entire project [9]. The workforce's functional ability is statistically related to project success and the performance of construction projects is directly influenced by labor productivity [5][10]. An unproductive workforce was the cause of unsuccessful project success [2]. The project manager, as a leader in a construction project, must be able to solve various problems and prioritize key factors to achieve project success, including labor productivity [11].

Issues pertaining to labor productivity in human resource management require further examination as they have a direct correlation with project success. This study aims to analyze the impact of labor productivity on the success of construction projects. The hypotheses in this study are as follows:

H_0 : There is no influence of worker management, communication, physiology, OSH implementation, leadership, working time, weather, and quality of labor on the success of construction projects simultaneously.

H_a : There is influence from worker management, communication, physiology, OSH implementation, leadership, working time, weather, and workforce quality on the success of construction projects simultaneously.

2 Method

The research was conducted regarding the effect of labor productivity on the success of construction projects. The research method employed in this study is quantitative. Quantitative research involves data that is numerical in nature and is analyzed using statistical techniques statistics [12]. The data used is categorized into two, namely primary data and secondary data. Primary data is gathered directly from research subjects, involving data collected firsthand in the field through predefined research instruments. In contrast, secondary data is data or information obtained through intermediaries, or in other words, the data is obtained indirectly [12]. The primary data for this study were collected by distributing questionnaires to Project Managers (PM) working for contractors in Banda Aceh City. Secondary data was gathered from relevant journals and articles related to the research topic.

The population for this study consists of contractor companies in Banda Aceh City that are members of the GAPENSI association. The total population was determined to be 30 contractor companies, each with a sample of one Project Manager (PM) from the respective company. The research variables consist of 8 (eight) independent variable from previous studies. Variable X in this study can be seen in Table 1.

Table 1. Independent variable.

Variable	Indicator	
Worker Management (X_1)	$X_{1.1}$	Briefing before doing work
	$X_{1.2}$	There is rework
	$X_{1.3}$	Increase the number of workers
Communication (X_2)	$X_{2.1}$	Duties and authorities are clear
	$X_{2.2}$	Effective communication in the field
	$X_{2.3}$	Solid and clear instructions

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Variable	Indicator	
Physiology (X_3)	$X_{3.1}$	Oxygen consumption (breathing hard and requiring a lot of energy)
	$X_{3.2}$	Pulse (pounding and a lot of energy)
	$X_{3.3}$	Energy expenditure (easily hungry, and a lot of energy)
	$X_{3.4}$	stress
	$X_{3.5}$	Body temperature (sweating and fresh air environment)
	$X_{3.6}$	Ergonomics (adjustment of work tasks to body conditions)
	$X_{3.7}$	Mental
OHS Implementation (X_4)	$X_{4.1}$	Provision of Personal Protective Equipment (PPE)
	$X_{4.2}$	Increasing awareness of K3
	$X_{4.3}$	There is a work accident
Leadership (X_5)	$X_{5.1}$	Labor supervision
	$X_{5.2}$	Misunderstanding between workers and supervisors
	$X_{5.3}$	Meetings with workers
Working Time (X_6)	$X_{6.1}$	Worked a full week
	$X_{6.2}$	Work overtime
Weather (X_7)	$X_{7.1}$	Temperature
	$X_{7.2}$	Wind
	$X_{7.3}$	Rain
Workforce Quality (X_8)	$X_{8.1}$	Experience
	$X_{8.2}$	Skills
	$X_{8.3}$	Age of workers

This study also utilized one dependent variable (Y) [13][14]. These variables shows in Table 2.

Table 2. Dependent variable.

Variable	Indicator	
Construction Project Success (Y)	Y_1	Competitive costs
	Y_2	Quality Suistability
	Y_3	Punctuality

The scheme between the independent variable (X) and the dependent variable (Y) can be seen in Figure 1.

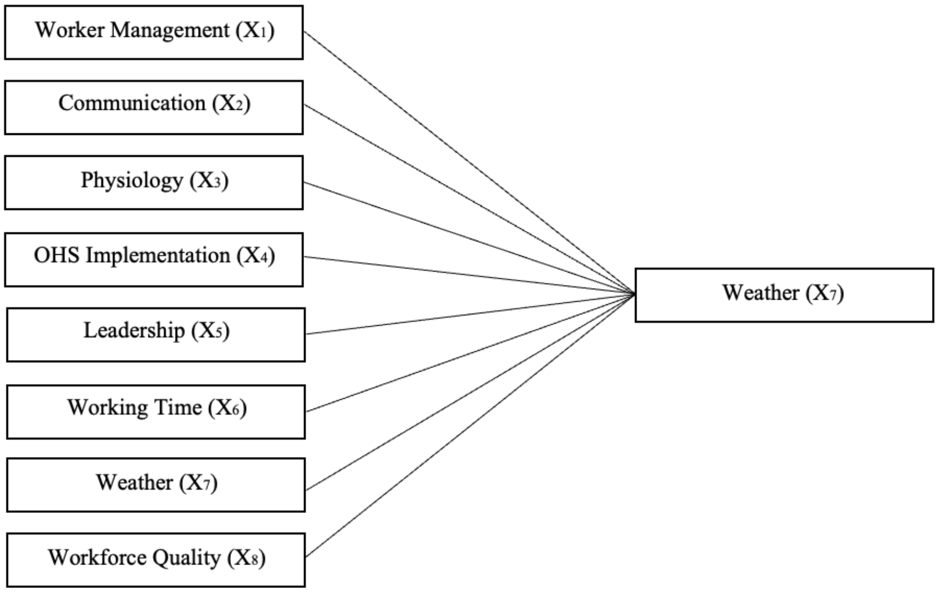

Fig. 1. Schematic of variable X and variable Y.

Data gathering involved the distribution of closed questionnaires to the participants. These questionnaires consist of statements provided to respondents either in person or through Google Form. The type of questionnaire used is:

- Questionnaire A: This questionnaire contains data on the characteristics of the respondent's description. Questions or statements that will be given include the respondent's name, company name, gender, position, age, and last education.
- Questionnaire B: This questionnaire contains respondents' opinions regarding indicators of the productivity of the construction workforce.
- Questionnaire C: This questionnaire contains respondents' opinions regarding the influence of labor productivity on the success of construction projects.

The questionnaire employs a Likert scale to gauge respondents attitudes and opinions concerning the statements presented by the researchers on the research topic. The assessment using the Likert scale can be seen in Table 3 [12].

TABLE 3. Likert scale rating weight.

Description	Value
Strongly Agree	5
Agree	4
Slightly Disagree	3
Disagree	2
Totally Disagree	1

Data analysis was conducted using 2 (two) methods, namely descriptive analysis to present the percentage and frequency of respondents characteristics and multiple linear regression analysis to assess the impact of labor productivity on the success of construction projects [12]. In multiple linear regression analysis, it is required to use an interval scale as a measurement scale. Based on this, a questionnaire scale that uses an ordinal scale needs to be transformed into an interval scale using the Interval Succession Method (MSI).

The utilization of multiple linear regression analysis aims to assess how several independent variables impact a dependent variable. In this study, multiple linear regression analysis was performed to determine the effect of labor productivity on the success of construction projects. Equation 1 displays the multiple linear regression model.

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_{10} X_{10} \quad (1)$$

Description :
Y_i = Construction project success variable (Y)
$X_1, X_2, \ldots, X_{10}$ = Variables - labor productivity variables (X)
$\beta_0, \beta_1, \ldots, \beta_{10}$ = The population coefficient whose value is unknown.

Prior to conducting multiple linear regression analysis, it is essential to satisfy three classic assumption tests [15]. These tests include the assessment of normality, checking for multicollinearity, and examining for heteroscedasticity.

The normality test is conducted to assess whether the distribution of residual values is normal [16]. One method for testing normality is through the One-Sample Kolmogorov-Smirnov test, which employs the following testing criteria:

- If the Sig. value is > 0.05, then the data is normally distributed
- If the Sig. <0.05, then the data is not normally distributed

Multicollinearity is a situation where there is a strong or near-perfect linear relationship among independent variables in a regression model. Multicollinearity is said to exist in a regression model when there is a perfect linear combination of some or all of the independent variables. Signs of multicollinearity can be detected by evaluating the Variance Inflation Factor (VIF) and tolerance. If the VIF value is below 10 and the tolerance is above 0.1, it is determined that multicollinearity is not a factor [16].

Heteroscedasticity is a situation where the variance of the residuals varies unevenly across all observations within the regression model. The purpose of the heteroscedasticity test is to assess the variation in the residuals' variance from one observation to another in the regression model [17]. If the variance is constant, it is referred to as homoscedasticity, whereas if it varies, it is considered heteroscedasticity.

In this study, the Spearman's Rho test method is employed to examine heteroscedasticity. This test involves correlating the independent variables with their corresponding residuals as per specific criteria [18]:

- If the value of Sig. > 0.05, then there is no heteroscedasticity
- If the Sig. < 0.05, then there is heteroscedasticity

If the classical assumption test has been fulfilled, then the data is valid and can be continued for the next step, namely the multiple linear tests. The multiple linear tests aim to measure how much influence labor productivity variables exert as independent variables on the success of construction projects as the dependent variable, called the coefficient of determination (R2). This coefficient elucidates the overall extent to which the independent variable can account for the variation in the dependent variable. It should be noted that when the R-squared (R2) value is close to 1, it indicates that the ability of the independent variables to significantly explain the variations in the dependent variable is more precise. On the contrary, when the value is closer to 0, it signifies that the ability of the independent variable to impact the dependent variable is more restricted.

In this study, a simultaneous hypothesis test (F test) was carried out with a significance level of error used was 0.05. So, the hypothesis decision-making is based on the provisions. The F-test equation can be seen in equation 2.

$$f = \frac{R^2/K}{(1-R^2)/(n-K-1)} \quad (2)$$

Description :
f = f value
R^2 = Multiple correlation coefficient
K = Number of independent variables
N = Number of sample members

F test steps can be seen as follows:

Develop a null hypothesis, namely $H_0 \rightarrow \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = \beta_8 = \beta_9 = \beta_{10} = 0.$ Develop a null hypothesis. This means there is no influence between worker management, communication, technical, physiology, OSH implementation, work environment, leadership, working time, weather, and workforce quality on the success of construction projects simultaneously.

Develop alternative hypotheses, namely $H_a \rightarrow \beta_1 \neq 0;\ \beta_2 \neq 0;\ \beta_3 \neq 0;\ \beta_4 \neq 0;\ \beta_5 \neq 0;\ \beta_6 \neq 0;\ \beta_7 \neq 0;\ \beta_8 \neq 0;\ \beta_9 \neq 0;\ \beta_{10} \neq 0.$ This means that there is an influence between worker management, communication, technical, physiology, OHS implementation, work environment, leadership, working time, weather, and workforce quality on the success of construction projects simultaneously.

Reject or accept the hypothesis. If value $F_{count} > F_{table}$ and Sig. value < 0,05, then H_a is accepted, and H_0 is rejected. This shows that the independent variable influences the dependent variable simultaneously. If value $F_{count} < F_{table}$ and Sig. Value > 0,05, then H_0 is accepted, and H_a is rejected. This shows that the independent variable does not influence the dependent variable simultaneously.

3 Result

The questionnaires were distributed directly and via Google Form with a total of 30 project managers from contractor companies in Banda Aceh City as respondents. Respondent characteristics include age, gender, last education, company qualifications, and experience in the construction sector. The results of the recapitulation of the characteristics of the respondents can be seen in Table 4.

TABLE 4. Characteristics of respondents.

No	Description	Total	Persentage
1	**Age**		
	21 - 30 years	5	17%
	31 - 40 years	11	37%
	41 - 50 years	9	30%
	> 50 years	5	17%
Total		30	100%
2	**Sex**		
	Male	30	100%
	Female	0	0%
Total		30	100%

No	Description	Total	Persentage
3	**Tertiary Education**		
	S1/D4	30	100%
	S2	0	0%
	S3	0	0%
Total		30	100%
4	**Qualification**		
	B	10	33%
	M	14	47%
	K	6	20%
Total		30	100%
5	**Experience in Construction**		
	3 - 5 years	3	10%
	6 - 8 years	5	17%
	> 8 years	22	73%
Total		30	100%

The respondents were predominantly in two age groups: 31-40 years and 41-50 years, accounting for 37% and 30%, respectively. It's noteworthy that all respondents (100%) were male. Additionally, all respondents (100%) held a bachelor's degree as their highest level of education. Regarding company qualifications, the majority of respondents came from medium-qualified companies, with a percentage exceeding 50%. These respondents also had over 8 years of construction experience.

In this study, classical assumption tests were conducted to evaluate normality, multicollinearity, and heteroscedasticity. Before proceeding with multiple linear regression analysis, the classical assumption test must be fulfilled.

1. Normality Test

The normality test aims to test whether the residual variables are normally distributed in the regression model. Based on Table 5, the results of the Kolmogorov Smirnov One Sample normality test show that the value of Sig. 0.085 > 0.05. This value indicates that the data is normally distributed and that the data is feasible for multiple linear regression analysis.

TABLE 5. Normality test results.

One-Sample Kolmogorov-Smirnov Test		
		Unstandardized Residual
N		30
Normal Parameters[a,b]	Mean	0,0000000
	Std. Deviation	0,14791474
Most Extreme Differences	Absolute	0,150
	Positive	0,133
	Negative	-0,150
Test Statistic		0,150
Asymp. Sig. (2-tailed)		0,085[c]

2. Multicollinearity test

The multicollinearity test aims to test the correlation between independent variables in the regression model. Table 6 shows that the tolerance values for all variables are > 0.10, and the VIF values for all variables are < 10. Based on this, it can be concluded that the multicollinearity test in the regression model does not occur correlation between variables or multicollinearity does not occur.

TABLE 6. Multicollinearity test results.

Variables	*Collinearity Statistics*		Description
	Tolerance	*VIF*	
X_1	0.144	6.951	No multicollinearity
X_2	0.371	2.692	
X_3	0.239	4.178	
X_4	0.433	2.312	
X_5	0.106	9.402	
X_6	0.427	2.341	
X_7	0.151	6.611	
X_8	0.110	9.098	

3. Heteroscedasticity test

The heteroscedasticity test aims to test the variance of the residuals from one observation to another in the regression model. Based on the results of the Spearman's rho test in Table 7, it was found that all variables have Sig values. >0.05. Thus it can be concluded that there is no heteroscedasticity problem.

TABLE 7. Heteroscedasticity test results.

Variables	Correlation Coefficient	Sig > 0,05	Description
X_1	-0.007	0.971	No Heteroscedasticity
X_2	0.025	0.894	
X_3	0.024	0.902	
X_4	-0.074	0.696	
X_5	-0.059	0.756	
X_6	0.066	0.730	
X_7	-0.016	0.931	
X_8	-0.022	0.907	

Furthermore, multiple linear regression analysis tests were carried out to determine the effect of labor productivity on the success of construction projects in Banda Aceh City. The results of the classical assumption test indicate that the regression analysis in this study was suitable for use. This is confirmed by the normality test, which shows that the data follows a normal distribution. Additionally, there is no evidence of multicollinearity, and heteroscedasticity is not observed. Thus, research can be continued with multiple linear regression analysis. The Sig value determines the influence of the variable. < 0.05; effect simultaneously through the F test; partial effect through the t-test and the percentage of influence obtained from the coefficient of determination.

A positive value indicates that any change in one of the independent variables will change the same direction for the dependent variable. Meanwhile, a negative value indicates that any change in one of the independent variables will result in a change in the opposite direction for the dependent variable.

The results of the multiple linear regression model in Table 8 indicate that the constant value (a) is negative, specifically -0.130. This implies that the project's success will decrease when all the independent variables are set to zero (0) units. The table further illustrates that several variables have a discernible impact on the success of the project. Specifically, worker management (X_1), physiology (X_3), working time (X_6), and labor quality (X_8) have a positive influence on the success of the project. On the other hand, the variables communication (X_2), OHS implementation (X_4), leadership (X_5), and weather (X_7) have a negative influence on the success of construction projects.

TABLE 8. Multiple linear regression test results (Y).

Variable	*Unstandardized Coefficients*		*Standardized Coefficients*	t	Sig.
	B	Std. Error	Beta		
(*Constant*)	-0.130	0.099		-1.313	0.203
X_1	0.403	0.150	0.392	2.685	0.014
X_2	-0.220	0.108	-0.184	-2.027	0.056
X_3	0.623	0.125	0.563	4.975	0.000
X_4	-0.035	0.121	-0.024	-0.289	0.775
X_5	-0.199	0.163	-0.206	-1.214	0.238
X_6	0.175	0.093	0.160	1.889	0.073
X_7	-0.690	0.181	-0.544	-3.821	0.001
X_8	0.947	0.208	0.762	4.561	0.000

Based on Table 9, the regression model is obtained:

$$\boldsymbol{Y = -0.130 + 0.403X_1 - 0.220X_2 + 0.623X_3 - 0.035X_4 - 0.199X_5 + 0.715X_6 - 0.690X_7 + 0.947X_8.}$$

The F test is used to determine the effect of the independent variables on the dependent variable simultaneously, with the test criteria being if the value $F_{count} > F_{table}$ and Sig. value < 0.05, then the independent variable influences the dependent variable simultaneously. If value $F_{count} < F_{table}$ and Sig. value > 0.05, the independent variable does not influence the dependent variable simultaneously. Mark F_{table} was obtained from the distribution of F_{table} values, namely 2.420. Meanwhile, the F_{count} obtained from the results of multiple linear regression can be seen in Table 9.

TABLE 9. F test results.

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9.223	8	1.153	38.159	0.000[b]
	Residual	0.634	21	0.030		
	Total	9.858	29			

According to Table 9, it was evident that the Fcount value was 38.159 > 2.420 with a Sig. 0.000 < 0.05. This signifies that the employee management variable (X_1), communication (X_2), physiology (X_3), OHS implementation (X_4), leadership (X_5), working time (X_6), weather (X_7), and the quality of labor (X_8) influences the success of the project (Y) simultaneously.

The coefficient of determination gauges the combined impact of independent variables on the dependent variable. The R-squared (R2) value typically ranges from 0 to 1, with values closer to 1 indicating a more precise influence of the independent variables on the dependent variable.s The test results for the coefficient of determination can be seen in Table 10.

TABLE 10. Coefficient of determination test results (R^2).

No.	Influence of Variables	*Adjusted R Square*	Persentase
1	X – Y	0.911	91.1%

According to Table 10, The coefficient of determination (R-squared or R2) is calculated from the adjusted R-squared value, which in this case is 0.911. This means that labor productivity (X) can account for approximately 91.1% of the variation in project success (Y). The remaining 0.9% of the variation is attributed to factors not considered in this study.

The analysis results obtained the magnitude of the influence of labor productivity with a coefficient of determination (R2) of 0.911. This shows that project success (Y) can be explained by labor productivity (X) of 91.1% simultaneously, while other variables outside the variables of this study explain the remaining 0.9%. There is a positive or significant influence between the human resource aspect variable (X) on the company performance variable (Y) [19].

The results of simultaneous hypothesis testing or the F test can be seen in Table 10, namely the Fcount value is 38.159 > 2.420 with a Sig. 0.000 < 0.05. This shows that the variables of worker management, communication, physiology, OHS implementation, leadership, working time, weather, and quality of labor influence the success of the project simultaneously. In other words, the null hypothesis (H0) is rejected, and the alternative hypothesis (Ha) is accepted. This suggests that these independent variables have a significant simultaneous impact on the success of the project.

4 Conclusion

This study aims to analyze how far the influence exerted by labor productivity on the success of construction projects is. A successful project should have a valuable asset, namely a good workforce that can produce high productivity under the auspices of the project manager. Productivity is the dominant aspect that drives the effective use of resources in the construction industry [8]. Factors directly related to labor significantly influence project success [7]. This study has shown that labor productivity, represented by 8 (eight) variables, namely worker management, communication, physiology, OHS implementation, leadership, working time, weather, and workforce quality, collectively influences the success of construction projects by 91.1%.

In conclusion, labor productivity has been demonstrated to have a significant impact on the success of construction projects. Therefore, effective management and efforts to optimize labor productivity are crucial for enhancing the success of construction projects.

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