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ANALYSIS OF THE INFLUENCE OF LABOR, MATERIALS, AND SITE CHARACTERISTICS ON INDIVIDUAL PERFORMANCE AND TIME PERFORMANCE IN THE IMPLEMENTATION OF STEEL FRAME BRIDGE PROJECTS

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ABSTRACT

Understanding the impact of project time performance on individual performance is key to demonstrating reliability, commitment, and valuable time management skills. This study aims to To find out, obtain, and analyze the influence of labor, material and site characteristics on individual performance of steel bridge construction projects, find out get, and analyze the influence of labor on Individual performance, find out get, and analyze the influence of material on Individual performance, find out get, and analyze the influence of site characteristics on Individual performance, find out, obtain, and analyze the influence of individual performance on time performance. find out, obtain, and analyze the control of labor factors, site characteristics, and materials on individual performance and time performance of steel bridge construction projects. The type of research used is quantitative research, with a sample size of 100 people consisting of contractors, consultants and suppliers, with regression analysis assisted by spss 21 software and path analysis with SmartPLS 4 software. The results of the study of labor, materials, and characteristics of the place together have a significant effect on individual performance in bridge construction projects, labor has a positive and significant effect on individual performance in bridge construction projects, materials have a positive and significant effect on individual performance in bridge construction projects, characteristics of the place have a positive and significant effect on individual performance in bridge construction projects, individual performance has a positive and significant effect on time performance in bridge construction projects and Control of labor factors, characteristics of the place, and materials on individual performance and time performance of steel bridge construction projects with special attention should be given to material and labor management, while still considering the characteristics of the place as a supporting factor.

KEYWORDS *Labor, materials, characteristics of the place, individual performance, time performance*

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INTRODUCTION

Global trends in bridge construction show significant innovations and developments. The main *trends* developed in bridge construction in the world are using advanced technology and digitization, using robots and automation, Robots are used for repetitive and dangerous tasks, increasing efficiency and safety in bridge construction. Then the trend is happening by using environmentally friendly materials, focusing on the use of recycled and environmentally friendly materials and materials to reduce the environmental impact of bridge construction corrosion-resistant with innovations including the use of reinforced polymers and stainless that are steel more durable and require less maintenance.

The schemes Indonesian government uses various innovative financing schemes such as PPP to attract private investment in bridge infrastructure developmentThese allow to projects be financed, built, and maintained by private parties with a return on investment through service availability payments over a specified period. trend This demonstrates the Indonesian government's commitment in improving bridge infrastructure to support economic growth, increase accessibility, and reduce congestion in major cities. development This does not only focus on big cities but also on remote and less developed areas, so that the benefits can be felt equally by the entire community.

Based on PUPR data 2023 the number of bridges in Indonesia can be seen in the following *histogram* image:

The Ministry of PUPR continues the bridge construction and revitalization program. Until 2023, there are 19,377 units of National Bridges with a total length of 562,213.79m. The province with with the highest number of bridges is East Java Province 1,037 units and a total bridge length of 36,417.62m.

The government issued regulations on the construction of bridges to be built in Indonesia. These regulations and projects reflect the government's efforts to ensure that the construction of steel in Indonesia frame bridges is not only safe and compliant with technical standards, but also sustainable and beneficial to society at large. Regulation of the Minister of Public and Works Housing (Permen PUPR) No. 10 of 2022: This regulation regulates the implementation of bridge and road tunnel safety. Some of the bridge criteria included in this regulation are bridges with a span of at least 100 meters, a total at least 3,000 meters, length of arch bridges with a span of at least 60 meters, and bridges with a pillar height of more than 40 meters.

In the fast-paced bridge building work environment, the ability to manage time effectively and complete work within the specified timeframe is critical to individual success. Understanding the impact of project time performance on individual performance is key to demonstrating reliability, commitment and valuable time management skills.

Individual performance is significantly influenced by effective project time management. Meeting deadlines and completing tasks on schedule demonstrates reliability and commitment, as well as strong time management skills, which are highly valued in professional environments (Larsen et al., 2017). Prioritizing tasks and setting realistic deadlines help individuals stay focused and contribute to overall project success, while also enhancing their reputation as dependable team members.

Moreover, individual performance is closely linked to human resource management and the adoption of construction technology. Training in tools such as Building Information Modeling (BIM), drones, robotics, and project management software is essential to improving efficiency and reducing human error. HR management should prioritize continuous training, the integration of new technologies, and recruitment of skilled professionals. Self-evaluation of time use also helps individuals identify areas for improvement and fosters personal development (Kamdjoug, 2023).

Other factors that impact individual performance include workforce support, material selection, and workplace design. A well-staffed and competent team can improve productivity through better workload distribution and collaboration. The choice of construction materials, such as lightweight and easy-to-use options, can also enhance efficiency. Additionally, a well-organized and ergonomic workspace minimizes wasted time and improves task execution. These combined factors enable individuals to manage their time effectively and perform their roles with greater precision and productivity.

Based on the above phenomenon, the authors are interested in researching with the title analysis of the influence of labor, material, and place characteristics on individual performance and time performance on the implementation of steel frame bridge projects.

The purpose of this study is to determine, obtain, and analyze the effect of labor, material and place characteristics on the individual performance of steel bridge construction projects. While the benefit of this research is that one of them can be used as a reference for stakeholders to make policies so that projects run on time by paying attention to time performance factors, especially labor, material and place characteristics.

RESEARCH METHOD

This research employs a quantitative approach using survey methods to analyze the influence of labor productivity, material usage, and site characteristics on individual and time performance in steel frame bridge construction projects on the island of Java. The study involves a population of 133 stakeholders, including contractors, consultants, and suppliers across five bridge projects. The sample size was determined using Slovin's formula at a 5% margin of error, resulting in 100 respondents. Data collection was carried out through questionnaires (primary data) and supported by literature reviews and previous research (secondary data). Multiple regression analysis and Structural Equation Modeling (SEM) using the Partial Least Square (PLS) method were applied to examine the relationship between variables and test hypotheses.

To assess the impact of each independent variable (labor, materials, and site characteristics) on individual performance (Y1) and time performance (Y2), this study used both partial (t-test) and simultaneous (F-test) statistical tests. The t-test determines the partial effect of each variable on Y, while the F-test evaluates the combined effect of all independent variables on the dependent variable. The regression equations derived from the analysis are used to explain how changes in labor, materials, and site factors influence performance outcomes. SEM-PLS further supports the model by analyzing indicator relationships with their respective latent constructs, aiming for a high total variance to validate the proposed causal model (Rahmati, Sa'adah & Aprillia, 2020; Ghodang & Hantono, 2020; Ghozali, 2018; Sugiyono, 2019).

RESULT AND DISCUSSION

Data Analysis Results

Analysis Requirement Test

The simultaneous test is carried out to test the exogenous variables together on the endogenous, variablesbefore the simultaneous test is carried out, first the analysis requirements are tested with normality, multicolonierity and heterocodicity tests as follows:

1. Normality Test

The normality test aims to determine whether the data collected is normally distributed or not test. The normality was carried out using the Kolmogorov-smirnov test. The results are presented in Table 1 below:

Table 1. Test ResultsNormality

One-Sample Kolmogorov-Smirnov Test		
		Unstandardized Residual
N		100
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	3.82462645
Most Extreme Differences	Absolute	.070
	Positive	.062
	Negative	-.070
Kolmogorov-Smirnov Z		.699
Asymp. Sig. (2-tailed)		.713
a. Test distribution is Normal.		
b. Calculated from data.		

Based on the table above, the Asymp sig. value of 0.713> 0.05, it can be concluded that the research data is normally and distributed research can continue.

2. Multicolonierity Test

To determine whether there are symptoms of multicollinearity, among other things, the co-linearity effect can be used. Symptoms of multicollinearity can be known if among the independent variables there is a strong or near perfect correlation or the *Variance Inflation Factor* (VIF) value is less than 10 and the *Tolerance* value is more than 0.1. The multicollinearity test results are presented in the following table:

Table 2. Multicolonierity Test Results

Coefficients[a]

Model		Collinearity Statistics	
		Tolerance	VIF
1	Labor	.819	1.221
	Materials	.633	1.579
	Venue Characteristics	.578	1.730

a. Dependent Variable: Performance Individual

From the results of table 2 above, the VIF value of each variable is less than 10 while the *Tolerance* value of each variable is greater than 0.1, so it can be concluded that there are no symptoms of multicollinearity.

3. Heteroscedasticity Test

The P-P plots test is one way to test heteroscedasticity in the variable data in the study by regressing the natural logarithm value of the squared residual. The P-P plot test results are presented in the following figure:

Figure 1. Test ResultsHeterocodesity

Based on Figure 1 above, the data points spread above and below or around the number 0, the distribution of data points is not patterned, thus it can be concluded that there is no heteroscedasticity problem, so that a good and ideal regression model can be fulfilled.

4. F test

The F test is used to prove whether labor, materials and site characteristics together have a significant effect or not on the individual performance of bridge construction projects.

Table 3. F Test Results

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1632.841	3	544.280	36.081	.000[b]
	Residuals	1448.149	96	15.085		
	Total	3080.990	99			
a. Dependent Variable: PerformanceIndividual						
b. Predictors: (Constant), Site Characteristics, Labor, Materials						

From the calculation results as shown in table 3 above, the significance value is 0.000 <0.05 or F count = 36.081> F table = 2.311. Thus labor, site characteristics and materials together have a significant effect on the individual performance of steel bridge construction projects. This means that hypothesis one (H1) which states: there is an influence between labor, place characteristics and materials on individual performance, is accepted.

5. T Test

To test whether there is an influence between variables, it is done by comparing the tcount with the ttable. The results of the t test using the SPSS application version l21 are presented as follows:

Table 4. Results of the t-test

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	11.852	2.991		3.962	.000
	Labor	.259	.091	.219	2.834	.006
	Materials	.287	.084	.300	3.416	.001
	Venue Characteristics	.245	.059	.379	4.123	.000
a. Dependent Variable: PerformanceIndividual						

The results of the analysis show that labor, materials, and site characteristics have a positive and significant influence on individual performance in construction projects. This is evidenced by the calculated t value of each variable which is greater than the t table value at $\alpha = 0.05$ (1.986), namely: labor (3.834 > 1.986), materials (3.416 > 1.986), and site characteristics (4.123 > 1.986). Thus, the three variables significantly influenced the improvement of individual performance in project implementation.

6. Regression Equation

The results of multiple regression analysis show that labor (X_1), materials (X_2), and place characteristics (X_3) together have a positive effect on individual performance (Y_1), with the regression equation: $\hat{Y}_1 = 11.852 + 0.259X_1 + 0.287X_2 + 0.245X_3$. This indicates that an increase in each of the X variables tends to increase individual performance in bridge construction projects. Meanwhile, simple regression analysis shows that individual performance (Y_1) also positively affects time performance (Y_2), with the equation: $\hat{Y}_2 = 2.388 + 0.489Y_1$, which means any increase in individual performance will increase project time performance.

Outer Model Test Results

The outer model test with smart PLS, namely the Validity Test and Test, Measurement Model Reliability is obtained as follows:

Validity Test

1. Convergent Validity

Convergent validity of the measurement model with reflective indicators is assessed by examining the correlation between item scores and construct scores, calculated using PLS. The loading factor value for each construct is used to identify unobserved variables, with a loading factor greater than 0.7 considered valid for confirmatory research, and a value between 0.6-0.7 acceptable for explanatory research. The Average Variance Extracted (AVE) value must be greater than 0.5, and for early-stage research, a loading factor between 0.5-0.6 is considered sufficient (Chin in Ghozali & Latan, 2015). The results show that all indicators meet the criteria, as demonstrated in Figure 4.5, with the loading factor values indicating the validity of each indicator for the variables of labor, material, place characteristics, individual performance, and time performance.

The second test for convergent validity, based on the Average Variance Extracted (AVE), shows that all variables meet the required threshold of AVE > 0.5, indicating good convergent validity. According to Table 4.15, the AVE values for labor (0.697), material (0.674), place characteristics (0.702), individual performance (0.551), and time performance (0.650) are all above 0.5, confirming that all latent variables in the model meet the criteria for convergent validity. This indicates that the measurement model is valid and reliable for further analysis.

2. Discriminant Validity

Discriminant validity assesses how distinct a construct is from other constructs, ensuring that a construct captures unique phenomena not represented by others in the model. This validity is tested through cross-loadings and the square root of the AVE. The results in Table 4.16 show that the correlation between each indicator and its corresponding construct is higher than with other constructs, confirming good discriminant validity. For example, the cross-loading for labor (X1.1) is 0.895, which is higher than its correlations with other constructs, indicating that the labor variable is distinct from the others.

Further analysis of discriminant validity using the Fornell-Lacker criterion also confirms its validity. According to Table 4.17, the square root of the AVE for each latent variable—such as labor (0.835), material (0.821), place characteristics (0.838), individual performance (0.743), and time performance (0.806)—is greater than the correlation values with other variables, meeting the required criteria. This shows that each variable is sufficiently distinct from the others in the model.

The HTMT (Heterotrait-Monotrait Ratio of Correlation) method, shown in Table 4.18, further validates the discriminant validity of the model. The HTMT values for all variable pairs are below 0.90, confirming that the variables maintain good discriminant validity. This approach is more sensitive in detecting discriminant validity compared to the Fornell-Lacker and cross-loadings methods, making it a reliable tool for assessing the uniqueness of constructs in the model.

Reliability Test

Test Measuring the reliability of a construct with reflexive items can be done in two ways, namely with *Cronbach's Alpha* and *Composite Reliability*. however, the use of *Cronbach's Alpha* to test the testing reliability of the construct will provide a lower value (*under estimate*) so it is more advisable to use *Composite Reliability* in the reliability of a construct. *rule of thumb* The that is is that the usually used to assess construct reliability *Composite Reliability* value must be greater than 0.7 for comfirmatory research and a value of 0.6-0.7 is still acceptable for *explonatory* research (Ghozali & Latan, 2015). The following are the output results of *Composite Reliability* and *Cronbach's Alpha*:

Table 5. *Composite Reliability* and *Cronbach's Alpha*

Variable	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)
Labor (X1)	0.781	0.788	0.873
Material (X2)	0.879	0.883	0.912
Place characteristics (X3)	0.914	0.923	0.934
Individual performance (Y1)	0.797	0.801	0.860
Time Performance (Y2)	0.731	0.761	0.847

Source: 2024 (processing results *SmartPLS 4 output*)

The results of construct reliability testing as presented in table 4.19 show the *Composite Reliability* and *Cronbachs Alpha* values of all latent variables> 0.70. So that all manifest variables in measuring latent variables in the estimated model are declared reliable.

Structural Model Analysis (*Inner Model*)

In the evaluation stage, the structural model has the aim of being able to predict the relationship between latent constructs. The test results on the structural model can be used to see whether the empirical data in the study support the relationship of the hypothesis development made. The existence of a hypothesized relationship in research can be seen from the relationship between exogenous latent constructs and endogenous latent constructs and from exogenous latent constructs with other exogenous latent constructs, so that by testing the structural model, researchers can see whether based on empirical data the hypotheses made in this study are accepted or rejected.

Endogenous in ValueConstruct Variance *R-Square*

In seeing the predictive power of the structural model, it & Latan, 2015). Henseler et al (2009) can use the R^2 value of each endogenous (construct Ghozali where the R square is 0.67 (value high), 0.33 (moderate), 0.19 (weak); implies a substantive influence (high), moderate and weak, so that it can be used to measure the variance of changes in exogenous constructs on endogenous constructs. This means that the variance of changes in endogenous (constructs coefficient of determination) that can be explained by exogenous constructs can be seen in table 6 as follows:

Table 6. Structural Model Evaluation

Variables	R-square	Adjusted R-square	Limit	Description
Individual performance (Y1)	0.530	0.516	0,33-0,67	Moderate
Time Performance (Y3)	0.485	0.480	0,33-0,67	Moderate

Source: 2024 (processing results *SmartPLS 4 output*)

The test results displayed in table 6 show the R^2 value of individual performance (Y1) of 0.530 between 0.33-0.67 is classified as moderate, these results explain that 53% of individual performance is influenced by labor, material and place characteristics while the remaining 47% is influenced by other that are factors not observed in this study. and for the second R^2 value, namely time performance is is 0.485 between 0.33-0.67 classified as moderate, these results explain that 48.5% of time performance influenced by labor, materials, place characteristics and individual performance while 51.5% is influenced by other factors not observed in this study.

Formative Construct Test

Formative constructs can be measured in two ways, namely reliability indicators with a VIF score value of less than 5 (Sarwono, 2015). This reliability indicator score can be seen from the results of measuring the model with the PLS algorithm outer weight section. The VIF score is also obtained from measuring the model using the PLS algorithm. Formative construct test results.

Table 7. Results*Colinearity Indicator* Measurement

Indicator	VIF
X1.1	2.111
X1.2	1.685
X1.3	1.520
X2.1	2.056
X2.2	2.103
X2.3	2.311
X2.4	2.950
X2.5	1.667
X3.1	2.148
X3.2	1.838
X3.3	3.323
X3.4	3.896
X3.5	3.398
X3.6	3.615
Y1.1	1.552
Y1.2	1.612

Y1.3	1.664
Y1.4	1.709
Y1.5	1.780
Y2.1	1.311
Y2.2	1.642
Y2.3	1.537

The table 7 above state that these indicators are in a safe score because all indicators are less than 5 (Hair, 2019). Variables in other wordsthere is no multicollinearity between the indicators that make up the risk perception and benefit perception. It can be concluded that according to the formative construct test, the five variables are valid and reliable.

Testing the Path Analysis Equation (Path Coefficient)

Before hypothesis testing, a structural model equation can be made based on the statistical test results presented in Figure 2:

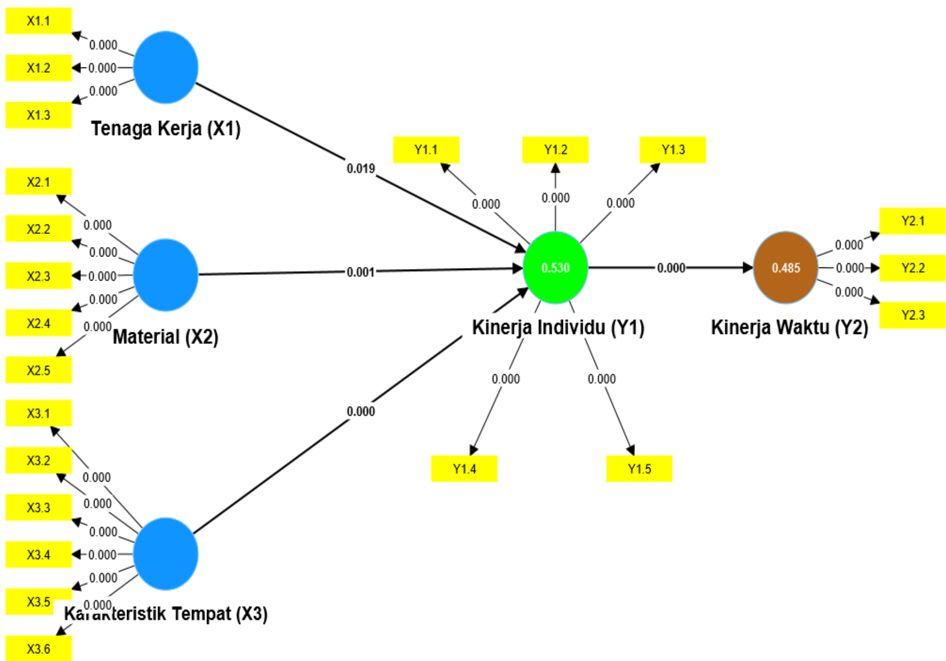

Figure 2. Path Diagram Value *Path Coefficient* (*Bootstrapping*)

Model: Y1 = 0.229X1 + 0.297X2 + 0.376X3+ ζ1........ (4.1)

Path Cofficient is to measure how much influence one variable has on another variable which can be seen through a significant level. The results of model testing show that labor variables (X1), materials (X2) and place characteristics (X3) have a effect significant positive on individual performance (Y1).

Hypothesis Test

In this study, the results of the *path coefficient* test and testing hypothesis that have been carried out by researchers will be explained.

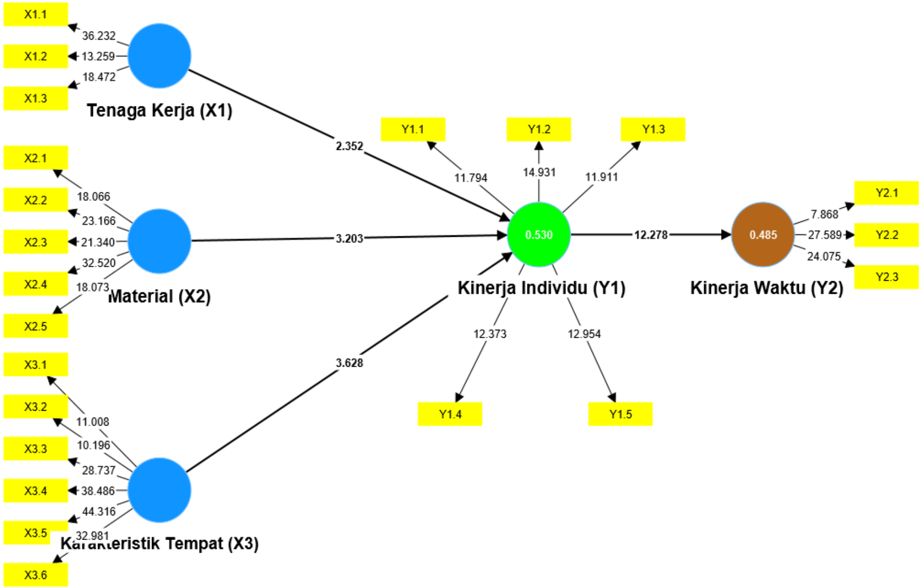

Figure 3. T-test Results

In the figure above is the result of boostrapping the calculation of the research hypothesis test, the numbers in the figure are the values of the T test between variables and variables with indicators, for more details in the table below:

Table 8. Test Hypothesis

Influence between	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	**Description**
Direct Influence						
Labor (X1) -> Performance Individual (Y1)	0.229	0.233	0.097	2.352	0.019	Influential Significant
Material (X2) -> Performance Individual (Y1)	0.297	0.311	0.093	3.203	0.001	Significant Effect
Place Characteristics (X3) -> Performance Individual (Y1)	0.376	0.370	0.104	3.628	0.000	Significant Effect
Individual Performance (Y1) -> Time Performance (Y2)	0.696	0.706	0.057	12.278	0.000	Significant Effect
Indirect Effect						
Labor (X1) -> Performance Individual (Y1) -> Time Performance (Y2)	0.159	0.164	0.068	2.350	0.019	Significantly Affected

Material (X2) -> Performance Individual (Y1) -> Time Performance (Y2)	0.207	0.218	0.064	3.212	0.001	Significantly Affected
Place Characteristics (X3) -> Performance Individual (Y1) -> Time Performance (Y2)	0.262	0.263	0.082	3.202	0.001	Significantly Affected

Source: 2024 (processing results *SmartPLS 4 output*)

The test criteria state that if the t-statistic value> t-table (1.96) or the p-value < significant alpha 5% or 0.05, it is stated that there is a significant effect of exogenous variables on endogenous , (Hair, 2019). variables

a. **Second Hypothesis (H2): labor has a significant effect on individual performance**

The test results displayed in table 4.22 show that the value of *path coefficient* labor on individual performance is 0.229 then the *t-statistic* value> t-table (2.352> 1.96) and at *p-value* < significance level (0.019 < 0.05), it can be concluded that labor has a positive and significant effect on individual performance thus **H2 is accepted.**

b. **Third Hypothesis (H3): materials have a effect significant on individual performance**

The test results displayed in table 4.22 show that the *path coefficient* value of materials on individual performance is 0.297 then the *t-statistic* value> t-table (3.203> 1.96) and at the *p-value* < significance level (0.000 <0.05), it can be concluded that materials have effect a positive and significant on individual performance, thus **H3 is accepted**.

c. **Fourth Hypothesis (H4): place characteristics have a effect significant on individual performance**

The test results displayed in table 4.22 show that the *path coefficient* value of place characteristics on individual performance is 0.376 then the *t-statistic* value> t-table (3.628> 1.96) and at the *p-value* < significance level (0.000 <0.05), it can be concluded that place characteristics have effect a positive and significant on individual performance, thus **H4 is accepted.**

d. **Fifth Hypothesis (H5): individual performance has a significant effect on time performance.**

The test results displayed in table 4.22 show that the value of *path coefficient* individual performance on time performance is 0.696 then the *t-statistic* value> t-table (12.278> 1.96) and at the *p-value* < significance level (0.000 < 0.05), it can be concluded that individual performance has a positive and significant effect on time performance thus **H5 is accepted.**

Influence of variables

F-Square testing is carried out to determine how much the relative influence of the independent latent variable on the dependent latent variable is. According to

Hair et al (2021) the criteria for measuring F-Square are as follows: 1) The value of f^2 0.35 indicates that the independent latent variable on the dependent latent variable has a great influence. 2) The value of f^2 0.15 indicates that between the independent latent variables on the dependent latent variable has a medium influence or medium. 3) The value of f^2 0.02 indicates that the independent latent variable on the dependent latent variable has a small influence.

The f square test is how much influence the variables have at the structural level, the calculation results can be found in the following table:

Table 4.23. Test Results of f^2

	Place Characteristics (X3)	Labor (X1)	Material (X2)	Individual Performance (Y1)	Time Performance (Y2)
Labor (X1)				0.092	
Material (X2)				0.119	
Place Characteristics (X3)				0.174	
Individual Performance (Y1)					0.94
Time Performance (Y2)					

Source: 2024 (processing results *SmartPLS 4 output*)

Based on table 4.23, the f square for labor on individual performance is 0.092, which means that the effect of labor on individual performance is in the is medium category, then the f square for materials on individual performance 0.119, which means that the effect of the effect of materials on individual performance is in the is is is medium category, then the f square for place characteristics on on individual performance 0.174, which means that place characteristics individual individual performance performance performance in the medium category. and the f square value for on time is 0.94, which means that the effect of individual performance performance on time in the high category.

Discussion

Labor, materials and site characteristics simultaneously on individual performance of bridge construction projects.

The simultaneous test equation in this study $\boldsymbol{Y_1 = a + b_1X_1 + b_2X_2 + b_3X_3}$ is obtained based on the results of the calculation $\boldsymbol{\widehat{Y_1} = 11,825 + 0,259X_1 + 0,287X_2 + 0,245X_3}$, based on this this equation, positive, the value of the regression equation is there is a shows that if the change in labor (X_1) increases, tendency for individual performance (Y_1) to increaseincreaseincrease increase the , as as wellif the if the material (X_2) changes , on materials, there is a tendency to for individual individual performance performance of the also also and characteristics of the place (X_3) ,bridge construction project will increase, with the greatest influence labor and the smallest place characteristics

The calculation results show that labor, materials, and site characteristics significantly influence individual performance in bridge construction projects, with statistical results showing a significance value of 0.000 (<0.05) and an F count (36.081) greater than the F table (2.311), confirming the hypothesis (H1). These findings align with previous research highlighting that material availability, limited workspaces, weather changes, and equipment maintenance issues affect productivity (Hernandi & Tamtana, 2020), as well as the impact of worker skills, leadership, and work pressure on labor performance (Fahirah et al., 2020). Labor productivity is shaped by various factors such as motivation, experience, and working conditions, while the use of appropriate materials—like fiber composites and pre-stressed concrete—enhances project strength, durability, and efficiency. Likewise, site characteristics, including weather, accessibility, and soil conditions, directly affect project timelines and costs. Therefore, effective management of labor, materials, and site factors is crucial to improving individual performance and ensuring the success of bridge construction projects.

Labor to individual performance of bridge construction projects

The results showed that the value of *path coefficient* labor on individual performance was 0.229 then the *t-statistic* value> t-table (2.352> 1.96) and at the *p-value* < significance level (0.019 < 0.05), it can be concluded that labor has a positive and significant effect on individual performance, the results of this study are in line with the research of Fahirah et al, (2020). The skills and experience of the workforce play a crucial role in determining productivity and work quality in bridge construction projects. A well-trained and experienced labor force can enhance efficiency, minimize errors, and improve final outcomes, with research indicating that skilled local workers significantly boost project productivity. Effective labor management—covering scheduling, task allocation, and supervision—is essential to ensure smooth project execution and optimal use of human resources. Overall, labor has a substantial impact on individual performance, influenced by factors such as motivation, experience, and working conditions, making proper workforce management vital for the timely and efficient completion of construction projects.

Materials affect the individual performance of bridge construction projects

The study found that materials have a positive and significant effect on individual performance in bridge construction projects, with a path coefficient of 0.297, t-statistic of 3.203 (>1.96), and a p-value of 0.000 (<0.05), supporting the findings of Hernandi & Tamtana (2020). Effective material management—including proper selection, timely procurement, and quality supervision—is crucial for ensuring project efficiency, minimizing delays, and maintaining construction quality. Delays in material delivery can disrupt workflows and increase costs, while well-managed materials contribute to project success by enhancing strength, durability, and cost-effectiveness. Thus, material factors play a vital role in improving individual performance and achieving optimal outcomes in bridge construction.

Place characteristics have a effect significant on the individual performance of bridge construction projects

The study revealed that place characteristics have a positive and significant effect on individual performance in bridge construction projects, with a path coefficient of 0.376, a t-statistic of 3.628 (>1.96), and a p-value of 0.000 (<0.05), supporting the findings of Fitri & Ferdian (2019) regarding the impact of work environment conditions on productivity. Site characteristics such as accessibility, weather conditions, and environmental factors greatly influence logistics, material delivery, labor mobilization, and overall work efficiency. Difficult terrain, extreme weather, and unstable soil conditions can lead to delays and reduced worker productivity. Therefore, effective management of these factors is essential to ensure safe, efficient, and timely project completion.

Individual performance has a significant effect on the time performance of the bridge construction project n

Simple regression analysis shows the equation of individual performance on time performance $\widehat{Y_2} = 2,388 + 0,489Y_1$. The results indicate that individual performance has a strong positive and significant effect on time performance in bridge construction projects, with a path coefficient of 0.696, a t-statistic of 12.278 (>1.96), and a p-value of 0.000 (<0.05), supporting the findings of Yanna et al. (2020). This suggests that improvements in individual performance—driven by factors such as productivity, labor management, skills, experience, motivation, and work conditions—directly enhance the project's ability to meet scheduled timelines. Therefore, effective management of these aspects is crucial to ensure that bridge construction projects are completed efficiently and on time.

Control of labor, site characteristics, and material factors on individual performance and time performance of steel bridge construction projects

The simultaneous test equation in this study $Y_1 = a + b_1X_1 + b_2X_2 + b_3X_3$ obtained based on the results of the calculation $\widehat{Y_1} = 11,825 + 0,259X_1 + 0,287X_2 + 0,245X_3$. Based on the regression equation, an increase in labor (X1), materials (X2), and site characteristics (X3) leads to an increase in individual performance (Y1), with labor having the greatest influence and site characteristics the smallest. In steel bridge construction projects, labor, materials, and site characteristics each impact individual and time performance differently. Materials play a crucial role in time performance, where effective management—through timely procurement and minimizing waste—helps reduce delays and enhance efficiency. Labor also significantly affects both individual and time performance, with productivity, skills, and proper management being key contributors. Although site characteristics such as accessibility and weather conditions also affect project outcomes, their impact is comparatively smaller. Therefore, optimizing labor and material management should be prioritized, while still considering site factors to support overall project success.

CONCLUSION

Calculations show that labor, materials, and site characteristics together have a significant influence on individual performance in bridge construction projects. Therefore, to improve individual performance, it is important to ensure the availability of qualified labor, the right materials, and easily accessible site characteristics. These steps support the smooth, efficient, and suitable implementation of the project with the initial plan, so that individual performance in the project can be optimally improved.

More specifically, labor has a major effect on individual performance, where productivity, skills, and work management are the determining factors for project success. Meanwhile, well-selected and managed materials will support the strength, durability, and cost efficiency of the project. On the other hand, site characteristics such as accessibility, weather, and soil conditions also affect the smoothness of work in the field. With good management of these three aspects, bridge construction projects can be carried out efficiently, safely, and on time.

REFERENCES

Apriani, W., Suryanita, R., & Lubis, F. (2020). Evaluasi Kinerja Struktur Jembatan Pelengkung akibat Beban Gempa dengan Analisis Riwayat Waktu. *Jurnal Infrastruktur*, *6*(2), 151-156.

Arumningsih. (2012). Perencanaan Dan Estimasi Biaya Pada Proyek Pembangunan Jembatan Patihan Kabupaten Sragen. Jurnal Teknik Sipil dan Arsitektur, 12(16).

Bakhtiyar, A., Soehardjono, A., & Hasyim, M. H. (2012). Analisis faktor-faktor yang mempengaruhi keterlambatan proyek konstruksi pembangunan gedung di kota lamongan. Rekayasa Sipil, 6(1), 55-66.

Bansambua, E. M. (2019). Faktor-Faktor yang Menyebabkan Keterlambatan Waktu Pelaksanaan Proyek pada Pekerjaan Jalan dan Jembatan di Kabupaten Morowali. Jurnal Maroso, 1(01).

Dharmawan, R. D., Safarizki, H. A., & Firdausi, A. A. Evaluasi Efektivitas Keputusan Addendum Proyek Terhadap Waktu Pekerjaan Proyek Berbasis Earned Value Method. J@ ti Undip: Jurnal Teknik Industri, 18(1), 51-61.

Enrico, Y., & Sumarman, S. (2020). Manajemen Konstruksi pada proyek pembangunan Jembatan untuk akses ke lokasi PT. Pertamina MB-04. Jurnal Konstruksi dan Infrastruktur, 8(1).

Ervianto, W. I., & MT, I. (2006). Studi Implementasi Teknologi Beton Pracetak Bagi Bangunan Gedung. In National Conference on Prospected Technology.

Gellysa Urva, & Aminah, S. (2022). Implementasi Metode Analytic Hierarchy Process dalam Pemilihan Proyek Kontruksi. JURNAL UNITEK, 15(2), 141-150. https://doi.org/10.52072/unitek.v15i2.405

Ginting, R., Purba, C. E., & Sinulingga, H. P. (2023). Analisa Manajemen Konstruksi Bangunan Bawah Pada Proyek Pembangunan Jembatan Overpass Ruas Kisaran-Indrapura STA 132+ 023. JURNAL Ilmiah Teknik Sipil, 12(2), 291-296.

Haseli, B., & Hasan Ebdali, E. (2022). Ranking of Project Delay Factors in the Construction of Civil Infrastructure, Case study: Tehran Highway Bridge. New Approaches in Civil Engineering, 5(4), 1-13.

Hai Nguyen, L. (2020). Empirical analysis of a management function's failures in construction project delay. Journal of Open Innovation: Technology, Market, and Complexity, 6(2), 26.

Hair, J. F., Babin, B. J., Anderson, R. E., & Black, W. C. (2022). Multivariate data analysis (8th ed.). London, United Kingdom: Cengage Learning.

Hidayat, A., & Suripto, H. (2019). Klasifikasi Pengendalian Material dalam Mencegah Keterlambatan Proyek di Kabupaten Rokan Hulu. Aptek, 91-96.

Hudoyo, C. P., Rustendi, I., Sismiani, A., & Sunarwono, B. E. (2023). Evaluasi Kinerja Biaya dan Waktu Proyek Konstruksi Jalan dan Jembatan Kawasan

Industri Terpadu (KIT) Batang dengan Metode Earned Value. Proceedings Series on Physical & Formal Sciences, 6, 42-47.

Husen, A. (2019). Manajemen Proyek (revisied). Yogyakarta: Cv. Andi Offset.

Intan, S. K., Muhyi, A., & Tengku, N. M. (2018). Alternatif Percepatan Waktu Dengan Penerapan Metode Time Cost Trade Off Pada Proyek Pembangunan Jembatan (Studi Kasus: Proyek Pekerjaan Jembatan Rangka Baja Namploh Kec. Samalanga Kab. Bireuen, Aceh). Portal: Jurnal Teknik Sipil, 10(2), 19-27.

Johari, S., & Jha, K. N. (2020). Interrelationship among belief, intention, attitude, behavior, and performance of construction workers. Journal of management in engineering, 36(6), 04020081.

Kala Kamdjoug, J. R. (2023). Change management and digital transformation project success in SMEs located in the Democratic Republic of the Congo. Journal of Enterprise Information Management.

Karthic, Prabakara, Sindhu Vaardini and A. Aswin bharath. Maximizing Real-Time Monitoring For Effective Delay Analysis In Bridge Construction Projects With Evm Scheduling. International Journal of Scientific Research in Engineering and Management (IJSREM). 8(1), DOI: 10.55041/IJSREM27859

Kuswandari, A. D., Koesmargoro, A., & Ervianto, W. I. (2018). Pengaruh Dampak Contract Change Order Terhadap Kinerja Kontraktor Proyek Studi Kasus: Rehabilitasi Jembatan Ngablak. Jurnal Teknik Sipil, 14(4), 255-282.

Larsen, K. R., Michie, S., Hekler, E. B., Gibson, B., Spruijt-Metz, D., Ahern, D., ... & Yi, J. (2017). Behavior change interventions: the potential of ontologies for advancing science and practice. Journal of behavioral medicine, 40, 6-22.

Mahapatni, I. A. P. S., Putra, C., & Murwanta, K. E. (2022). Analisis Kinerja Waktu dan Biaya Pelaksanaan Proyek dengan Metode Earned Value Pada Proyek Pembangunan Jembatan Pangkung Dalem Ruas Jalan Gitgit-Wanagiri. Jurnal Ilmiah Kurva Teknik, 11(2), 17-25.

Maulina, F., & Mahmuddin, M. (2020). Identifikasi Risiko Pada Proyek Pembangunan Penggantian Jembatan Baja Di Aceh Jaya Dan Aceh Besar. Journal of The Civil Engineering Student, 2(3), 211-217.

Nasution, W. S. I. (2012). Hotel Forest di Bukit Lawang Tema Green Architecture (Doctoral dissertation).

Ramadhan, F. (2021). Evaluasi Penjadwalan Kurva–S Dan Critical Path Method (Cpm) Dalam Mengendalikan Pelaksanaan Pondasi Bore Pile (Studi Pada Pekerjaan Jembatan di Jalan Relokasi Bendungan Tapin) (Doctoral dissertation, Universitas Islam Kalimantan MAB).

Rebut, R., Mangare, J. B., & Walangitan, D. R. (2018). Analisis Perbandingan Tenaga Kerja Lokal Dan Tenaga Kerja Luar Dalam Jasa Konstruksi Di Manado (Studi Kasus: Transmart). Jurnal Sipil Statik, 6(3).

Robbins, Stephen. 2019. Perilaku Organisasi. Edisi Kesepuluh. Jakarta; Indeks.

Sari, A. M. (2021). Faktor Yang Berhubungan Dengan Program Penanggulangan Covid-19 Pada Proyek Jembatan Ploso Jombang Menggunakan Analisis Fishbone. Jurnal Indonesia Sosial Teknologi, 2(09), 1460-1474.

Sianipar, H. B. (2013). Analisis Faktor-Faktor Penyebab Keterlambatan Penyelesaian Proyek Konstruksi Pengaruhnya Terhadap Biaya.

Sigit, A., & Nurhidayat, H. (2019). Penerapan Earned Value Concept pada Proyek Penggantian Jembatan Ruas Nanga Tepuai–Nanga Semangut Kalimantan Barat. Jurnal Teknisia, 24(2).

Simanjuntak, I. J., Siagian, R. T., Prasetyo, R., Rozak, N. F., & Purba, H. H. (2022). Manajemen Risiko Pada Proyek Konstruksi Jembatan: Kajian Literatur Sistematis. Jurnal Teknologi dan Manajemen, 20(1), 59-76.

Soeharto, I. (2001). Manajemen proyek dari konseptual sampai operasional. Jakarta; Erlangga

Sugiono, G. J., Antonio, J. K., & Ratnawidjaja, S. (2022). Analisis Faktor-Faktor Yang Mempengaruhi Cost Overrun Dan Pengaruhnya Terhadap Keuangan Proyek Konstruksi Di Surabaya. Jurnal Dimensi Pratama Teknik Sipil, 11(2), 76-83.

Sugiyono (2019). Metode Penelitian Kunatitatif Kualitatif dan R&D. Bandung: Alfabeta.

Surachmad, N., Azis, S., & Putranto, E. H. D. (2018). Faktor-Faktor Risiko Kegagalan Pencapaian Sasaran Proyek Tepat Waktu Dan Mutu Pada Pembangunan Proyek Jembatan Di Kabupaten Probolinggo. Infomanpro, 7(1), 1-12.

Tabrani, N., Mulia, A. P., & Anas, R. (2023). Analisis Faktor Keterlambatan Pelaksanaan Proyek Jembatan di Provinsi Sumatera Utara. Jurnal Syntax Transformation, 4(1), 119-133.

Trauner, T. J. (2019). Construction delays: Understanding them clearly, analyzing them correctly. Butterworth-Heinemann.

Tristania, A., & Nursin, A. (2019). Tinjauan Pengendalian Waktu Pekerjaan Jembatan Anak CBL Pada Proyek Jalan Tol Cibitung–Cilincing Seksi II. In Prosiding Seminar Nasional Teknik Sipil (Vol. 1, No. 1, pp. 639-647).

Wahyuningtyas, A., & Waskito, J. P. H. (2021). Analisa faktor faktor penyebab keterlambatan proyek pembangunan jembatan joyoboyo. axial: jurnal rekayasa dan manajemen konstruksi, 9(2), 071-078.

Widayat, W. W. (2019). Pengantar Manajemen Proyek & Ekonomi Teknik. Jakarta: Jurusan Tektik SIPIL UI

Wirabakti, D. M., Abdullah, R., & Maddeppungeng, A. (2017). Studi Faktor-Faktor Penyebab Keterlambatan Proyek Konstruksi Bangunan Gedung. *Konstruksia*, *6*(1).