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ANALYSIS OF COMMUNICATION MANAGEMENT FACTORS ON THE LEVEL OF PROJECT SUCCESS
(Case Study: Construction of North Sumatra Suspension Bridge)

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Abstract

Communication management plays a crucial role in ensuring the success of construction projects. This research aims to examine how communication management influences project success, taking the construction of the North Sumatra Suspension Bridge as a case study. The study utilizes the PLS-SEM method, with data gathered through surveys distributed to key stakeholders, including contractors, supervisory consultants, and the project owner. The findings reveal that the most significant communication management factors affecting project success are communication skills (0.917), contributing 10.39%; the use of tools and technology (0.904), contributing 10.25%; and communication frequency (0.901), contributing 10.21%. Overall, communication management accounts for 75.9% ($R^2 = 0.759$) of the variation in project success indicators. These results highlight a strong correlation between communication management components and project success in the North Sumatra Suspension Bridge. Implementing structured, technology-driven, and transparency-focused communication strategies can significantly enhance the effectiveness and efficiency of construction project execution.

Keywords: ***Communication Management, Project Success, PLS-SEM, Construction, Suspension Bridge***

INTRODUCTION

Bridges serve as vital infrastructure that facilitates social and economic activities, particularly in regions with complex geographical conditions like North Sumatra. The suspension bridge project in this province is intended to connect remote and isolated areas. However, its implementation has faced several challenges. Effective communication is recognized as a crucial element in project management (William et al., 2020). According to (Saputra et al., 2017), it has demonstrated a meaningful and beneficial effect on project execution success, especially in the collaboration between contractors and subcontractors. Communication plays a central role in coordinating the various stakeholders involved—such as contractors, consultants, and project owners. As a fundamental aspect of project management, communication ensures alignment across cost, quality, and scope dimensions to achieve the desired project outcomes.

Project communication management encompasses all activities necessary to ensure the accuracy and consistency of information throughout the project lifecycle, including planning, gathering, creation, distribution, storage, retrieval, oversight, control, monitoring, and reporting (Kenneth H. Rose, 2008). It is a critical component of overall project management, as effective communication serves as a bridge connecting stakeholders with diverse cultures, backgrounds, expertise, perspectives, and interests—factors that can significantly influence project execution (Senaratne & Ruwanpura, 2016). Poor communication can lead to delays, cost overruns, and quality issues—risks that must be avoided in any project. Given that information is a powerful asset, understanding and managing it effectively is essential to project success (Annisa, 2019).

This study identifies several factors that influence project communication management, including the frequency of communication, the presence of two-way communication, clarity of messages, honesty in interactions, approaches to conflict resolution, decision-making without pressure, the existence of a communication management plan, communication skills, performance reporting, and the utilization of facilities and technology. The success of a construction project is a complex matter that involves multiple factors requiring careful consideration. As noted by (Atkinson, 1999), project success can be evaluated through several dimensions, such as time, cost, quality, and user satisfaction. However, the criteria for measuring success may differ based on the specific context of the project and the priorities of the stakeholders involved. A key focus in evaluating the success of a construction project is ensuring its timely completion. Time management is critical in construction, as delays can result in increased costs and interfere with the scheduling of related activities. Therefore, effective scheduling and strict time control are essential components of project success.

Another vital factor is cost management. A successful project must be delivered within the allocated budget, avoiding cost overruns. This requires consistent budget tracking, proactive management of cost-related changes, and effective risk mitigation strategies that could impact financial estimates. In addition to conventional project success factors such as time, cost, and quality, recent studies have emphasized the importance of sustainable engineering approaches, especially in the construction sector. Hasibuan et al. (2025) revealed that the integration of circular economy (CE) practices in construction and demolition waste management plays a strategic role in achieving long-term project efficiency, resource optimization, and stakeholder collaboration. These sustainability-oriented practices are closely connected with communication quality, since CE implementation requires coordinated stakeholder engagement and transparent data-sharing mechanisms across project phases.

METHOD

This study adopts a quantitative methodology by utilizing the PLS-SEM technique. The sample was selected through purposive sampling from a population of 136 individuals involved in the project, yielding 102 respondents. Data collection was carried out using a questionnaire designed to assess 10 indicators of communication management and 3 indicators of project success, namely cost, quality, and time.

The PLS-SEM framework comprises two main components: the structural model, which illustrates the relationships among latent variables, and the measurement model, which represents the connections between constructs and their respective indicators (Hair, J. F., et al, 2021) described in Figure 1:

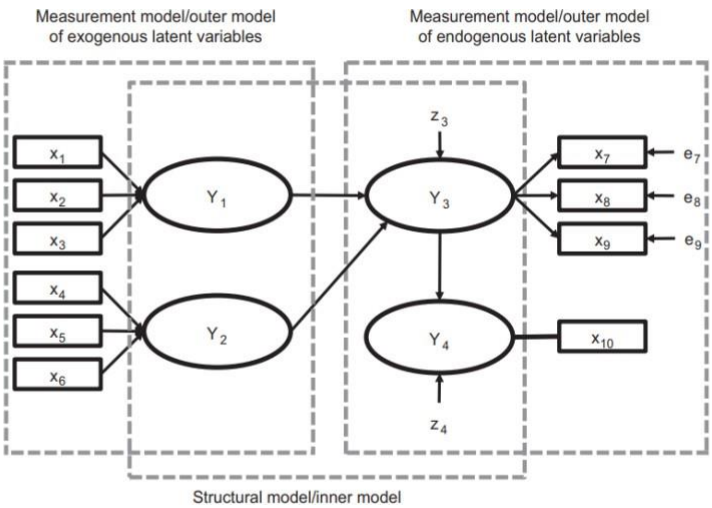

Figure 1. PLS-SEM Line Model

Sumber: (Hair, J. F., et al, 2021)

Model testing consists of PLS-SEM variable test and PLS SEM model quality test which will be explained as follows:

Variable test of the PLS-SEM model

Several variable tests within the PLS-SEM model are categorized into the outer measurement model and the inner structural model, as outlined in Table 1.

Table 1. Testing of variables within the PLS-SEM framework

Model	Types of Testing	Parameter	Value	Interpretasi
	Reliability Indicator	*Loading Factor*	≥ 0.7	Reliabel
Outer	Reliability	*Cronbarch's Alpha*	≥ 0.7	Reliabel

Model	Types of Testing	Parameter	Value	Interpretasi
Measurement Model	konstruk	*Composite Reability*	≥ 0.7	Reliabel
	Validitas Convergence	*Average Variance Extracted*	≥ 0.5	Valid
	Discriminatory Validity	*Fornell-Larcker Criterion*	≥ 0.7	Valid
Inner Structural Model	Path coefficient	*β-value*	Positive value	Positive correlation
			Negative value	Negative correlation
	Significance test (t-test)	*p-value*	≤ 0.05	Significant
	Size Effect Test	*f-square*	≥ 0.02	Small
			≥ 0.15	Medium

Quality Assessment Model

The quality of the model generated in this study will be evaluated through several metrics, including the coefficient of determination (R^2), cross-validated redundancy (Q^2), goodness of fit, and the goodness of fit index. The R^2 value can subsequently be assessed based on the classifications outlined in Table 2.

Table 2. Interpretation of the coefficient determination

Value of the determination coefficient	Interpretation of the coefficient of determination
$R^2 < 0.19$	Very weak
$0.19 \leq R^2 \leq 0.33$	Weak
$0.33 \leq R^2 \leq 0.67$	Medium
$R^2 \geq 0.67$	Substantial

Source: (Fornell, C., & Cha, 1994)

Cross-validated Redundancy (Q-square) is used to assess the predictive relevance of the model for the observed variables. As stated by (Fornell, C., & Cha, 1994), a Q-square value greater than 0.25 signifies a moderate level of predictive accuracy. This value is derived using the Blindfolding procedure. Additionally, the Goodness of Fit Index is applied to assess the overall quality of the model, encompassing both the outer measurement model and the inner structural model. The Goodness of Fit Index is calculated using the following formula:

$$\text{GoF} = \sqrt{Average\ R^2} * Average\ communality$$

Dengan:

- Gof : Goodness of Fit
- Average R^2 : Coefficient of determination
- Average communality : Average AVE value

The model's quality can be interpreted using the classification of the goodness of fit index as shown in Table 3.

Table 3. Interpretation of the *Goodness of Fit Index Value*

Godness of Fit Index	Interpretation
$GoF \geq 1.0$	Small
$GoF \geq 0.25$	Medium
$GoF \geq 0.36$	Large

Source: (Hussain et al., 2018)

RESULTS AND DISCUSSION

Outer Measurement Model

The indicator reliability test was conducted to assess how well each indicator represents its corresponding latent variable, using a standardized loading factor ranging from 0 to 1. Indicators with loading factor values above 0.7 are considered acceptable, whereas those with values below 0.7 are excluded from the model (see Table 4).

Table 4. Loading Factor Research Indicators

	Communication Management	Cost	Quality	Time	Conclusion
X1	0.901				Credible
X10	0.904				Credible
X2	0.864				Credible
X3	0.88				Credible
X4	0.838				Credible
X5	0.844				Credible
X6	0.894				Credible
X7	0.896				Credible
X8	0.917				Credible
X9	0.884				Credible
Y1.1		0.941			Credible
Y1.2		0.909			Credible
Y1.3		0.935			Credible
Y2.1			0.912		Credible
Y2.2			0.906		Credible
Y2.3			0.932		Credible
Y3.1				0.950	Credible
Y3.2				0.936	Credible
Y3.3				0.955	Credible
Y3.4				0.958	Credible

Table 4 demonstrates that the indicators for each variable are acceptable, as their loading factor values exceed 0.7, confirming the validity of the research data. The model's structural diagram is presented in Figure 2.

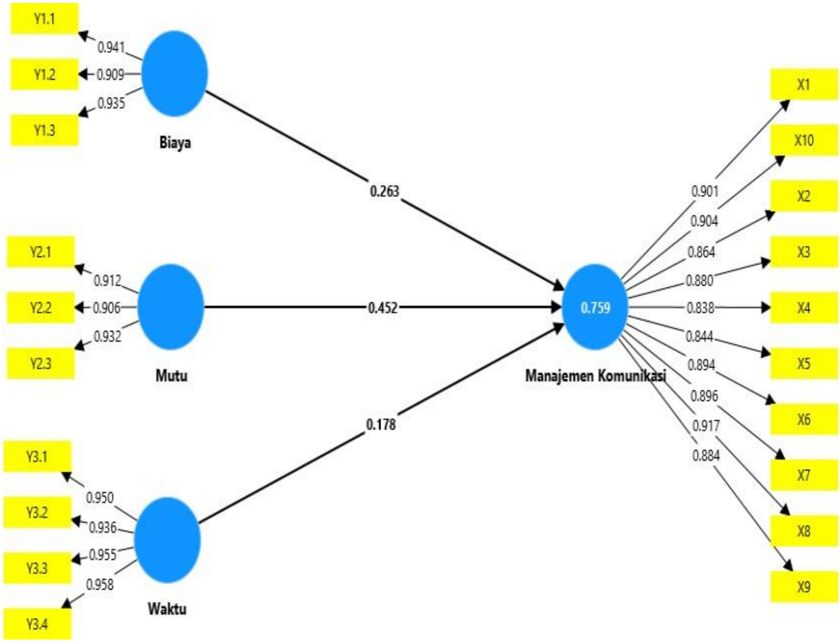

Figure 2. Structural PLS-SEM model

Figure 2. Explains the correlation structure of the two main PLS-SEM models, namely *the outer measurement model* and *the inner structural model*. The percentage significance of each communication management variable to the project success variable is shown in Table 5.

Table 5. Percentage of Dependent Variable Values

Variable X	**Percentage**	Rank
Frequency of Communication	10.21	3
Use of Facilities and Technology	10.25	2
Two-Way Communication	9.79	8
Clarity of Message Content	9.98	7
Honesty in Communication	9.50	10
Conflict Resolution	9.57	9
Decisions Without Pressure	10.13	5
Communication Management Plan	10.16	4
Communication Skills	10.39	1
Performance Reports	10.02	6
Total	100.00	

Source : Research data processing

The reliability of the variable constructs was assessed using Cronbach's Alpha and Composite Reliability (CR), while convergent validity was evaluated through the Average Variance Extracted (AVE) value.

Table 6. Results of the construct reverability test and the validity of the convergent variable

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Communication Management	0.968	0.969	0.972	0.779
Cost	0.920	0.921	0.949	0.862
Quality	0.905	0.908	0.941	0.841
Time	0.964	0.965	0.974	0.902

**Cronbarch Alpha and Composite Reability (CR) Threshold=0.70;*
*** Average Variance Extracted (AVE) Threshold =0.5 (Hussain et al., 2018)*

According to the results presented in Table 6, the overall reliability of the measurement variables is satisfactory, with composite reliability values ranging from 0.908 to 0.969 and Cronbach's alpha values between 0.905 and 0.968, all exceeding the 0.70 threshold (indicating reliability). The convergent validity, indicated by AVE values ranging from 0.779 to 0.902, also surpasses the minimum requirement of 0.50, demonstrating good convergent validity. The outcomes of the discriminant validity test are provided in Table 7.

Tabel 7. Discriminant Validity Test

	Cost	Communication Management	Quality	Time
Cost	**0.928**			
Communication Management	0.849	**0.883**		
Quality	0.934	0.86	**0.917**	
Time	0.923	0.834	0.915	**0.950**

Discriminant Validity Threshold: 0.70 (Hussain et al., 2018)

Based on the results obtained, Table 7 shows that the cross-loading value for the variable itself is greater than 0.70. It can be judged that the discriminant validity of the entire variable is acceptable.

Inner Structural Model

Bivariate Analysis

The correlation between variables can be seen in Table 8. The correlation value between these variables is standardized on a scale of 0 to 1, so the larger the correlation, the higher the correlation.

Table 8. Correlation between latent variables

	Cost	Communication Management	Quality	Time
Cost	1.000	0.849	0.934	0.923
Communication Management	0.849	1.000	0.860	0.834
Quality	0.934	0.860	1.000	0.915
Time	0.923	0.834	0.915	1.000

Table 8. shows that the variable with the highest correlation coefficient to the communication management variable is the quality variable (0.860) then the cost variable (0.849) and finally the time variable (0.834) shows the lowest variable. Furthermore, the value of the correlation coefficient can be interpreted in Table 9.

Table 9. Interpretasi koefisien korelasi variabel laten

Variabel	Correlation Coefficients	Interpretation*
Cost	0.849	Strong Relationship (Close to +1)
Quality	0.860	Strong Relationship (Close to +1)
Time	0.834	Strong Relationship (Close to +1)

Table 9. shows that the Quality variable has the strongest relationship with communication management because the value of the variable correlation coefficient is close to +1 which is 0.860.

PLS-SEM Multivariate Analysis

The purpose of PLS-SEM multivariate analysis is to determine which exogenous variables significantly impact endogenous variables and to measure the strength of these effects. This influence is evaluated using the path coefficient (β-value), significance testing (t-test), and effect size assessment (f-square). A positive path coefficient (+) signifies a positive correlation between variables, whereas a negative value indicates a negative correlation, as shown in Table 10.

Table 10. PLS-SEM line coefficient

Variable Description	**Variabel**	**β-value**
Cost	Y1	0.263
Quality	Y2	0.452
Time	Y3	0.178

Table 10. showing the variables that have a positive effect on the three indicator variables with the quality indicator as the first rank with the most influential of 0.452.

Additionally, the inner structural model represents the relationships among latent variables. The values between these latent variables correspond to the path coefficients. The significance test results for each independent variable's effect on the dependent variable are presented in Table 11.

Table 11. Significance test

	Original sample (O)	**Sample mean (M)**	**Standard deviation (STDEV)**	**T Statistics (|O/STDEV|)**	**P Values**	**Information**
Cost -> Communication Management	0.263	0.268	0.145	1.806	0.071	Insignificant
Quality -> Communication Management	0.452	0.458	0.17	2.653	0.008	Significant
Time -> Communication Management	0.178	0.169	0.153	1.163	0.245	Insignificant

In Table 11. A variable is said to have a significant influence when it has a p-value of no more than 0.05. The significant variable that affects the dependent variable is the Quality variable (0.008).

Table 12. F-Square Value

Variabel	f-squared*	Information
Cost -> Communication Management	0.280	Moderate Effect

Variabel	f-squared*	Information
Quality -> Communication	0.920	High Effect
Time -> Communication	0.017	Small Effect

*f-square value cut-off: ≥0.02 (small), ≥0.15 (moderate), and ≥0.35 (large) (Hussain et al., 2018)

In table 12, the highest F-square values are found in the quality variable with the *high effect* category, the cost variable with the moderate *effect* category and the time variable with a low effect (*small effect*). The influence of the Quality variable in increasing the Project Success Index is large at the structural level (f square = 0.920).

PLS-SEM Model Testing

Furthermore, the PLS-SEM model evaluation involves assessing the goodness of fit, determination coefficient (R^2), cross-validated redundancy (Q-square), and goodness of fit index. The model's goodness of fit is examined using SRMR, Chi-Square, and NFI metrics. Additionally, the overall model—including both the outer measurement model and the inner structural model—is assessed through the goodness of fit index. The R-square values are presented in Table 13.

Table 13. Model determination coefficient

	R-square	***R-square adjusted***
1. Communication Management	0.759	0.752

Based on Table 13, the coefficient of determination of the model in explaining the dependent variable is 0.759 or 75.9%. Overall, Communication Management, which is a dependent variable, has a percentage contribution of R^2 = 75.9% in forming project success indicators. These results show that the relationship between Communication Management elements to the success of the project in the North Sumatra Suspension Bridge project has a great influence.

Tabel 14. Test of fit model

	Saturated Model	*Estimated Model*	*Cut-off Value*	Model
SRMR	0.041	0.041	<0.080	Fit
d_ULS	0.345	0.345	-	-
d_G	0.769	0.769	-	-
Chi-Square	405.436	405.436	Expected small	Fit
NFI	0.86	0.86	>0.900	Not Fit

Moreover, the model fit evaluation presented in Table 14 displays the results of the model fit assessment. According to (Dash & Paul, 2021), an SRMR value below 0.08 indicates a well-fitting model. The estimated Standardized Root Mean Square Residual (SRMR) for the model is 0.041, which satisfies the fit criteria (SRMR < 0.08). The model's Chi-Square value is 405.436. However, the Normed Fit Index (NFI) is 0.86, which falls short of the acceptable threshold (NFI > 0.900).

Tabel 15. Q-square value

	SSO	**SSE**	**Q^2 (=1-SSE/SSO)**
Cost	306	306	0
Quality	306	306	0
Time	408	408	0
Communication Management	1020	424.13	0.584

Table 15 presents the Q-square value of the model. A Q-square value of 0.584 suggests that the model possesses moderate predictive accuracy, meeting and exceeding the commonly accepted threshold (>0.25). This indicates that the model's structural paths are capable of predicting the endogenous variables. According to (Fornell, C., & Cha, 1994), Q-square values greater than 0.25 and approaching 0.5 reflect moderate to high predictive power. Therefore, it can be concluded that the model demonstrates strong predictive capability for the Suspension Bridge Project Success Index and is suitable for assessing the influence of communication management factors on project success.

Table 16. Goodness of Fit Index

	Average variance extracted (AVE)	R-square
Cost	0.862	
Quality	0.841	
Time	0.902	
Communication Management	0.779	0.759
Average values	0.846	0.759
AVE x R^2	0.642	
GOF*	0.801	

**GoF Value Cut-off: ≥0.1 (small), ≥0.25 (medium), and ≥0.36 (large) (Hussein et al., 2018)*

Table 16 shows the results of the *Goodness of Fit Index test*. The Goodness *of Fit Index value* is obtained by the following equation:

$$\text{GoF} = \sqrt{Average\ R^2} * Average\ communality$$
$$\text{GoF} = \sqrt{0.759 * 0.846}$$
$$\text{GoF} = 0.801$$

Dengan:

- Gof : Goodness of Fit
- Average R^2 : Coefficient of determination
- Average communality : Average AVE value

Based on the equation, the model's Goodness of Fit index is 0.801, which falls into the high category (≥0.36).

The dependent variable, Communication Management, contributes R^2 = 75.9% in explaining the success indicators of the project. This indicates that the elements of Communication Management significantly influence the success of the North Sumatra Suspension Bridge project. Among the variables, X8 (communication skills) holds the highest contribution at 10.39%, highlighting that effective communication skills are essential for every stakeholder. The second most influential factor is X10 (use of facilities and technology), contributing 10.25%, emphasizing that modern tools and technologies enhance efficiency, quality, and sustainability in bridge construction. Third is X1 (communication frequency), with a 10.21% contribution, indicating that structured and consistent communication improves team coordination, accelerates decision-making, and reduces delays and conflict risks. Furthermore, the variables X7 communication management plan were 10.16%, X6 decisions without pressure were 10.13%, X9 performance reports were 10.02%, X3 message content clarity was 9.98%, X2 two-way communication was 9.79%, X5 conflict resolution was 9.57% and the last rank was X4 honesty in communication contributed to the influence of 9.50%.

Communication skills for each stakeholder contribute to an important role in the success of the Suspension Bridge construction project. This has been validated by the relevant parties from the results of the interviews that have been carried out. The available facilities and technology are obstacles because there are still those who do not understand the procedures for using them. Then to succeed the project, intense communication and transparent progress reporting are needed.

These findings reaffirm that communication-related competencies are critical in construction project success. Notably, communication skills (10.39%), use of facilities and technology (10.25%), and communication frequency (10.21%) emerged as the top contributors to project performance. This is consistent with Hasibuan et al. (2025), who assessed the impact of project management in the Deli Serdang Biomass Power Plant project. Their study highlighted that when project management integrates systematic communication, stakeholder coordination, and digital monitoring, the project outcomes, especially in cost, quality, and timeare significantly improved.

CONCLUSION

The results of the analysis showed that the three dominant factors in communication management were communication ability (0.917), use of facilities and technology (0.904), and communication frequency (0.901). These three factors contributed 10.39%, 10.25%, and 10.21% to the success of the project, respectively. The overall model shows that communication management explains 75.9% of the variance in project success ($R^2 = 0.759$). These findings indicate the importance of a systematic and technology-based communication strategy to improve the effectiveness of construction projects.

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