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Analysis of the Effect of Time and Cost Performance Risk of Toll Road Project Based on the Principle of PMBOK

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ABSTRACT
Toll road facilities are needed by the community to improve economic standards with adequate mobility. Toll Road Projects often have delays in the implementation schedule which results in increased project costs. This study aims to determine the effect of the risk of increasing costs on toll road projects caused by delays in project implementation time based on PMBOK guidelines. This research is based on the object of the Japek II Selatan Package III Toll Road project and studies journal literature, surveys, and questionnaires using the SEM Smart PLS program. The effect of risk on cost performance is variable due to the lack of project land readiness. Based on project data from the contract, it was supposed to be completed in December 2020 but was pushed back to mid-2024 estimates. The effect is due to an increase in costs, with a percentage of 2%; in this study, the factor of implementing K3 Projects is in the form of work accident costs. The analysis of SEM PLS shows the effect of time and cost performance on the Planning and Implementation of land readiness indicators, unit price increase, project K3 implementation, and risk management implementation. The study concludes that the risk of increasing costs includes poor planning, which is hampered by land readiness and results in delays in implementation time and year differences that cause changes in material unit prices, resulting in an increase in project costs. Risk Management, as stated in the PMBOK guidelines on Toll Road Projects, must be implemented to reduce the impact of the risk of increasing project costs.
Keywords: Analysis, Effect, Time and Cost Performance Risk, PMBOK, Project, SEM Smart PLS.

INTRODUCTION

Toll road facilities are needed by the community to improve economic standards with adequate mobility. Toll Road Projects often have delays in the implementation schedule which results in increased project costs.

The toll road project has experienced delays in implementation as the Jakarta Cikampek II Selatan Package III Toll Road project has been delayed up to 33 months from the initial contract. This happened within 2 years from 2020, so the difference in project time caused an increase in material prices, and eventually, over-project costs reached around 2%. Against this background, the author wants to research the effect of risk on toll road projects on increasing costs and delays in project time. Time delays and cost overruns are still major risks that haunt almost all construction projects in the world (Eddy Husin, 2024)

Obstacles to project implementation affect work results, thereby reducing project productivity. Risks that arise must be controlled through risk analysis that affects project performance with risk identification and mitigation plans during planning and control/monitoring during project implementation. Project risk management, as in PMBOK, is one of its 9 knowledge areas, having 6 project risk management processes.

Based on previous research, among others, as ventilated by Wattimury et al. (2015) natural disasters and unexpected weather affect the increase in project costs. Dapu (2016) conducted research that found that risk factors do not take into account unexpected costs that have an effect on performance. Research from Jongo et al. (2019) causes of cost overrun / increased project costs in ineffective planning and scheduling, variations in the design and licensing stages, and land disputes/land readiness, as well as the relationship between management and labor, is not good. Subramani (2014) stated that the cause of the risk of increasing costs was caused by an increase in material and equipment prices, and according to Marpaung et al (2017), was due to repetition of work due to poor quality.

This study aims to obtain survey results from project implementers and similar project implementers on the influence of any factors that are thought to affect the improvement of project cost performance and project implementation time.

RESEARCH METHODS

This research is qualitative and quantitative from survey results using questionnaire instruments and data analysis using SEM PLS software through observation, questionnaires, and interviews with respondents in the Japek II Selatan project and several similar projects guided by the application of the Project Management Body of Knowledge (PMBoK).

Project data and risk management reports of Japek II Selatan Toll Road Package III are used as research objects on the alleged risk effect of increasing project costs. In addition, literature reviews in previous journals are also a reference in data processing and analysis using interviews, surveys, and literature review methods.

Study literature reviews from books and journals in online media, as well as articles from the internet related to construction road and toll road projects and PMBOK book seventh edition in 2021.

Population questionnaires were sent from employees and workers on the Jakarta Cikampek II Selatan Package III Toll Road project and similar toll road construction projects. The Slovin formula is used to calculate the population:

$$n = \frac{N}{1+N\,d^2}$$

Where:

n: Number of samples

N: Total population

d^2: Preset precision (5%, 10%, 15%)

Finding and systematically compiling data obtained from interviews is one method of research, followed by processing field data so that it can be easily understood and the findings can be shared with others (Sugiyono, 2008). The data analysis method with Structural Equation Modeling (SEM) through a path model with latent variables in it.

Testing of Questionnaire Results

Validity and Reliability Test

Whether data from the field is feasible must be tested for validity and reliability. The validity test is used to measure the validity or absence of a questionnaire with criteria

1. R-alpha is positive and greater than R-table; hence, the statement is reliable.
   Cronbach's Alpha score > 0.6 then reliable
2. R-alpha is negative and smaller than the R-table hence the statement is not reliable.
   Cronbach's Alpha score < 0.6 is therefore not reliable

Furthermore, testing was carried out using the PLS-SEM program method to find out all the results of the data analysis.

Hypothesis Testing

This hypothesis testing performs tests on:

1. Effect of Project Preparation and Implementation (x1) on Time and Cost Performance (Y)
2. Effect of Implementation of Occupational Safety and Health System (x2) on Time and Cost Performance (Y)
3. Effect of Application of Risk Management based on PMBOK (x3) on Time and Cost Performance (Y)

RESULTS AND DISCUSSION

Project Data

Japek II Selatan Package III Toll Road Project is a toll road with a span of 30.6 KM starting from STA 31+400 to STA 62+000 starting from Sadang to Gate Sukabungah. The implementation of the project began in May 2019 and continued through September 2023, with several contract addendums from the initial plan to be completed in December 2020, which were affected by the risk of not being ready for land to be freed.

As a result of the delay in implementation, there is a cost overrun of around 2%, showing the indicator of land readiness in the Planning and Implementation variable. In addition, there is also a cost overrun of 0.4% due to the risk of miscalculating costs and rising unit prices of materials.

In the Implementation of Occupational Safety and Health System, there is a risk of project work accidents, namely the cost of compensation and the purchase of Safety and Health facilities at a cost of around 0.1% of the contract value, which affects the variables of performance, cost, and implementation time.

SEM SMART PLS Program Analysis

The system used to process hypothesis data is SEM Smart PLS, which includes variables that affect cost and time performance.

Table 1. Research Variables and Indicators

Variable		Indicators
Project Preparation and Implementation (x1)	1.	Increase in material prices
	2.	Damage to the results of work
	3.	Land readiness
	4.	Cost budget changes
Implementation of Occupational Safety and Health System (x2)	1.	Implementation of Project Safety and Health Program
	2.	Health disorders
	3.	Traffic disruptions
	4.	Road damage due to flooding and heavy equipment mobility
Application of Risk Management based on PMBOK (x3)	1.	Risk identification
	2.	Risk mitigation
	3.	Risk analysis

	4.	Risk evaluation

Source: Author's Processed Data

The variables mentioned above are thought to affect endogenous variables (Y) on performance, increased cost, and extended time. The object of obtaining the questionnaire results using the Slovin formula and analysis using SEM PLS as began below.

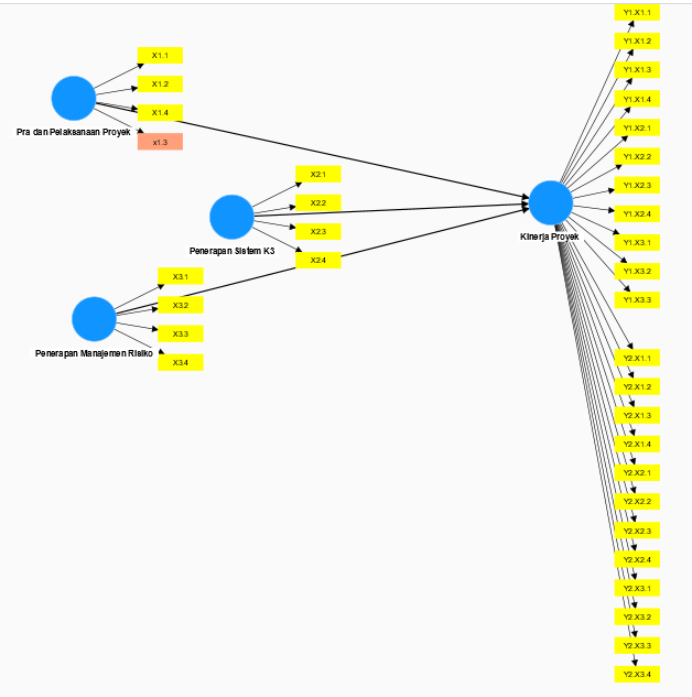

Figure 1. Smart PLS SEM Model Graph

Outer Model Test

The Outer Model Test to see the feasibility of relationships between variables, namely in Convergent Validity, Reliability, and Discriminant Validity.

Convergent validity

Loading Factor

If the loading factor in an exogenous variable (X) and endogenous variable (Y) ≥ 0.7, it is declared valid, while the loading factor between 0.5 - 0.6 can still be tolerated (Yamin and Kurniawan, 2011; Haryono, 2017).

Table 2. Loading Factor Results

Variable	Indicators	Loading factor	Criterion	Information

Project Preparation and Implementation (x1)	1. Increase in material prices	(-)	> 0.7	Invalid
	2. Damage to the results of work	0.209	> 0.7	Invalid
	3. Land readiness	0.719	> 0.7	Valid
	4. Cost Budget Changes	0.919	> 0.7	Valid
Implementation of Occupational Safety and Health System (x2)	1. Implementation of Project K3 Program	-0.54	> 0.7	Invalid
		0.039	> 0.7	Invalid
	2. Health Disorders	0.919	> 0.7	Valid
	3. Traffic disruptions	0.678	> 0.7	Valid
	4. Road damage			
Application of Risk Management based on PMBOK (x3)	1. Risk Identification	0.909	> 0.7	Valid
	2. Risk Mitigation	0.728	> 0.7	Valid
	3. Risk Analysis	0.752	> 0.7	Valid
	4. Risk Evaluation	0.629	> 0.7	Valid

Source: SEM Smart PLS Analysis Results

Effect of Exogenous Variables on Endogenous Variables of Performance

Table 3. Path Coefficient Matrix

Variable	Ratio to Y Value	Information
Project Preparation and Implementation (x1)	0.580	Significant effect on time and cost performance
Implementation of Occupational Safety and Health System (x2)	0.098	Does not affect time and cost performance
Application of Risk Management based on PMBOK (x3)	0.527	Significant effect on time and cost performance

Source: SEM Smart PLS Analysis Results

Significant influence occurs on Pre and Implementation and Application of Risk Management variables on time and cost performance while K3 System Implementation variables have no effect on time and cost performance.

Discriminant Validity

Discriminant validity – Fornel – Lacker criterion shows that the correlation between latent variables is greater for all variables, so it is concluded that all three latent variables are valid.

Table 4. Discriminant Validity Results

Discriminant validity – Fornell – Larcker criterion				
	X1 Project Preparation and Implementation	**X2** Implementation of Occupational Safety and Health System	**X3** Application of Risk Management	**Y Time and Cost Performance**
X1 Project Preparation and Implementation	0.685	0.126	0.294	0.748
X2 Implementation of Occupational Safety and Health System		0.632	0.199	0.276
X3 Application of Risk Management based on PMBOK			0.761	0.717
Y Time and Cost Performance				0.580

Source: SEM Smart PLS Analysis Results

Convergence Reliability Test

Reliability Testing to measure reliable stability. It can be stated that the answers to the results of the questions are consistent or stable in several tests through the Internal consistency method or the composite reliability feature and Cronbach's Alpha coefficient.

Composite Reliability

Table 5. Composite Reability Results

Construct reliability and validity - Overview				
	Cronbach's alpha	**Composite reliability (rho.. a)**	**Composite reliability (rho.. c)**	**Average variance extracted (AVE)**

X1 Project Preparation and Implementation	0.282	0.543	0.682	0.469
X2 Implementation of Occupational Safety and Health System	-0.274	0.506	0.302	0.399
X3 Application of Risk Management based on PMBOK	0.756	0.791	0.844	0.579
Y Time and Cost Performance	0.886	0.924	0.902	0.336

Source: SEM Smart PLS Analysis Results

Composite Reability results that the variables of Risk Management Application and Project Preparation and Implementation are valid, but the variable of Implementation of Occupational Safety and Health System is less valid the lowest with a value of 0.302 (with criteria 0.6-0.7)

Combach's Alpha

Cronbach's Alpha variable Application of Risk Management is valid, but for variables Implementation of Occupational Safety and Health System and Project Preparation and Implementation is less valid with the lowest value of - 0.274 (criteria 0.6-0.7). So that the answers in filling out the questionnaire are unstable.

Average Variance Extracted (AVE)

The average Variance Extracted on Risk Management and Project Preparation and Implementation variables is valid, but the Implementation of Occupational Safety and Health System variable is invalid with a value of 0.399 (criteria 0.4 -0.5)

Inner Model Test

Goodness Model (R Square)

The inner model determines the percentage of endogenous variables to exogenous variability and the goodness of structural equation models. With the condition that the higher the R-square value indicates, the larger the exogenous variable, showing the structural equation of the endogenous variable, the better.

Table 6. R Square Results

	R-square	R-square adjusted
Time & Cost Performance	0.838	0.824

Source: SEM Smart PLS Analysis Results

The table shows the Cost and Time Performance Variables with values of 0.838 > 0.6, meaning that the variables are valid and good structural equations. R2 criteria of 0.6, 0.33, and 0.19 indicate strong, moderate, and weak models, so it is concluded that time and cost performance are strong variables.

Effective Size (f model)

Table 7. Effective Size Results

f-square List	
	F-Square
X1 Project Preparation and Implementation -> Y Time and Cost Performance	1.895
X2 Implementation of Occupational Safety and Health System -> Y Time and Cost Performance	0.057
X3 Application of Risk Management based on PMBOK -> Y Time and Cost Performance	1.522

Source: SEM PLS Results

The data shows that the largest influence value on performance is the Project Preparation and Implementation variable with fsquare 1.895. The second variable is the Application of Risk Management with fsquare 1.522. Meanwhile, the Implementation of Occupational Safety and Health System variable is stated to have little effect on time and cost performance.

Inner Model Test / Hypothesis Testing (Influence Between Variables) Path Coeffiiens

Table 8. Coefficient Path Results

Path coefficients – Mean, STDEV, T values, P values					
	Original sample (O)	**Sample mean (M)**	**Standard deviation (STDEV)**	**T statistics (IO/ STDEVI)**	**P values**
X1 Project Preparation and Implementation -> Y Time and Cost Performance	0.580	0.598	0.137	4.222	0.000
X2 Implementation of Occupational Safety and Health System -> Y Time and Cost Performance	0.098	0.103	0.094	1.040	0.298
X3 Application of Risk Management based on PMBOK -> Y Time and Cost Performance	0.527	0.474	0.155	3.396	0.001

Source: SEM Smart PLS Results

Hypothesis testing of T Statistics in this study is:

1. Ho: There is no effect of Risk Management based on PMBOK on Time and Cost Performance
   Ha: There is an effect of Risk Management based on PMBOK on Time and Cost Performance
2. Ho: There is no effect of Implementation of Occupational Safety and Health System on Time and Cost Performance
   Ha: There is an effect of Implementation of Occupational Safety and Health System on Time and Cost Performance
3. Ho: There is no effect of Project Preparation and Implementation to Time and Cost Performance
   Ha: There is an influence of Project Preparation and Implementation to Time and Cost Performance
   a. Ho is accepted when T Statistics < 1.96 (No effect)
   b. Ho rejected if T Statistics ≥ 1.96 (Influential)

T Statistic > 1.96 on the relationship of exogenous and endogenous variability Ho was rejected and had an effect on endogenous variability of 3.396 and 4.22 on the Application of Risk Management and Project Preparation and Implementation, while the Implementation of Occupational Safety and Health System with values of 1.04 < 1.96 showed a small influence on exogenous variables, performance (time and cost).

Research Hypothesis Test Results

Table 9. Research Hypothesis Test Results

	Hypothesis	Std value of coefficient	T Statistics	P-Value	Information
H1	Project Preparation and Implementation -> Time and Cost Performance	0.58	4.22	0.00	Supported
H2	Implementation of Occupational Safety and Health System -> Time and Cost Performance	0.098	1.040	0.298	Less Supported
H3	Application of Risk Management based on PMBOK -> Time and Cost Performance	0.527	3.396	0.001	Supported

Source: SEM Smart PLS Analysis Results

Mediation Variable Effect Test

Path analysis at the output of Indirect Effect, if the P value is less than 0.05 then there is a mediation influence (Sofyani, 2013: 27) Based on Table 9 in the P-Value column of 0.001 and 000 in accordance with the criteria of < 0.05, it can be concluded that the biggest influence of time performance is from the variables Project Preparation and Implementation and Implementation of Risk Management, but less affecting cost performance in the variables of Project Preparation and Implementation and Implementation of Occupational Safety and Health System. The Original Table of positive samples means that all variables are strong enough to affect time performance as well as cost performance.

SMRM value

Table 10. Model SMRM

Fit model		
	Saturated models	**Estimated model**
SRMR	0.186	0.186
d_ULS	18.276	18.276
d_G	N/a	N/a
Chi-square	∞	∞
NFI	N/a	N/a

Source: SEM Smart PLS Analysis Results

From the table above, the SRMR value is 0.186, so the model does not meet the criteria for the goodness of fit model. Based on previous research, Zurich Busnaenina, (2022) in the Journal of Management Research stated that there was a delay in construction projects in Libya by 51.9%. Charles Teye, et. Al, (2015) stated that there are 10 impacts of project delays, one of which is cost overrun or increased project costs. Yulia Rahmawati et al., (2020) wrote a Probability Impact Matric according to PMBOK to identify cost overrun risk factors at the Project Preparation and Implementation stages.

CONCLUSION

The risk that affects time and cost performance in the Project Preparation and Implementation variables is contained in the land readiness indicator as it is in the Japek II Selatan Package III project that the initial contract that expires in December 2020 is delayed until September 2023 (33 months) caused by unprepared land.

Based on SEM Smart PLS analysis the effect of risk on Project Preparation and Implementation variables on-time performance with t value calculated> t table (3.396 > 1.96) or

P Value 0.001 < 0.05. This is also stated in a previous study, namely Zuhir Busneina, in the Journal of Management Research, where there were 51.9% delays in construction projects in Libya.

Based on processed data, the risk that affects the performance of implementation costs in the Japek II Selatan Toll Road project costs up to 2% towards the contract. The application of risk management has a strong influence on cost performance with a calculated t value > t table (2.621 > 1.96) or P-value 0.009 > 0.05. Researcher Charles Teye, et. Al, (2015) stated that there are 10 impact factors of project delays, one of which is cost overrun or increased project costs.

Risk management, in accordance with the Project Management Body of Knowledge (PMBOK), has been carried out by the project with risk identification, risk mitigation, and risk evaluation and monitoring to facilitate risk control that affects the performance of both project time and cost. Researchers Yulia Rahmawati et al., (2020) stated the Probability Impact Matric based on PMBOK as a method to identify cost overrun risk factors at the predawn implementation stage. Delay of schedule on a project will give domino effect on the project costs. It is therefore, it requires analyses to optimize construction project scheduling to achieve shorter schedule and less costs (Eddy Husin, 2018).

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