Critical Risk Factor Affecting Cost Overrun in Highway Project of West Sumatera

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Abstract. One part of the form of public capital that is collected into investments made by the government is infrastructure. Several types of infrastructure are roads, bridges, irrigation, and others to support economic activities. It can be seen that there is still a slowdown in the implementation of infrastructure development in Indonesia, which is marked by the lack of quality and quantity of infrastructure. Infrastructure work is part of the responsibilities of the construction industry players, which are very dynamic with various threats to be faced. In practice, every construction project contains risks, unless the owner can transfer it to another party. This study aims to identify critical risks that occur in infrastructure development projects, especially roads in West Sumatra which have an impact on cost overruns in their implementation. This research uses literature study, data collection, and questionnaires which are analyzed using quantitative statistical analysis. The findings in this study are the cost overrun factors that occur in the implementation of road projects in West Sumatra which consist of 12 (twelve) critical risk factors. The highest of the twelve delay factors is the lack of experience of contractors who cannot manage a project properly.

1. Introduction

Developing countries differ from developed countries in many ways. Less than one billion people, out of a world population of six billion, live in high-income countries [1]. The United States trade representative on the World Trade Organization (WTO) said that Indonesia was already a developed country and not a developing country. Indonesia meets 2 of the 3 indicators of developed countries, the first is that Indonesia is a global economic group, the second is that Indonesia's world export market share is above 0.5%. A developed country is a country that has quality infrastructure and human resources. These two things are well recognized by the Indonesian government and become the motivation to focus on them to realize the 2045 Indonesia Gold-Vision.

In every economic activity, infrastructure formed from investments made by the government plays an important role. In this case, infrastructure, which includes roads, is a means of supporting economic activities to run smoothly. [2]. In addition, according to The Routledge Dictionary of Economics [3], a broader understanding of the strategic role of infrastructure is obtained, namely as the main servant of a nation in assisting the movement of economic activities and community activities, including through the provision of transportation and other supporting facilities.

The impact of infrastructure on economic growth is also seen in a study conducted by David Aschauer [4] where he uses the production model created by Cobb-Douglas, and the results show that there is a positive correlation between infrastructure investment activities and productivity output. In this case, core infrastructure such as transportation, energy, and water has a greater impact than other infrastructures such as buildings and hospitals.

2. Literature Review

Expansion of costs in building projects often occurs for various reasons, which are not only difficult to predict but also difficult to manage. [5]. A study conducted in Turkey by Arditi, et al, [6] shows that the causes of the swelling of construction costs are caused by various things, including inflationary pressures, increases in material prices and labor wages, difficulties in obtaining building materials, delays in construction implementation time, lack of cost estimates initially prepared by consultants, and also caused by unpredictable underground conditions. However, Mansfield, Ugwu, and Doran [7] stated that the cause of the increase in construction costs was caused by various things, including inflationary pressure, rising material prices and labor wages, difficulties in obtaining building materials, delays in construction implementation time, lack of cost estimates initially prepared by consultants, and also due to unpredictable underground conditions. Apart from that, other things were found beyond that, namely cost overruns related to problems in financial and payment arrangements, poor contract management practices, lack of material availability, rapid changes in site conditions, design changes, errors and inconsistencies in contract documents, errors during construction, market price fluctuations, inaccurate price estimates, delays in execution of work, additional work, shortened construction periods, and fraudulent and bribery practices. Meanwhile, according to Robert F. Cox [8], the project owner identified five reasons for project cost overruns, namely additional works, variation orders, fluctuations, delays, and provisional sums [9].

In a related study, Heravi & Mohammadian [10] have conducted research on how delays and cost overruns occur due to planned time, planned costs, types, and nature of urban construction projects using real project data. In their study, there were a total of 72 urban construction projects surveyed. The main findings of his study were 7 reasons, namely: (1) only 7% of the studied projects were completed within budget; (2) only 8.5% of the projects studied were completed on time; (3) large urban construction projects are facing cost overruns and the time and overall cost performance of newly built projects are better than renovation; (5) the cost performance of urban road projects is better than that of building projects; (6) delays in new building projects and building renovations are not significantly different and (7) cost overruns for new construction projects and road renovations are not significantly different.

According to the research of Creedy et.al. [11], cost overruns occur due to uncertainty or uncontrollable risk (which should be controllable) and therefore will be more difficult to manage in the future. Provisions for setting a more realistic percentage of contingencies across such projects would help provide better reporting on road projects, program outcomes, and related key project performance indicators.

Seen as a whole from various causes, the cost overruns that arise are the impact of financial risk. But besides that, all the factors that cause cost overruns do not only occur in financial matters but are more complex than that. Referring to previous studies, several factors have also been identified that cause cost overruns in each construction project. In the opinion of Senouci et.al., [12], mentions in his research that the factors that can cause budget swelling in a project he studied are poor quality management, work implementation control systems, quality of labor, estimated project execution time, financial condition constraints and clarity of scope and objectives of the work. Senouci et.al., [12] and Samarghandi et.al.,[13] have identified the factors causing cost overruns in their research from the perspective of project owners, implementing contractors, consultants, applicable regulations, and another common defect, where the results of their research show that there are some differences between each party with the most important factors being the cause of time delays and cost overruns. In addition to some of the opinions above, referring to previous research conducted by Al-Hazim et.al., [14] where they also found that the most important factors that caused time delays and cost overruns from the implementation of a project's work were terrain conditions that difficult. [15-19].

There are several factors causing cost overruns that have been described in the literature above which are used as a reference for this study as follows in table 1.

Table 1. Comparison factors causing cost overrun in construction projects

Factors	Samarghandi et.al.,[13]	Al-Hazim et.al., [14]	Aljohani et.al., [17]	Saiful et.al., [18]	Herrera et.al., [19]
1. Site availability delay				√	
2. Site conditions		√		√	
3. Social site conditions					
4. Change order	√			√	
5. Rework		√			
6. Subcontractors' and/or vendors' performance					
7. Approval/ permit delay	√			√	
8. Inaccuracy in budgeting, scheduling, and resource planning	√				√
9. Materials price fluctuations		√			√
10. Rules and regulations	√				√
11. Owner's additional requirements		√			
12. Inflation				√	
13. Delay in payment					
14. Weak cash flow	√				
15. Bad weather		√		√	
16. Frequent Design Change	√	√		√	
17. Contractors' Financing	√		√		√
18. Payment Delay					
19. Lack of Contractors' Experience			√		
20. Poor Cost Estimation			√		
21. Poor Tendering Documents			√		
22. Poor Material Management			√		
23. Failures in design					
24. Unrealistic contract duration			√		√
25. Inadequate bidding method					√

3. Research Methodology

This study uses two types of approaches in the process of statistical analysis for data collection and processing. The two approaches taken are a kind of quantitative approach and a qualitative approach [19-21]. For the two types of approaches used, there are some differences in the methods and techniques used, such as objectives, concepts, research approaches, data collection methods, data analysis, and sampling [21-22]. All kinds of references relevant to critical risk factors were collected and how they were implemented in various infrastructure works, as mentioned by various previous researchers for review. The reviews are not only limited to articles published in peer-reviewed journals, but include several papers published by well-known publishers, as well as several theses, dissertations, and books. The date of the referral search is the period of the last 20 years to cover various and at the same time to reveal new findings. Furthermore, in the second stage, factors or aspects related to critical risk factors and their implementation were collected which were then distributed in the form of questionnaires to respondents using the purposive sampling method. In the selection of respondents, those who have experience involved in road work activities in various National Road Projects in West Sumatra, Indonesia are taken. They were given a form containing some general and background information of the respondents and data on the importance of risk factors in road works identified through the literature as shown in the Relationship Model (Figure 1).

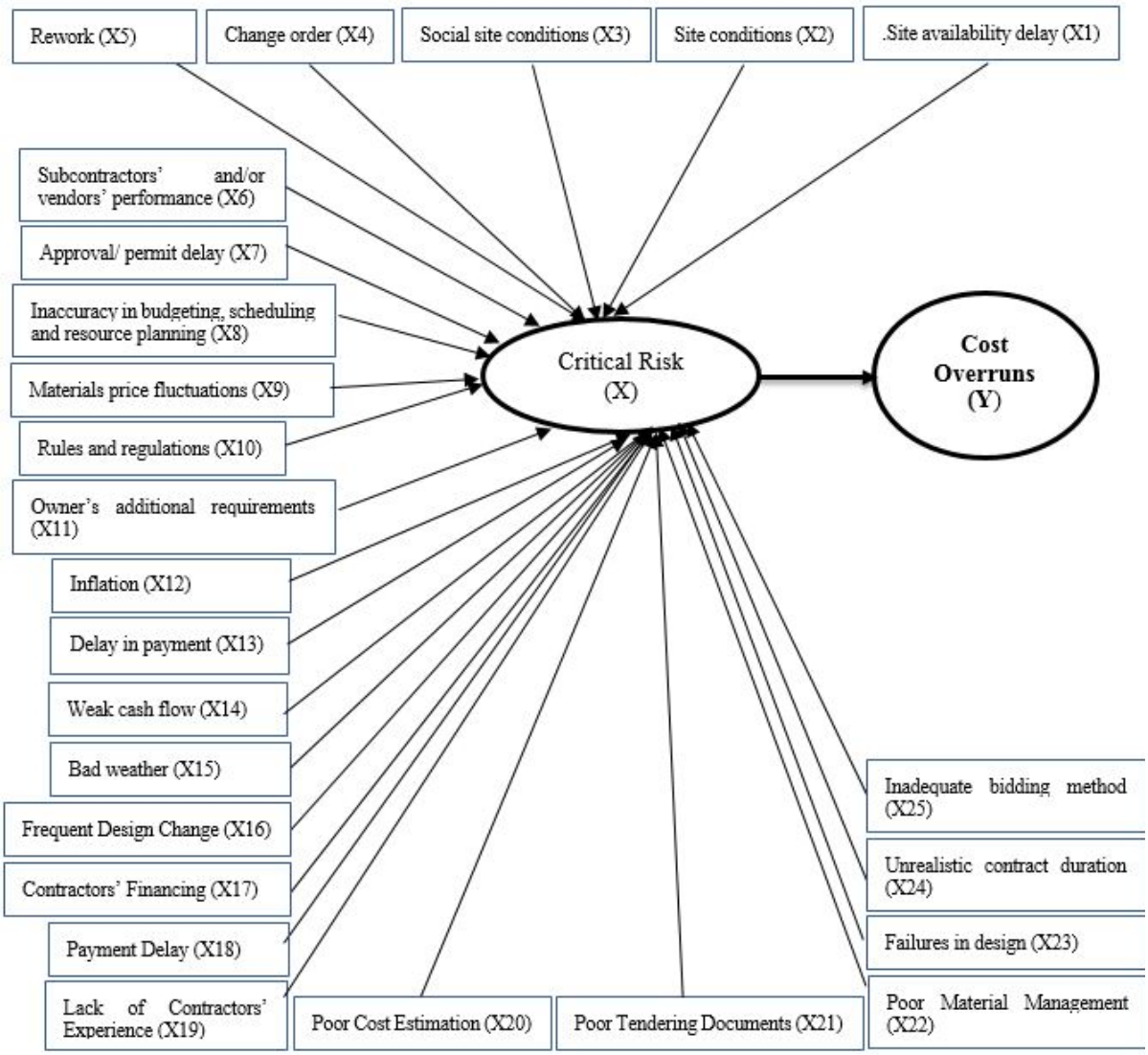

Figure 1. Relationship model between critical risk factors and cost overruns

4. Data Collection and Analysis

All respondents were sent a questionnaire file, namely, those who are stakeholders from the Implementation of Highway Construction in West Sumatra (Project Owners, Supervision Consultants, and Contractors) from various job positions who have worked > 12 years in Highway Construction Projects. In the selection of respondents using the purposive sampling method, where the number taken exceeds 1 or (n + 1) from the number of questionnaire questions circulated to them. Several answers to the questionnaire (25+2) have been received from a total of 30 respondents who circulated the questionnaire and 3 of them did not return it. Factor measurement is carried out using a Likert Scale consisting of five points to measure the delay factor that has an impact on cost overruns. All data received were analyzed using the Statistical Package for Social Sciences (SPSS). The calculated reliability value is found to be above 0.70 (Cronbach's Alpha), while the validity value must exceed the "r" value in the reference table. From all these results, the highest factor value will be the determining factor for the Delay Factor that results in Cost Overruns for Highway Projects in the West Sumatra region, Indonesia.

The data processing carried out in this study uses SPSS version 24.0 and according to Supriyadi [23] that the testing techniques that are often used to test the validity are Pearson Bivariate Correlation (Pearson Moment Product) and Item-Total Correlation Correction. In this study using Corrected item-total with the results for the amount of data (n) = 25 obtained r table = 0.4040 (r table for Pearson's Product Moment) with a significance level of 0.05. The results of SPSS data analysis can be seen in table 2.

Table 2. Corrected Item-Total Correlation Results

Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
X1	96.5926	169.943	.136	.938
X2	97.0741	169.917	.036	.941
X3	97.2222	155.641	.734	.932
X4	97.0741	157.994	.728	.933
X5	97.3333	162.000	.474	.935
X6	98.5556	152.179	.803	.931
X7	97.7407	156.892	.596	.934
X8	97.5185	156.336	.594	.934
X9	97.5926	153.712	.684	.933
X10	97.5185	152.567	.729	.932
X11	97.1852	159.234	.542	.935
X12	97.3333	159.077	.593	.934
X13	97.0741	161.840	.462	.936
X14	97.3333	155.308	.858	.931
X15	97.4074	161.174	.394	.937
X16	97.1481	163.516	.380	.937
X17	98.5556	152.179	.803	.931
X18	97.7407	156.892	.596	.934
X19	97.5185	156.336	.594	.934
X20	97.5926	153.712	.684	.933
X21	97.5185	152.567	.729	.932
X22	97.1852	159.234	.542	.935
X23	97.3333	159.077	.593	.934
X24	97.0741	161.840	.462	.936
X25	97.3333	155.308	.858	.931

Based on table 2, the value of Corrected item-total Correlation shows that the calculated r-value (Pearson Correlation) is smaller than r table 0.4040, namely X1 (Site availability delay), X2 (Site conditions), X15 (Bad weather), and X16 (Frequent Design Change). The reliability test method must use the Cronbach's Alpha method whose value is > 0.7 which is used to determine the reliability and is indicated by Cronbach's Alpha of all factors > 0.700.

Furthermore, data processing is carried out using SPSS tools, namely multiple regression analysis, to be able to see the extent of the relationship between the delay factors that are suspected to be the cause of Cost Overruns as shown in tables 3, 4, and 5.

Table 3. Model Summary

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.887[a]	.787	.604	.57664

a. Predictors: (Constant), X25, X5, X24, X19, X22, X23, X4, X20, X18, X3, X17, X21

Viewed table 3 above, shows how much the values of R and R2 are, where the R-value of 0.887 means that there is a large correlation between all factors X (Delay) and Y (Cost Overruns). While the R2 value of 0.787 means that the contribution of the X factor affects Y by 78.70%.

Table 4. Annova (correlation)

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	17.197	12	1.433	4.310	.006[b]
	Residual	4.655	14	.333		
	Total	21.852	26			

a. Dependent Variable: Y

b. Predictors: (Constant), X25, X5, X24, X19, X22, X23, X4, X20, X18, X3, X17, X21

In addition, based on table 4 above, shows how much the significant value is, where the value of sig. of 0.006 <0.05, which means that there is a significant effect between all factors X3, X4, X5, X17, X18, X19, X20, X21, X22, X23, X24, X25, and Y.

Table 5. Coefficient (correlation)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	2.528	3.966		.637	.534
	X3	-.130	.986	-.115	-.132	.897
	X4	.379	.355	.287	1.068	.304
	X5	-.399	.532	-.313	-.751	.465
	X17	.319	.778	.319	.411	.688
	X18	.146	.946	.144	.154	.880
	X19	.941	.198	.965	4.743	.000
	X20	-.124	.664	-.132	-.187	.854
	X21	-.119	.789	-.127	-.151	.882
	X22	.292	.418	.262	.699	.496
	X23	-.347	.425	-.291	-.816	.428
	X24	-.176	.861	-.143	-.204	.841
	X25	-.293	.485	-.229	-.604	.555

a. Dependent Variable: Y

Based on the results of the analysis from Table 5 above, it shows how much the influence value (significant), where the value of sig. of 0.000 < 0.05 and t statistic 4.743 > 1.96 which means a significant effect between X19 (Lack of Contractors' Experience) and Y (Cost Overruns).

5. Discussion and result

From the data analysis and the hypothesis above, it can be explained that those that affect Y (Cost Overruns) are X3 (Social site conditions), X4 (Change order), X5 (Rework), X17 (Contractors' Financing), X18 (Payment Delay), X19 (Lack of Contractors' Experience), X20 (Poor Cost Estimation), X21 (Poor Tendering Documents), X22 (Poor Material Management), X23 (Failures in design), X24 (Unrealistic contract duration) and X25 (Inadequate bidding method). Most of it can be seen from the poor management of finances, materials, and financial planning. There are also weaknesses in calculating the design, implementation costs, late payments from the project owner. However, the one that plays a major role in influencing Cost Overruns is the Lack of Contractors' Experience. However, the highest cause was the Lack of Contractors' Experience who could not manage a project properly since the beginning of the auction or during the duration of project implementation.

6. Conclusion

From the results of the discussion of the hypotheses above, the main factors of cost overruns that occurred in the implementation of toll road projects in West Sumatra were found to be 12 (twelve) factors causing delays. All of these critical factors, delays are often the main cause of cost overruns in any road project. The cause of the highest delay of the twelve factors is the contractor's lack of experience. In continuing this research, more in-depth analysis steps are needed to find out other factors of delay and affect cost overruns in more detail. In addition, all of these factors can also be developed to obtain more detailed sub-factors.

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