

CRITICAL RISK ANALYSIS OF TOLL ROAD PUBLIC-PRIVATE PARTNERSHIP (PPP) PROJECT CONSTRUCTION PHASE

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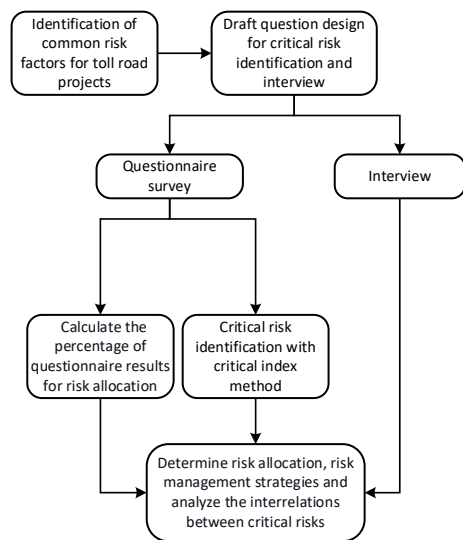
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Graphical abstract



Abstract

Limited funding in meeting the financing needs for the provision of toll road infrastructure makes the government need to look for alternative financing so that the project can still be carried out. Public Private Partnership (PPP) is an alternative option to overcome this problem. However, infrastructure projects with PPP schemes require large investments and a relatively long concession period, thus allowing risk uncertainty to arise as a result of decisions made during the project. Risk identification in a construction project is important at the beginning of the project. This study was aimed at identifying critical risks, determining risk allocation and risk mitigation strategies, and analyzing the interrelationship between critical risks. The case study was conducted on the Trans Sumatra toll road project in South Sumatra. Quantitative data (questionnaire survey) and qualitative data (interview) were collected from the toll-road private sector. The results of the study identified five critical risks in the construction phase (CP) of the toll road project along with the allocation of risks, namely the risks of geographical conditions (shared), delays in work progress (private sector), design errors (private sector), force majeure (shared) and weather conditions (shared). The mitigation strategy for the risks of geographical conditions and design errors was to redesign the construction structure by adjusting with the land conditions of the toll road. Force majeure (Covid-19) causing delays in work progress required rescheduling and recalculation of construction costs. Weather conditions (heavy rain) occurring on swampy land caused puddles/floods; this condition caused delays in construction work. The mitigation strategy that could be carried out was by coordinating with the Indonesian Meteorology, Climatology, and Geophysics Agency (BMKG) in the region and preparing disaster management Standard Operating Procedures (SOPs). The cause and effect of each risk showed that the critical risks in the construction phase of the toll road project were interrelated to each other which the risks would finally contribute to the increase in the construction costs of the toll road project.

Keywords: Critical Risk Analysis, Indonesia, Toll Road, PPP, Construction Phase

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1.0 INTRODUCTION

Public Private Partnership (PPP) is one of the cooperation systems used for infrastructure projects in developed and developing countries. The PPP scheme is widely used by countries having limited funding to meet the infrastructure provision financing. The PPP scheme has various benefits for the government and the private sector. For example, the

private sector can innovate in infrastructure development, benefit from operating infrastructure during the concession period, and can share risks between the government and the private sector [1].

The PPP scheme has a working system in which the private sector will design, finance, build, operate, maintain, and manage risks in the infrastructure during the period [2]. This method is considered by the government to be more profitable

than being managed traditionally. The government can share risks that should be borne by the private sector, and the private sector can give the risks that they cannot bear to the government [3]. The problem is that infrastructure projects with PPP schemes require a large investment value and a relatively long concession period, thus allowing for the uncertainty of risks that arise during the project, especially during the construction phase. Delays in work progress, changes in design, geographical and weather conditions, shortages of tools, materials, and manpower can trigger an increase in construction costs which will cause the failure of investments made by the private sector [4].

Risk uncertainty and inappropriate risk allocation are additional causes of failed investments made by the private sector [4]. It is necessary to prepare a plan to anticipate the risks so that the project can be completed on time according to the budget and simultaneously generate a return on investment made during the concession period [2]. The problem is that the risks in each project are different/dynamic and dependent on the contextual variables of each project; therefore, to identify risks in a project, it is necessary to conduct a special investigation on the project [5].

Previous studies identified risks affecting finances on toll road infrastructure projects. In Vietnam, the risks of land acquisition and construction costs caused many PPP projects to be abandoned by investors [5]. In Indonesia, the development of toll road projects was slow due to financial problems. Twenty-four toll road sections had been planned for the development process, but they were constrained by financing [6]. The projects starting the construction process, like the Trans Sumatra toll road project in South Sumatra, had potential risks that would have an impact on the financial and investment aspects of the private sector, leading to the problems like those in Vietnam.

Several risks had arisen in the construction phase of the toll road construction. First, on the Kayu Agung-Palembang-Betung toll road, the construction costs increased. Based on the study conducted by Wraharjo, the results showed that the Net Present Value (NPV) of the project had a negative value of -5.56 million, which means that the project will not be profitable [7]. Second, the Palembang-Indralaya toll road had road conditions not meeting the minimum service standards for toll roads; as a result, people were less interested in using the toll road. The impact is that the average daily traffic value of the toll road plan did not reach the plan's target value. The average daily traffic value of the Palembang-Indralaya toll road in 2021 was only 5,000-6,000 vehicles/day [8]. As for the Kayu Agung-Palembang-Betung toll road section 1 in 2020, the average daily traffic value was only half of the plan, which is 4,000-5,000 vehicles/day. It is necessary to identify the critical risks in the construction phase that have an impact on the financial aspect of the project, determine the risk mitigation strategies and risk allocation so that the project can proceed according to plan. Nguyen et al. recommended that further study could analyze the interrelationship between critical risks in toll road projects to find out whether there was an interrelationship between risks that can have a greater impact on project costs; therefore, this study would also analyze the interrelationship between critical risks of the toll road project [5].

2.0 LITERATURE REVIEW

Risk is the uncertainty of an event that does not necessarily occur, and most of the risks will cause unwanted losses. Risk analysis is important in a business to minimize losses. Risk analysis aims to determine or identify the possibility of profit or loss for a business [9]. A critical risk is a specific risk that directly affects the project, where the context of the critical risk is assessed depending on each study conducted. Examples include critical financial aspects, the critical decline in project quality, and the contribution to project implementation delays [5][10].

Meanwhile, according to Turner, a critical risk is an event that can cause severe damage to a business operation that results in cost, material, and death losses due to the risks [11]. Critical risks can be interpreted as threats or dangers that pose significant risks and allow very adverse consequences to occur, such as construction failures due to data and design assumptions errors, failure to invest in or a project that is not financially viable due to lack of public interest in using the infrastructure. Critical risks can impact projects equivalent to 20% of the gross domestic product of some countries, which means that risks will be very detrimental to investors [12]. The critical risks in this study are viewed from financial aspects that will affect the investments made by the private sector in toll road management. Risk falls into the critical risk category if the risk of incurring losses is close to 20% or more than the maximum profit obtained by the manager.

Based on government Regulation Number 3 of 2021, the weight of the profitability ratio is 20% or a weighted value of at least 3.2 of the company's performance value, which shows profits in running a business [13]. Therefore, if the risk causes an impact that affects finances that exceeds the maximum permissible profit, the private sector experiences losses or investments made while not running as planned.

A previous study has identified risks that impact investments made by the private sector with risk limits on the NPV. This method converts the inflow of cash inflows and cash outflows of the project to the present value to determine the project's financial feasibility [5]. The results of the study by Nguyen et al. showed that delays in the progress of work due to land acquisition and design changes became critical risks that impacted the project's financial project [5]. Late land acquisition due to government policies considered inappropriate compensation and the unavailability of accommodation for land owners to move makes private sector forced to accept the risk of delays in work progress. This will have an impact on activity plans and costs. The risk of design changes will certainly result in additional costs, but private sector sometimes expects this to receive compensation from the project owner. The cause of this risk often occurs as a result of the direct appointment of a private sector by the government to manage the project. Suppose the risks are reviewed based on the point of view of the owner/government. In that case, the risks that can arise during the construction phase are the risks of inappropriate design, land acquisition, project delays, project locations, and construction failures [14]. Meanwhile, according to Diez based on a literature study conducted, risks on toll roads that have the potential to arise and become the responsibility of private sector are the risk of over-run costs, delays in work, and technical specifications that are not met [4].

In Indonesia, common risks related to toll road projects are summarized by the Ministry of Public Works in the construction and building guidelines for toll road investment risk analysis [15]. PT.PII issues the guidelines for toll road project risk allocation in a draft guidebook [16]. Based on the guidelines [15] and previous studies [4][5][14][17], a list of common risks that occur in toll road projects is developed in the construction

phase. The results of the identification of common risk factors in the construction phase can be seen in Table 1. The risk factors can be further developed according to the discussion of each study. Based on the list of risks in Table 1, it has not yet been known what risk factors greatly affect the financial aspect of the project

Table 1 The General Risk Factors of Construction Phased Toll

No	Risk Factors	Sources				
		Nguyen et al (2018)	Sandhyavitri and Saputra (2013)	Diez (2015)	Wibowo et al (2012)	PUPR (2005)
1.	Design changes requested by the owner (Government)	✓	✓	✓	✓	✓
2.	Geographical and weather conditions	✓	×	✓	✓	✓
3.	Environmental adjustments to construction	✓	×	✓	✓	✓
4.	Request for a change in the scope of work from the owner	✓	×	✓	✓	✓
5.	Unavailability of materials and labor	✓	×	✓	✓	✓
6.	Delays in construction permit approval caused by the owner	✓	×	✓	✓	✓
7.	Delay of the work addendum	✓	×	✓	✓	✓
8.	The technical specifications selected on the contract document are not suitable	✓	×	✓	✓	✓
9.	Design errors that cause changes in addendums/construction modifications	✓	×	✓	✓	✓
10.	The occurrence of force majeure during construction	✓	✓	✓	✓	✓

Critical risks should be managed by the right people so that the risks could be handled as needed. The reason for the government to use the PPP scheme is to share the risks between the government and the private sector. Usually, the various kinds of risks have been determined in advance who will bear the risks in the contract document; however, as the project progresses, there are many causes of risks that result in one party feeling that the risks should be borne together. Therefore, the stipulations for the initial allocation may change.

Risk allocation refers to the main measure of assignment between participants in overcoming risk, namely the government, the private sector, or shared between the government and the private sector. Risk must be allocated to the right parties provided that the parties have the ability to control the possibility of risk, can manage the impact of the occurrence of the risk, and is able to bear the risk at the lowest risk cost. Risks in critical categories/ levels need to be managed by the right parties so that risk management is as needed. On the risk of toll road projects in Indonesia, the risk allocation has actually been determined based on the reference guidelines for toll road risk allocation that have been issued by PT.PII [16]. In scientific study, the determination of risk allocation can be determined by conducting a questionnaire survey to the parties involved in the project, one way to determine risk allocation can be by calculating the percentage of respondents' answers [5].

One of the steps in risk management is to determine the attitude or response that must be taken to resolve the risk that occurs. The response is carried out by developing strategies that can be carried out to overcome risks. Scope in determining risk management strategies includes risk estimation, analyzing risks, how to handle risks, and studying risks based on experience. Thinking about handling strategies early can reduce the addition of project financing [18]. It is important to know in advance the potential risks that may occur. The process of

developing and determining the most effective and efficient actions with the aim of increasing opportunities and reducing the risk of losses is the goal of risk mitigation. It can be made to avoid risks, divert risks, reduce the probability of risk to an acceptable level, and accept the risks.

Identifying the interrelationship between the risks that occur in construction projects is also important to do. Especially on toll roads with PPP projects. Critically identified risks need to be analyzed whether there is a link between these risks. For example, it was identified that the critical risk that occurs on toll roads is that unexpected geographical conditions will have an impact on design changes. Then it turns out that this risk will also have an impact on increasing construction costs due to changes in the design desired by the owner. Thus, it is known that the risks of geographical conditions, design changes, and construction costs are interrelated [4]. Infrastructure with PPP projects have a complex series of work and many parties are involved in the project, by identifying links between risks can minimize the occurrence of problems. The parties involved in the project can determine mitigation and allocate risks to the right parties. In addition to the success of project work, proper risk management can generate profits and successful investments made [9]. Analyzing the interrelationship between risks can be done qualitatively and quantitatively. The interrelationship of risks in construction projects can be qualitatively analyzed by conducting interviews with parties involved in construction projects. However, using quantitative data can produce a more certain interrelationship through existing data. Such as data on questionnaire results, changes in implementation schedules, cash flow, and others.

3.0 METHODOLOGY

3.1 Study Location

Five Trans-Sumatra toll road sections in South Sumatra were targeted for the study, namely the toll road sections of Pematang Panggang-Kayu Agung (85 Km), Kayu Agung-Palembang-Betung (111.69 Km), Palembang-Indralaya (22 Km), Simpang Indralaya-Muara Enim (88 Km), and Muara Enim-Lahat-Lubuk Linggau (125 Km).

3.2 Study Design

This study was aimed to analyze critical risks in PPP toll road projects. The scope of the analysis is identifying critical risks, determining the allocation and risk mitigation strategies, and analyzing the interrelationship between critical risks in the construction phase of the Trans-Sumatra toll road project in South Sumatra. The study was conducted quantitatively (questionnaire survey) and qualitatively (interview). The respondents to the questionnaire were the stakeholders of toll road private sector. The common risk factors for toll road projects had previously been determined from various literature (Table 1). The first data collection (quantitative) was conducted by a questionnaire with google form to the respondents, and the criteria of respondents being people working in the field of risk management, finance, and/or directly involved in overcoming the risks that occur in the toll road project in each of the Trans Sumatra toll road sections in South Sumatra.

In this study, there were 16 respondents from five Trans Sumatra toll roads in the South Sumatra region. This project is only carried out by one state-owned, that is Hutama Karya Company, so respondents in this study are people representing divisions directly involved in managing the risks of toll road projects. Among them, thirteen respondents worked on the construction phase of the toll road project and three respondents worked on the operational phase of the toll road project. As for the interview, five respondents were selected who gave the closest opinion to the results of the critical risk identification carried out. The number of respondents is quite limited considering that only respondents know and understand the risks of toll road projects.

The survey form used to collect the respondents' answers in determining the critical risks affecting the financial aspect of toll roads had a weighted value of one to five (1-5) in the form of a Likert scale. The determination of the value of one to five (1-5) was based on the maximum profitability ratio obtained by the Toll Road company in operating toll roads during the concession period. Based on government Regulation Number 3 of 2021, the weight of the profitability ratio is 20% or a weighted value of at least 3.2 of the company's performance value, which shows profits in running a business [13]. The effect of risk on the financial aspects of the project can be seen in Table 2. A limit of >20% is taken for risks that are Extremely critical, 15-20% for very critical, 8-14% for critical, 1-7% for quite critical, and 0% for not critical. For example, if the risk that occurs incurs an increase in costs that can exceed the maximum profit of toll roads (20%), then respondents give a score of 5 on the questionnaire and the risk will be an extremely critical risk in this study.

The questionnaire data were used to identify critical risks and risk allocation. Risk identification was carried out by using critical indeks (CI) method.

Table 2 Level of Risk

Score	Information	Limit
1	Not critical	0%
2	Quite critical	1-7%
3	Critical	8-14%
4	Very critical	15-20%
5	Extremely critical	>20%

CI method could be used to identify risks (critical risks) if the data are from a questionnaire survey. With the CI method, the risks can be sorted based on the criticality rating in the aspects reviewed [5]. The highest CI value being the critical risk of the toll road project.

The results of critical risk identification were used for further data collection (qualitative), namely conducting interviews with the respondents to discuss whether the identification results were in accordance with what happened in the project, to discuss risk allocation, mitigation strategies and the interrelationship between critical risks. The risk allocation determination was based on not only the results of interviews, but also the percentage of the results of questionnaire, literature studies and the guidelines for risk allocation for toll road project issued the PT.PII.

The interrelationship between risks was carried out by descriptive analysis based on the opinions of respondents in the interview. Interviews were conducted in a semi-structured manner to understand in depth the causes of risks and management/ mitigation strategies in addressing critical risks and analyze whether there is a link between these critical risk factors. Interview respondents will be selected with a purposive sampling approach to representing a population that understands related issues in order to obtain logical and accurate results. The respondents' opinions were compared with literature studies and previous study, where the interrelationship between risks was discussed based on the effects of risks on the financial aspect of a toll road project. The results of the interviews conducted were used in compiling a discussion of each risk identified as a critical risk in this study.

4.0 DATA ANALYSIS

The questionnaire survey was conducted to the respondents working in the Trans Sumatra toll road in south sumatera, the respondents to the questionnaire were the stakeholders of toll road private sector. There were 16 respondents who gave their opinions about the critical risks in five toll road sections. The respondents were people working in the field of Site Contract Administration and Risk Management (SCARM), construction staff, Site Administration Officer (SAO) and supervisors (Project control engineers) with two to five years of work experience in the Trans Sumatra toll road project.

The questionnaire instrument in a study should be tested for its validity and reliability to determine whether the questionnaire instrument can measure/produce what should be measured and can be used repeatedly for different respondents, and is reliable [19]. A validity test is needed to

determine whether or not the questionnaire instrument is valid. The validity test can be done with the help of the Statistical Package for the Social Sciences (SPSS) program using the Pearson bivariate correlation by correlating each score on the item with the total score of the entire items being tested. Whether or not the instrument is valid can be determined from the significance value (p-value). A significance value < 0.05 is declared valid and a significance value > 0.05 is declared invalid. If the significance value is exactly at 0.05, it is necessary to do a comparison between r-count and r-table. The questionnaire instrument is declared valid with a significance value of < 0.05 for all existing question items. After the data is valid, reliability testing is carried out. Reliability testing was carried out with the Cronbach's Alpha (α) statistical test. The result was Cronbach's Alpha (α) > 0.6, meaning that the existing study instrument/questionnaire was reliable. The value of < 0.6 is not reliable [20]. The results of the Cronbach's Alpha test with a value of < 0.50 is considered to have low reliability, 0.50 < α < 0.70 moderate reliability, > 0.70 sufficient reliability, > 0.80 strong reliability, and > 0.90 perfect reliability [15]. The results of reliability testing using Cronbach's Alpha (α) were summarized in Table 3. The test results showed that thirteen risk factors had an alpha value (α) > 0.90, which means that all risk factors had perfect reliability and the risk factors could be used for study analysis. If the value of alpha (α) < 0.50 or low reliability, then the questionnaire should be fixed by data transformation, data addition, statistical data addition, and others so that the data used for the study could be trusted.

Calculation of the CI value using the formula 1, Where n1: respondents who gave the number five, n2: respondents who gave the number four, n3: respondents who gave the number three, n4: respondents who gave the number two dan n5: respondents who gave the number one in the questionnaire.

$$CI \text{ for risk} = \frac{5n_1 + 4n_2 + 3n_3 + 2n_4 + n_5}{5(n_1 + n_2 + n_3 + n_4 + n_5)} \dots\dots\dots(1)$$

The following is an example of calculating CI values using Formula 1 for geographical conditions, such as mountainous areas, swamps, and others risk factors. With the data from the questionnaire survey result are: n1= 3, n2= 7, n3= 4, n4= 1, n5= 1. The calculation results using Formula 1 show the CI value for the risk is 0.73. A CI value in each risk that is close to 1 means that the risk affects the financial aspects of the project. However, if the risk with a CI value is close to 0, the risk does not affect the financial aspect of the project. Each risk factor is used the same calculation as that. The calculation results can be seen in Table 3.

4.1 Identify Critical Risk

After having tested the reliability and the data being declared reliable and feasible, the questionnaire data could be used in the first analysis to identify the critical risks of the toll road project. Based on the calculation of the CI for each risk factor, the CI values were shown in Table 3 with the ranking of each risk. In this study, five risk factors with the highest CI were taken, namely the risk of geographical conditions, such as mountainous areas, swamps and others (CP2), delays in work progress/not completed on time (CP 9), design errors causing

addendums/construction modifications (CP11), force majeure (natural disaster/political change/revolution) affecting the failure/delay in work completion (CP12) and extreme weather conditions such as strong winds, high rainfall and others (CP3). The five critical risks were the objects of discussion in this study: what were the appropriate mitigation strategies to overcome the risks? who was the right risk-manager? and was there an interrelationship between the critical risks?

The results of CIs in Table 3 showed that there were eight risks having a CI value of 0.61 - 0.73 and five risks having a CI value of 0.50 - 0.60. The data showed that each risk had the same relative potential to become a critical risk in the project.

Table 3 Reliability test results and critical risk calculation (CI)

Code	Risk Factor	α	CI	Rank
CP 1	Design changes requested by the owner (Government)	0.952	0.65	6
CP 2	Geographical conditions, such as mountainous areas, swamps, and others	0.952	0.73	1
CP 3	Extreme weather conditions include strong winds, heavy rainfall, and others	0.947	0.68	5
CP 4	Environmental adjustment to construction	0.949	0.59	9
CP 5	Changes in the scope of work requested by the owner (government)	0.951	0.64	8
CP 6	Limitations of tools and materials	0.947	0.56	12
CP 7	Lack of labor	0.947	0.58	11
CP 8	Delay in approval due to licensing caused by the owner (government)	0.945	0.65	6
CP 9	Delay in construction/ not completed on time	0.946	0.69	2
CP 10	Improper technical specifications on the selected auction documents	0.944	0.59	9
CP 11	Design errors that cause addendums/ constructions modifications	0.945	0.69	2
CP 12	Force majeure (natural disaster/political change/revolution) that affects failure/delay in completing work	0.946	0.69	2
CP 13	Other risks	0.947	0.50	13

4.2 Risk Allocation

Proper risk allocation is critical to the success of a project. Risk allocation refers to the main measure of assignment between participants in overcoming risks, namely the government, the private sector or shared. The risk must be allocated to the right party provided that the party has the ability to control the possibility of risk occurrence, can manage the impact of the risk, is able to bear the risk with the lowest cost, and determine risk allocation based on the calculation of the percentage of risk allocation according to the perspective of the people involved in the project [5][21]. The results of analysis are needed to find out their response to whom the risk should be borne. This

response would be compared with literature studies and guidelines for risk allocation by PT.PII in 2021.

The percentage calculation was carried out using Formula 2 where A: the risk borne by the government, B: the risk borne by the private sector, and C: the risk shared between the government and the private sector. The results of risk allocation in this study were only based on the perception of private sector.

$$\text{Risk Allocation} = \frac{EA,B,C}{\Sigma \text{Respondent}} \times 100\% \dots \dots \dots (2)$$

The following is an example of calculating risk allocation values using Formula 2 for geographical conditions, such as mountainous areas, swamps, and others risk factors. With the data from the questionnaire survey result are: A= 1, B= 5, C=10 and number of respondents= 16. Based on the calculation of the presentation of the risk allocation, 6% of respondents think that risk needs to be managed by the government, 31% by the private sector, and 63% should be managed by the government and private sector.

Table 4 Critical risk allocation for the construction phase of toll road projects

Critical risk	Risk Factor	Risk Allocation			PT.PII (2021)
		Questionnaire Survey			
		A (%)	B (%)	C (%)	
1	Geographical conditions, such as mountainous areas, swamps, and others (CP 2)	6	31	63	Private sector
2	Delay in construction/ not finished on time (CP 9)	6	56	38	Private sector
3	Design errors that cause addendums/ constructions modifications (CP 11)	6	50	44	Private sector
4	Force majeure (natural disaster/ political change /revolution) that affects the failure/delay in completing work (CP 12)	13	13	74	Shared
5	Extreme weather conditions, include strong winds, heavy rainfall, and others (CP 3)	0	44	56	Shared

Information: A (Government); B (Private sector); C (Shared)

Based on the results of the risk allocation analysis in Table 4, of the five risk factors, there was one risk that should be considered in the risk allocation. Based on the respondents' answers to the questionnaire, geographical conditions should be shared between the private sector and the government. However, based on the risk allocation guidelines, the risk is the responsibility of the private sector because it is one of the risks occurring during the construction period.

4.3 Results of Interviews And Literature Studies Of Interrelationships Between Risk And Risk Mitigation Strategies

The analysis of the interrelationship between risks and risk mitigation strategies was determined based on the results of interviews and literature studies. In this study, the interrelationship between risks was determined only based on qualitative analysis. Statistical methods are quite difficult to determine that. Varying number of respondents, data and time limitations make statistical analysis impossible.

Scope in determining risk mitigation strategies is risk estimation, analyzing risks, how to handle risks, and studying risks based on experience. In the previous study objectives, risk estimates have been carried out in the form of identifying critical risks of toll road projects, allocating risks, and analyzing the interrelationship between risks. Based on the results, it is important to plan a mitigation strategy that can be carried out to prevent, minimize and/or overcome risks. The ultimate goal of this study is to determine the mitigation strategy for each of the critical risks identified. The mitigation strategies that can be carried out are summarized based on respondents' opinions, previous study, and risk mitigation in the reference risk allocation of PT. PII in Tabel 5.

Table 5 Interview results for interrelationship between risk and risk mitigation strategy

Risk Factor	Interrelationship	Mitigation
Geographical conditions, such as mountainous areas, swamps, and others	Inaccurate data assumptions in the feasibility study	Joint mutual checks, construction redesign, changing construction specifications
Delay in construction / not finished on time	Design errors, Extreme weather, Force majeure, unavailability of land	Adjustment of government regulations and public demand, rescheduling of work
Design errors that cause addendums/ constructions modifications	Inaccurate data assumptions in the feasibility study, Delay in construction, maintenance on a large, and resulting in additional costs	Preparing good design, knowing contract and contract amendments. If risks have occurred, it is necessary to redesign the construction of the project.
Force majeure	Delay in construction, lack of financial resources	To propose an extension of time the concession from the private sector to the owner
Extreme weather conditions, include strong winds, heavy rainfall, and others	Delay in construction	Coordinating with the BMKG and can do dewatering puddles or others in location needed.

Based on the Tabel 5 causes and strategies for mitigation risks that occur in the trans Sumatra toll road project in the South Sumatra Region were known. The strategy may differ from the causes of risk in other projects. In general, the mitigation strategy for each risk in each project will be the same, but it can be modified in such a way as to address the risks that occur in the project.

5.0 RESULTS AND DISCUSSION

Based on the analysis that has been done, in this study five risks that have the highest CI value are taken as critical risks in toll road projects for the construction phase. That is, the risk of geographical conditions, such as mountainous areas, swamps and others (CP2), delays in work progress/not completed on time (CP9), design errors causing addendums/construction modifications (CP11), force majeure (natural disaster/political change/revolution) affecting the failure/delay in work completion (CP12) and extreme weather conditions such as strong winds, high rainfall and others (CP3). As for other risks, that are the risks of design changes requested by the owner (Government) (CP1), environmental adjustment to construction (CP4), changes in the scope of work requested by the owner (government) (CP5), limitations of tools and materials (CP6), lack of labor (CP7), Delay in approval due to licensing caused by the owner (government) (CP8), Improper technical specifications on the selected auction documents (CP10), and Other risks (CP13) are not a critical risk in this study. Therefore, discussions were conducted on 5 critical risks.

5.1 Geographical Conditions, Such As Mountainous Areas, Swamps, And Others (CP 2)

The risk of geographical conditions was the first critical risk in the Trans Sumatra toll road project in South Sumatra. The selected toll road alignment was in a plain area but with swamp soil type. The land topography did not require much excavation or embankment to equalize the elevation of the main road. The risks occurring in the construction and operational phases were the type of soil used as the toll road alignment; the risks included the inaccurate method of soil repair/compaction, construction failure, and main road damage. The Palembang-Indralaya toll road section was the first toll road in Indonesia using the vacuum preloading method, namely by sucking water from the ground using a special machine. Based on the results of previous studies, the Palembang-Indralaya toll road was located in swampy soil with soft clay soil type having low bearing capacity [22]. Soil with these conditions resulted in landslides and damage to the pavement above the embankment [22][23]. Therefore, the Palembang-Indralaya toll road section was planned to use the vacuum preloading method to accelerate the reduction of groundwater. However, the method was not entirely successful; the soil consolidation was completed within 14 days, which should take 2.71 years to achieve 90% consolidation using the loading method [23]. This method resulted in the Palembang-Indralaya toll road experiencing problems on the main road. The road became bumpy and potholed. As a result, major repairs were needed, but the toll revenue was still less than planned.

On the Kayu Agung-Palembang-Betung toll road section, there was an unforeseen condition where the pavement layer cracked due to the stratigraphic condition of soil layer; the condition of existing toll road soil in the form of soft soil with a thickness of up to 24 m was unable to withstand the load on it. Therefore, it was necessary to do soil improvement to increase the bearing capacity of the soil as the toll road subgrade layer.

The first mitigation strategy was that the contractor should officially submit a letter to recalculate the volume of work (joint mutual check) for construction conditions subject to subsoil stratigraphy. After the mutual check, the design

changes, the volume of work and the value of the project contract could be mutually agreed upon. Based on the risk allocation analysis, the risk of geographical conditions in the Trans Sumatra toll road project should be shared between the government and the private sector considering the draft contract that was offered by the owner at the beginning of the appointment of the private sector. The draft contract resulted in the private sector not analyzing in detail the construction design specifications offered in the contract.

It was not only the Trans Sumatra toll road sections that were at risk. On the Semarang-Solo toll road section, geographical conditions were also a critical risk [23]. The geographical conditions of the toll road alignment affected three bridge works. Uneven contoured soil conditions caused the work of bridge structures having pillars up to 54m high with the jump from and slip form construction techniques to be hampered [23]. The risk of geographical conditions was an unavoidable risk category. However, based on the results of interviews with experts, the risk can be minimized with a construction design in accordance with the land used for the toll road alignment. The contractor can also choose the best alignment of the toll road, such as on flat land, choose a road in the soil to have a good structure. This risk factor was a challenge for the private sector in the toll road construction project in Indonesia. Especially on the Trans Sumatra Toll Road in the South Sumatra region due to the type of swampland that becomes the toll road route.

5.2 Delay in Work Progress / Incompleted On Time (CP 9)

Seven out of 16 respondents thought that the risk of delays in work progress was a critical risk affecting the financial aspect that could reach 15% of the profit generated by a private sector. This risk became a critical risk in the toll road project when viewed by the stakeholders of private sector. The risk could be a non-critical risk when viewed from the perspective of the owner/government because each stakeholder had different risk factors [13]. In the contractor's perception, delays in work progress would affect the planning of costs, prices of materials and tools, wages and project completion time. This of course increased the project costs which resulted in other risks, such as filing claims for the occurring changes.

Various kinds of risks will certainly affect other works, but not all risks have a major impact on the financial aspect. For example, for a toll road project, if there is a problem in a certain station, the work can first be done in another station, thus the work can still be expected to be completed on time. However, if risks, such as land acquisition, inappropriate construction methods, delays in licensing from stakeholders and lack of funding, occur, it will certainly have an impact on project implementation time and finance. For example, the Pejagan-Pemalang toll road project experienced a two-year delay in construction completion. The impact occurred on the NPV value of six trillion and a decrease in the IRR value from 15.7% to 11.5%. The delay in completing the project created additional costs in contingency, escalation, overhead costs and interest [24].

On the Kayu Agung-Palembang-Betung toll road section, the work progress was hampered due to the soil layer stratigraphy which resulted in design changes, delays in project completion and construction cost overrun. Wraharjo's study results

showed that the construction cost of the Kayu Agung-Palembang- Betung project increased and caused the project to be financially unfeasible with an NPV value of -5,552,062 million [7]. Work progress and costs increased due to delays in land acquisition on toll road sections in several stations passing through the community environment, the incompatibility of the compensation value between the community and the government, the overlapping land ownership status making the land acquisition process to be delayed. Therefore, the strategy that could be taken to facilitate the land acquisition was to choose the toll road alignment not belonging to the community. It is better to use land owned by the government. So that the risk of land acquisition can be avoided.

5.3 Design Errors That Causing Addendums/ Constructions Modification (CP 11)

The risk of design errors/changes is common in the construction project. However, if there is a significant design change, it will result in a large increase in project costs. It is necessary to adjust the contract value and reinvestment plan, so it is very important to conduct an accurate feasibility study and assume the right data to minimize the occurrence of errors/project design modifications. Sometimes the design results having been determined based on a feasibility study are not re-examined by investors on the grounds that changes can occur in the future and investors can file claims to receive compensation [5].

There are many causes of design changes in construction projects. It happened not only on the Trans Sumatra toll road sections in South Sumatra. On the Pekanbaru- Dumai section, there was a design change caused by the toll road corridor passing through densely populated settlement and cemetery that were not possible to be acquired [17]. On the toll roads in South Sumatra, there was a design change due to embankment plan that was not suitable for the project location, and there was a difference between design and implementation. The risk of design errors happened on the Kayu Agung- Palembang-Betung toll road section; the main road embankment plan was not suitable for the project location; cracks happened on the surface layer of road pavement. The contractor should redesign the toll road embankment system. This problem resulted in delays in completion time and changes in project costs, so that contractor should make claims for design errors.

On the Palembang-Indralaya toll road section, the damage on the toll road section was not caused by a design error, but by an inaccurate embankment compaction method using the loading method as described in the previous sub-chapter. The risks related to construction problems could not be known because the toll road had been in operation. On the other Trans Sumatra toll road sections in South Sumatra, the risk of design errors had not been known because the construction work was still in process.

5.4 Force Majeure (Natural Disaster/ Political Change/ Revolution) Affecting The Failure/ Delay In Work Completion (CP 12)

Every occurrence of a disaster in a construction project will definitely affect the project finance. Construction damages,

delays in work progress and other risks arising as a result of these circumstances can be claimed to the owner. In the implementation of the construction of the Trans Sumatra toll roads, there had never been force majeure, but the Coronavirus 2019 pandemic happening in 2020 was assumed by some respondents to be force majeure due to the impacts from the pandemic, namely delays in project completion, delays in material delivery, operational limitations and delays in submitting tariff adjustments on toll roads that had been in operation, where this condition was not included in the risk analysis estimate.

According to the respondents, this risk was an unavoidable risk. The risk should be a shared responsibility between the government and the private sector, considering the impacts arising from this situation. The mitigation strategy that could be done to overcome this risk was to propose an extension of the project/concession time from the private sector to the owner. However, the proposal could not be decided quickly by the owner. Further studies were needed to determine whether or not the proposal requested by the toll road private sector would be accepted.

5.5 Extreme Weather Conditions Such As Strong Winds, Heavy Rainfall, And Others (CP 3)

Weather conditions affecting the work in the Trans Sumatra toll road project were the rainy season and wind speed. The rainy season would hamper the work related to land and road construction. The progress of toll road work would be slightly hampered at the end and beginning of each year ranging from October to March with a monthly rainfall intensity of more than 250 mm [25]. High rainfall greatly affected the work in the Trans Sumatra toll road project in South Sumatra. The swamp land having poor drainage resulted in puddles of water in the work area. This happened on the Kayu Agung-Palembang-Betung toll road section; the access road used for work mobility experienced waterlogging and made it difficult for large vehicles, heavy equipment and other means of transportation to enter the work area. However, other risks such as work accidents, damage to tools and machines, heavy equipment falling into the swamp and others did not occur because the prediction of rain had been known through the relevant agencies.

On the Prabumulih- Muara Enim toll road section, the work location on the river banks would cause puddles of water after it rained. Therefore, it was necessary to carry out dewatering and sucking water into the river before continuing the work. However, because the construction work progress had not reached 20%, the delay in work progress had not much affected the project finance. According to Wibowo, on the Semarang-Solo toll road section, weather conditions with high rainfall were also a critical risk hindering the project work [14]. However, the rainwater drainage flowed faster because the toll road was not on swamp land like those in South Sumatra. In addition to rain, another weather condition affecting work was wind speed. High wind speed could affect the work of lifting the girder beams to the abutment/toll road pillar (erection girder), where the work used a crawler crane. Unpredictable strong wind condition could result in work accidents causing death, construction damage, and equipment damage. These risks actually do not have a high potential to occur, but if they occur,

they will greatly affect the project finance. Risk anticipation can be done by measuring wind speed using tools and coordinating with the Meteorology, Climatology and Geophysics Agency (BMKG) in the region before carrying out the work.

6.0 CONCLUSION

This study identified critical risk factors in the Trans Sumatra toll road project. Five critical risks were identified for the toll road project. They were the risk of geographical conditions, the risk of delays in work progress, the risk of design changes, force majeure and the risk related to weather conditions. The identified risks were critical risks having an impact on the financial aspect based on the private sector's point of view. Generally, based on the construction project contract, the risks in the construction phase were the risks that should be borne by the private sector, but the results of this study showed that for the risk of geographical conditions, the risk allocation should be shared by both parties, because the risks occurred as a result of design errors and mechanism for selecting the contractor of toll road project. Critical risks due to force majeure and weather conditions were construction-phase risks that should be shared between the government and the private sector because they were unexpected risks and beyond the risk analysis estimate at the feasibility study stage.

The strategies to overcome these risks were by redesigning the toll road embankment system, rearranging work schedules and costs, and preparing disaster management Standard Operating Procedures (SOPs). Based on the results of discussion with the respondents and literature studies, it could be concluded that the critical risks occurring in the construction phase of the Trans Sumatra toll road project were interrelated with each other; the risks of geographical and weather conditions, design errors and force majeure would have an impact on delays in construction work, and consequently affecting the project finance. The risks could lead to changes in scope, increasing the volume of work and increasing the duration of project work.

This study has many shortcomings from various aspects. Considering that the Trans Sumatra toll road construction project is still relatively new, not many risks have been identified. It is hoped that further study could reach more respondents so that the results of critical risk identification could be more varied. The findings of this study regarding the interrelationship between risks, such as geographical conditions causing unforeseen conditions and requiring redesign, indicated that geological studies related to land used for toll roads could be conducted separately.

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