Risk Analysis of Trans Papua Corridor Road Infrastructure Development in West Papua and Papua Province of Indonesia

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ABSTRACT

Trans Papua corridor highway is now an important highway, predictable way Trans Papua will experience overcapacity in the future. To overcome this situation the trans-Papua road building is planned. The investment of highway construction will always be involved in risk with certain scale, it is necessary to do the risk analysis. The purpose of this study is to identify and analyze the risk, measuring of risk probability point and risk impact and risk test by performing simulations using @Risk For Excel software. This research was conducted using a survey method and interview with respondents. The survey was conducted in three phases, namely: beginning survey, preliminary survey and detailed survey. Based on research conducted identified four risk factors are financing risk, construction risk, equipment risk and force majeure. These four risks are identified in the medium risk category. The influence level of risk impact to the increase of construction investment budget plan trans-Papua roads as a whole amounted to 8.07% (IDR. 1,183 trillion equivalent to USD 82,684 million) with risk factor for 0.549 then classified as medium risk. While detaily 15% (IDR. 2,194 trillion equivalent to USD 153,346 million) by a factor of 0.685 then risk being classified as at risk. The most sensitive risk is the risk of Construction.

Keywords: Risk Analysis, Impact, Trans Papua, Probability, West Papua

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1. INTRODUCTION

The vast and unmanageable nature of the Papua and West Papua Province causes the level of connectedness between one region and another region to be low or not yet connected. This causes the prices in isolated areas to be very high, because these areas (the Central Mountains in Papua Province and Maybrat, Tambrau Kaimana) do not have land access to the port so that the supply of logistics becomes very expensive, because it must be supplied through air or by sea / river with a limited quantity so the price is high. The price disparity in these two provinces is quite far from other regions in Indonesia. A sack of cement in one district in the mountains of Papua can reach millions of indonesian rupiah (IDR). The price of premium gasoline (before the one-price gasoline policy) can reach tens of thousands of IDR per liter.

This condition causes the most eastern tip of Indonesia to be a part of the lowest position in the development of the welfare of its citizens. At least there are for two main indicators that reflect the lag. First, the two provinces are provinces that have the highest poverty value. The Indonesian Statistic data in 2018 shows that the percentage of poor people in Papua is 27.6% and West Papua is 23%. In other words, more than a quarter of the population in Papua can be classified as poor.

![Map of Papua Island, Indonesia](image)

**Fig. 1.** Map of Papua Island, Indonesia
The second indicator is the low number of the Human Development Index (HDI). This index measures the achievement of a country's average in three dimensions: health, education, and individual income to support a decent life. There are four categories of human development, which are very high (HDI more than 80), high (between 70 and 80), moderate (between 60 and 70), and low (below 60). Data from UNDP and BPS (2018) state that Papua and West Papua occupy the lowest position with numbers below 57 (bottom) and 62 (moderate), far below the national average which reaches 70.8.

Strengthening connectivity is one of the national development agendas that must be made in the span of 2015-2019. Improved regional connectivity will further enhance competitiveness. Having increased competitiveness will increase the productivity of economic resources, which in turn will make a positive contribution to economic growth. One infrastructure that is supposed to be able to improve connectivity is the road. Road construction is considered to be able to open up the isolation of the region and trigger an increase in the socio-economic activities of the community.

Efforts to build connectivity are largely dependent on the efforts of accessibility. Accessibility is a concept that is understood as an effort to connect the system of regulating geographical land use with the transportation network system that connects it. One important dimension of regional accessibility is the relationship formed between the location of housing and the location of workplaces through the provision of existing road networks. Accessibility consists of infrastructure (road network system) that is available along with the availability of means to carry out movements (private transport and public transportation).

Trans Papua stretches 4,330.07 km in two provinces, namely Papua and West Papua. Especially in Papua Province, Trans Papua is divided into 10 segments along 3,259.45 km. After the infrastructure is completed, it becomes very important to encourage economic stretches along the Trans Papua corridor. In the context of construction management, the risks that arise in each construction project can have an impact on the failure to achieve goals. In addition, the urgency of risk identification and risk analysis of the construction phase in the construction of Trans Papua road infrastructure will provide efficiency for regional development in the future.

2. THEORY REVIEW AND RESEARCH METHODOLOGY

2.1. Definition of Risk and Risk Analysis

The phenomenon of risk is a subject of investigation for many both practitioners and theorists. However, only a few of them take these problems and try to formulate the problem within the framework of a procedure. In many publications, the authors deal with the problem of identification of hazards areas and their classification in different groups, among others, due to the source of origin, the impact size, etc. [10].

The number of papers proposing a methodology of quantifying of the risk and elaboration of procedures for the adoption of appropriate actions (so called “an appropriate strategy on risk response”) is relatively lower. Risk is an association of the probability of an event with its consequences or consequences. Risk analysis is a method of identifying and measuring risk, development, selection and management programs to deal with these risks in an organized manner. This includes three aspects, namely: risk identification, risk assessment and risk management [11, 12, 14].
2. 2. Risk management

Risk management is a systematic process of planning, identifying, analyzing, responding, and monitoring project risks. Risk management involves processes, tools, and techniques that will help managers maximize the possibilities and results of positive events and minimize the possibilities and consequences of negative events. Risk management generally consists of 2 processes, namely: the risk analysis process and the risk management process.

In recent years, it is noticeable the increased interest of the risk problem from the perspective of the construction industry. The research areas in the risk management are focused on the identification of random factors, determination of the probability of their occurrence and their impact on the course of a construction project. The problems, which often occur in terms of the risk analysis in the listed publications, are the following ones:

(1) Methodology/procedure of risk analysis for a project [1, 13, 24-26, 30].
(2) Proposition of risk classification according to the source of origin, type, consequences [1, 10].
(3) Review and classification of selected methods supporting the risk management in projects [2, 21].
(4) Analytical application of method/tool to a specific problem in the scope of risk analysis [4-7, 13, 15-19, 22-26, 28-30].
(5) Risk management in construction projects – theory and practice [3, 8, 9, 27].

2. 3. Risk Level Analysis Method

Risk level analysis is built on the investment risk factor equation, where the magnitude of the risk factors is an illustration of the level of investment risk that occurs. The risk factor equation is defined as the multiplication of the magnitude of the impact and probability of the risk event, which is calculated from the following equations [6, 8, 20]:

\[ RF = L + I - (L \times I) \] ................................................................. (1)

where:

RF = Risk factor, with a scale of 0-1
L = Risk Probability
I = The amount of impact in the form of increased costs

<table>
<thead>
<tr>
<th>RF Value</th>
<th>Category</th>
<th>Steps for Handling</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 0,7</td>
<td>High Risk</td>
<td>Risk reduction must be carried out to a lower level</td>
</tr>
<tr>
<td>0,4 – 0,7</td>
<td>Moderate Risk</td>
<td>Repair steps are needed in a certain period of time</td>
</tr>
<tr>
<td>&lt; 0,4</td>
<td>Low Risk</td>
<td>Repair steps whenever possible</td>
</tr>
</tbody>
</table>

Table 1. Risk Categories
The multi-attribute approach is well suited to the problem related to selection, including: the variant of a project, investment, contractor, location, technology of production of particular structure elements in a building, choice of a tender strategy, evaluation of tenders, specifying utility state of a building, estimation of construction costs, evaluation of accident situation in the construction industry, etc. according to the predefined criteria (the qualitative ones and the quantitative ones) [5, 11, 12, 22, 24, 29, 30].

In the Fig. 2 it is presented an assessment of investment projects from the perspective of a risk. It was used one of the popular multi-criteria methods, namely Risk Category Matrix, and it was assumed the similar significance criteria as at the risk register.

2.4. Data collection

The research that will be conducted is used by the survey method by distributing questionnaires and interviews with respondents. Respondents were selected who were competent and understood about risks in road infrastructure projects. In general, the survey was conducted in 3 (three) stages:

1) Pre-preliminary survey is a survey that is intended to identify risk factors in the construction of the Trans Papua road construction phase.
2) Preliminary survey is a survey that aims to measure the likelihood / probability of occurrence of risk factors and their impact or effect if the risk occurs and identify the effect / impact of the occurrence of risk factors on the construction of the Trans Papua road construction phase
3) Detailed survey is a survey that aims to justify risk factors and risk mitigation from several risk factors in the construction of the Trans Papua road construction phase which is classified as medium and high risk factors and determines the percentage magnitude of the impact on the budget plan for alternatives in risk sensitivity testing using @Risk for excel software
3. RESULTS AND DISCUSSION

Based on data on road and transport growth and future projections, it can be projected that the growth of the average vehicle volume (Passenger Car Unit / PCU) that passes the Trans Papua road in West Papua Province from 2010-2035 ranges from around 20% while after 2010-2015 the volume increased by 35%. The projection of the volume projection of the Trans Papua road vehicle in West Papua Province after the construction of the trans-Papua road corridor in 2020 with a total of 14,514 PCU / day.

![Projected traffic volume of West Papua Province](image)

<table>
<thead>
<tr>
<th>Year</th>
<th>2010</th>
<th>2015</th>
<th>2020</th>
<th>2025</th>
<th>2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total (PCU/day)</td>
<td>8,946</td>
<td>10,736</td>
<td>14,514</td>
<td>29,403</td>
<td>47,666</td>
</tr>
</tbody>
</table>

**Fig. 3.** Graph of Projection of Traffic Volume of Trans Papua corridor in two provinces of West Papua and Papua

On the other hand, the projection of the volume of road vehicles in Papua Province after the construction of the trans-Papua road corridor is projected to increase the average vehicle volume volume from 2010-2015 to around 25% and 2015-2020 the volume continues to increase by 38%, and volume projected the Trans Papua road vehicle in Papua Province in 2020 with a total of 39,581 PCU / Day while road capacity in Papua province was 27,936 PCU / Day, so based on the conditions of the Papua Province road section of 2 lanes and 2 directions it was predicted that this section would experience overcapacity (Provincial Statistics of Papua, 2018).

To overcome traffic growth and increase the efficiency of distribution services to support economic growth in the Papua Province. Road repairs in Trans Papua are needed both in West Papua Province and Papua province.

3. 1. Pre Preliminary Survey Results

In the pre-preliminary survey phase, to identify each risk factor in the construction phase of the Trans Papua road project, the respondents needed must be competent in the construction of roads and bridges. At this stage of the identified risk factors include: financing, Construction, Equipment, Force Majeure
3.2. Preliminary Survey Results

The preliminary survey is measuring the risks that have been identified previously in the introductory survey by measuring how likely / probable the risk is to occur and how big the impact is if the risk occurs.

3.3. Risk Probability Measurement

The results of the measurement of the probability / probability of risk in the construction of the Trans Papua road can be observed in Figure 4. The results of the preliminary survey for the measurement of the probability of occurrence of risk in financing risk factors showed a value of 0.545 while the previous year's research was 0.591. There was a difference of about 8%. For Construction risk factors, there is different from those of around 16% between the results of the preliminary survey and the results of the previous year, namely 0.461 in the preliminary survey and 0.548 in the previous year.

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Probability Average Preliminary Survey</th>
<th>Probability Average Previous Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financing</td>
<td>0.545</td>
<td>0.591</td>
</tr>
<tr>
<td>Construction</td>
<td>0.461</td>
<td>0.437</td>
</tr>
<tr>
<td>Equipment</td>
<td>0.518</td>
<td>0.437</td>
</tr>
<tr>
<td>Force Majeure</td>
<td>0.333</td>
<td>0.504</td>
</tr>
</tbody>
</table>

Fig. 4. Graph of Comparison of Risk Probability

On equipment risk factors show a value of 0.518 while the results of the previous year's research are 0.437, there is a difference of 16%. Whereas force majeure there is a difference of about 34% between the results of the preliminary survey and the results of the previous year's research, which was 0.333 in the preliminary survey and 0.504 in the previous year. Thus it can
be seen that the probability of the occurrence of risk factors for the construction phase in the construction of the trans-Papua road is generally smaller than the typical probability of occurrence of road infrastructure investment risks in Indonesia sourced from the Center for Research and Development of Public Works. This is caused by differences in the characteristics of the Papua Province and West Papua Province.

3. 4. Risk Impact Measurement

The results of the measurement of the effect or impact of risks on the construction of the trans-Papua road can be observed in Figure 5. The results of the preliminary survey to measure the impact of risk on financing risk factors showed a value of 0.670 while the consequences of the previous year were 0.134, there was a difference of around 80%.

For Construction risk factors, there is different from those of around 69% between the results of the preliminary survey and the results of the previous year, namely 0.601 in the preliminary survey and 0.189 in the previous year. On equipment risk factors showed a value of 0.554 while the results of the previous year's study were 0.116, there was a difference of 79%.

![Comparison of the impact of risk in the construction phase obtained from the preliminary survey based on the guidelines of last year's survey / previous survey](image)

**Fig. 5.** Comparison of Risk Impact Charts
Whereas to force majeure there is a difference of around 72% between the results of the preliminary survey and the results of the previous year's research, namely 0.631 in the preliminary survey and 0.178, in the previous year. Thus it can be seen that the effect (impact) of the risk factors of the construction phase on the construction of the trans-Papua road is greater when compared to the typical value of the impact due to the risk of road infrastructure investment sourced from the Research and Development Center for Public Works. This may be due to high-cost phenomena in the provinces of Papua and West Papua related to aforementioned road infrastructure projects.

3. 5. Road Infrastructure Risk Analysis

The results of the measurement of risk factors and risk categorization at the construction stage on the Trans Papua road can be seen in Figure 6.

![Graph of Risk Factor Measurement and Risk Categorization](image)

**Fig. 6.** Graph of Risk Factor Measurement and Risk Categorization

The results of the measurement of risk factors and risk categorization are as follows: financing risk 0.606, Construction risk 0.563, equipment risk 0.574, and force majeure 0.452. Because the value of risk factors is more important than 0.4 and smaller than 0.7, all risk factors identified in the construction of the Trans Papua road are included in the medium risk category.

3. 6. Investment Risk Simulation Construction Phase Using @Risk For Excel

To test the risk sensitivity, the construction phase is split into 4 (four) alternatives.
a) First Alternative (Option 1)

The first alternative was developed with risk probability data taken through a preliminary survey and data on the magnitude of the risk impacts taken from the Bridge and Road Research Center in the previous year.

![Investment Risk Simulation Results for First Alternative](image)

Based on the simulation results using the triangle distribution (using the model 2 tails 90% value for 5% error), obtained the average value (mean value) is IDR. 15,028 trillion in the range of budget plans costing IDR. 14,327 trillion to IDR. 15,768 trillion (Fig. 7).

b. Second Alternative (Option 2)

This second alternative was developed with risk probability data and data on the magnitude of the risk impacts taken through a preliminary survey.

Based on the simulation results using the triangle distribution (using the model 2 tails 90% value for 5% error), obtained the average value (mean value) is IDR. 16,233 trillion with a budget plan for IDR. 14,655 trillion to IDR. 17,962 trillion (Fig. 8).
c. Third Alternative (Option 3)

This third alternative was developed with risk probability data taken through a preliminary survey and data on the magnitude of the risk impacts taken through a detailed survey to the Head of Planning Section for Highways in the Public Works Office of the Provinces of Papua and West Papua.
Based on the simulation results using the triangle distribution (using the model 2 tails 90% value for 5% error), obtained the average value (mean value) is IDR. 14,961 trillion with a budget plan costing IDR. 14,195 trillion to IDR. 15,746 trillion.

d. Fourth Alternative (Option 4)

The fourth alternative was developed with risk probability data taken through a preliminary survey and the magnitude of the risk impact data taken through a detailed survey to the Head of the Planning Section of Highways at the Public Works Office of Papua and West Papua Provinces assuming that the Government can control risk by managing risk.

The simulation results using the triangle distribution (using the model 2 tails 90% value for 5% error), obtained the average value (mean value) is IDR. 14,630 trillion with a budget plans costing IDR. 14,152 trillion to IDR. 15,081 trillion.

Fig. 10. Investment Risk Simulation Results for Fourth Alternative

4. CONCLUSIONS

The following are conclusions that can be drawn from the research. Identified risks are: A. Financing risks, B. Construction risks, C. Equipment risks. D. Risk of force majeure. The magnitude of the risk probability measured in the Trans Papua road construction project construction phase is smaller than the typical probability of the occurrence of road infrastructure investment risks in Indonesia originating from the Center for Public Works. This is caused by differences in the characteristics of the Papua Province and West Papua Province.

The magnitude of the risk impact obtained in the preliminary survey is greater than the typical value of the impact due to the risk of road infrastructure investment sourced from the
Center for Public Works. This may be caused by high-cost phenomena in the provinces of Papua and West Papua related to previous road infrastructure projects.

Based on the level of risk analysis, the financing risk factors obtained are 0.606; Construction risk factors of 0.563; risk factor of 0.574; force majeure risk factors of 0.452. From these results, it can be seen that the financing risk, Construction risk, equipment risk and force majeure risk is classified as moderate risk.

Risk sensitivity analysis in the construction project of the Trans Papua road construction phase with 4 (four) alternatives obtained: A. The first alternative, which is the Construction of data from the Bridge and Road Research Center in the previous year, obtained a mean value of IDR. 15,028 trillion. B. The second alternative, which is the Construction of data from the preliminary survey, obtained a mean value of IDR. 16,233 trillion. C. The third alternative, which is the Construction of data from detailed surveys (before risk mitigation), obtained a mean value of financing of IDR. 14,961 trillion. D. The fourth alternative, which is the Construction of data from detailed surveys (after risk mitigation), obtained an average value of IDR. 14,630 trillion.

The policy implications of the results of this study are as follows: For the Government that is fully responsible for the activities of the Trans Papua road construction project, especially this construction phase so that it can be taken seriously and wholeheartedly, so that the budget plan is in accordance with the fourth alternative, and if it is not taken seriously it is not possible rise above the first, second and third alternatives. For Construction risks that have high sensitivity, it is necessary to develop mitigation alternatives specifically to reduce the impact of these risks.

At the risk of financing (investment) that can hinder the realization of the Trans Papua road, it needs to be further investigated and specifically developed mitigation alternatives (government policy) so that the Trans Papua road construction project can be realized immediately. For further research into the risk analysis of the Construction of the Trans Papua road in the post-construction phase, to complete the 2 analysis of the risks of the Construction of the Trans Papua road.

Reference


