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Risk Management in Suai Highway Construction Project, Município Covalima - Timor Leste

Gregorio Antero Varela Guterres[1], Yulvi Zaika[2], Agus Suharyanto[3]
[1, 2, 3]Department of Civil Engineering, University Brawijaya, Malang, Indonesia-65145

Abstract**—***Highway construction from Suai to Beaço – Timor Leste was the first highway construction ever established Timor Leste after 19 years of being separated from the Republic of Indonesia. This toll connected 4 regions in Timor Leste; Município Covalima, Município Ainaro, Município Manufahi and Município Viqueque. This toll road was constructed to facilitate the transportation of various products from natural resources such as fossil fuel and gas that were processed in Suai, Município Covalimaand Beaço, and Município Viqueque. The implementation of highway construction often faced some problems including land acquisition, financial problems, and time which constraints were considered dominant enough that needed special risk management. This study was conducted to analyze the identified risks in the field, in which 40 types of risk were known to affect the toll road construction. Those risks were categorized into two dominant risks; unacceptable risk which consisted of 13 types of risk (32%) and 17 unexpected risks or 43%. Regarding to the results of this study, it was considered necessary to minimize the risks by conducting better risk mitigation to the concerned parties including project owners, contractors, and consultants.*

Keywords**—***Highway, risk, Timor Leste, mitigation.*

I. INTRODUCTION

Environment is the place where people live their daily life and interact each other. Favorable and healthy environment will support better life. Environment sustainability should be seen as an obligation for every person, in which each person is expected to have adequate knowledge of environment in order to establish better environment in the future for the next generation. Environmental knowledge teaches the society about the environment and how environment affects human's life on earth.

Infrastructure development is an important agenda in today's era of modern society. This importance is indicated by the development of various infrastructure facilities in various sectors, including the energy system, road transportation, office buildings which require adequate support from reliable infrastructure. Economic growth and development in Timor Leste is regarded as one of infrastructures that can be built in all part of Timor Leste.

This research focused on the highway construction project carried out in Suai - Zumalai (Fatucai), Municipio Covalima, Timor Lesteas the first toll road project in Timor Leste which was expected to increase the accessibility and provide significant benefits for the community. Thehighway was also expected to provide betteraccess to the port. The highway connects four municipalities in the southtern part of the country, Covalima, Municipio Ainaro, Municipio Manufahi and Municipio Viqueque. The highway construction project was divided into four work sections; first section with 34.275 km (main road) from Suai (Municipio Covalima) - Fatucai (Sub Distrito Zumalai), the second section of 34,300 km long (main road) from Fatucai - Betano (Municipio Manufahi), the third section of 34.475 km long from Betano - Clacuc (Município Viqueque) and fourth section of 52.662 km from Clacuc - Beaço (Municipio Viqueque). Besides this project was expected to parse the traffic congestion, it was also expected to support the transportation of natural resource products from Suai to Beaço.

The construction of the highway project in Suai - Fatucai, Município Covalima was the first highway construction which took a long time to complete. Regarding to the length of the project duration, it is necessary to conduct research on possible risks that might arise during the implementation of the construction project. The results of the risk analysis of the highway construction project from Suai to Zumalai (Posto Adminitrativo) showed some risks should be seriously taken into account by the contractoras the impact of the risks might hamper and disrupt the implementation of the project in terms of land acquisition, techniques used, equipment, costs and time.

According to Setiawan, A. et al. (2014), researchon the risk management analysis ofhighway development projectis able to help in determining the possbile the risk factors in some phases including; planning stage, public response, auction, determination of project value, the construction phase, external or non-technical aspects and other deviations.

Sandhyavitri, A. et al. (2014) has analyzed the risks of highway construction in Pekanbaru - Dumai using a qualitative descriptive analysis method which result showed that the possible risks included; Risk of project financing, project development risk, equipment risk and force majure risk.

Nurlele, et al. (2014) identified and analyzed the risk management in high-rise building infrastructure development projects using the House of Risk (HOR) method. The research successfully identified several risks including the ones that occurred during resource procurement process, inadequate coordination with project owner and unfavourable scope of work.

Patrickson, A. et al., conducted a study using the Fault Tree Analysis method to analyze the risks of Kapuk Naga Indah bridge construction. Based on the results of previous research, the risk of collapse or fall of the bridge girder is the most dominant risk that might appear in the implementation process and equipment preparation.

Karim, AM (2017) conducted a study entitled the Identification of Risks in the Construction of Long Range

Gregorio Antero Varela Guterres, Yulvi Zaika, and Agus Suharyanto, "Risk Management in Suai Highway Construction Project, Município Covalima - Timor Leste," *International Research Journal of Advanced Engineering and Science*, Volume 3, Issue 4, pp. 33-38, 2018.

International Research Journal of Advanced Engineering and Science
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Bridges (Case Study of Sunda Strait Bridge Development). This research was administered using qualitative research method to identify the risk of delays, quality failures, and cost overruns during project implementation, planning, supervision of work in the field and monitoring for long-range bridges in and external risks such as bad weather conditions.

Iek, M. (2013) analyzed the impacts of road construction on the growth of business and economy in the inside of May Brat, West Papuan Province using a qualitative descriptive research method. The result of the study inferred the presence of negative impact related to changes in community economic business income, and greater social impact than economic impact.

Research Objectives

This research was done to:

1. Assess various sources of risks in the construction of toll road from Suai to Fatucai.
2. Identify the dominant risks (major risks) in highway construction from Suai to Fatucatai, Covalima.
3. Mitigate the dominant risks (major risks) in highway construction from Suai to Fatucatai, Covalima.

II. Research Method

2.1 Research Data

This research took place in Timor Leste, focusing on the construction of the Suai, Município Covalima highway project. This research was conducted using a qualitative descriptive method and quantitative method. The qualitative descriptive method was used to obtain systematic description and systematic pictures.

Fig. 1. The Site Map of Suai, Municipio Covalina – Posto Adiminitrativo Zumalai (Covalima) highway Construction.

As explained in the introduction, the highway construction in the southern region of Timor Leste was administered to improve the transportation of natural resources products such as crude oil and natural gas to be processed in Suai and Beaço areas.

The site map shows the four sections of the construction project. However, the researcher only had access to investigate the one in section I; from Suai, município Covalima to Fatucai sub-district.10 risk sources and 40 variables have been identified from the first section, the discussion on the risk sources matched the use of the research method. Yet, the researcher only investigate the first section, with a 34.275 km of highway length as shown in table 1.

Based on research conducted in the field, 30 sample data were obtained from: one Government or Project Owner, 10 Project consultants, 5 Technical supervisor consultants, 5 project contractors, 4 village heads, 3 academician, and 2 local communities.

The validity and reliability of the obtained data were analyzed using SPSS version 20.0 software to see the correctness and consistency of respondents' answers.

TABLE 1. The steps of project administration.

No.	Section	Município	Distance (Km)
1	I	Suai, Covalima – Fatucai, Zumalai	34.275
2	II	Fatukai – Betano, Manufahi	34.300
3	II	Betano, Manufahi – Clacuc, Viqueque	34.475
4	IV	Clacuk – Beaço, Viqueque	52.629
Total			155.679

Source: Research data 2018

2.2 Risks and Sources of Risk

Risk variables were analyzed based on 40 variables, while the sources were determined from the questionnaires. Hence, the risk analysis was in accordance with the related variables and risk sources.

TABLE 2. Risk analysis variables.

No	Risk Variable	Risk Sources
1	Is there any tender process that is not transparent?	Licensing
2	Is there any contract document that is not made in detail?	
3	Is the auction unsuitable with the regulations that applied?	
4	Are the design and the real construction often different?	Design
5	Are unsuitable design often occurring?	
6	Are the estimation used in the error-free?	Appropriateness
7	Does inappropriate planning might cause changes in plan?	
8	Is BOQ not completed with details?	
9	Is there any problem related to land acquisition with the community?	Land Acquisition
10	Is there any problem with the land acquisition and compensation process?	
11	Are there any objections from residents related to the land that will be used for toll roads?	
12	Does land acquisition spark any conflict with the community?	
13	Is there any financial risks that might trigger construction delays?	Financing
14	Is there any increase in the price of materials during the construction project?	
15	Is there any delays of the schedule that affect the project financing?	
16	Is there any increase in non-technical factors?	
17	Is there any changes in national economic condition and government financial regulation?	
18	Is there any unpredictable occurrences on field?	Construction Implementation
19	Is the weather suitable for the construction project?	
20	Is there any lack of materials for the construction project?	
21	Is there any loss of materials?	

Gregorio Antero Varela Guterres, Yulvi Zaika, and Agus Suharyanto, "Risk Management in Suai Highway Construction Project, Município Covalima - Timor Leste," *International Research Journal of Advanced Engineering and Science*, Volume 3, Issue 4, pp. 33-38, 2018.

International Research Journal of Advanced Engineering and Science
ISSN (Online): 2455-9024

22	Is the quality of the construction appropriate with the specification?	
23	Is there any worker strike during the project implementation	
24	Is the schedule incompatible with the real condition?	
25	Does the implementation method match the technical specification?	Construction Implementation
26	Is there any difficulties in material procurement (accessible location)?	
27	Is material supply schedule inappropriate?	
28	Is there any considerable material damage in the storage?	
29	Is there any work that need to be repaired during the construction?	
30	Is there any monitoring activity toward the material supply on site?	
31	Is there any damage in the tool (heavy tools) that causes project delay?	Tools
32	Is there any lack of tools during the work?	
33	Is there any risk of natural disaster such as earth quake, land slide, flood that might disturb and lead the construction project to failure?	Force Majure
34	Is there any unexpected unstable land movement?	
35	Is there any political issues that disturb the implementation of the project?	
36	Is there anything that need to be repaired in the project maintenance?	Operational Stage
37	Is it cost-free to use the toll road?	
38	Is there any long-term operational cost in the project?	
39	Is there any natural disaster that occurred after the project finished?	Force Majure
40	Is there any land subsidence after the completion of the project?	

Source: Research data 2018

2.3 Research Method

The data analysis on the risk variable was conducted using a descriptive qualitative method. Meanwhile, the validity and reliability test conducted on the scale of risk probability and risk consequences are presented in Table 3.

TABLE 3. Scale of probability and risk consequences.

Probability Level	Scale	Level of Consequence	Scale
Highly frequent (100 %)	5	Very high (100 %)	5
Frequent (75%)	4	High(75%)	4
Seldom (50%)	3	Moderate (50%)	3
Infrequent (25%)	2	Low (25%)	2
Never/Very rare (0%)	1	None/Very low (0%)	1

Source: Godfrey (1996)

The level of risk acceptance seen from the scale of acceptance, value of risk and risk acceptance in the construction of the Suai - Fatucai, Covalima highway can be measuredthrough risk assessment by multiplying the risk mode frequency value by the frequency mode of risk consequences. The result of the multiplication shows the risk value to determine the level of risk acceptance. The risk probability and risk consequence are determined based on the maximum percentage of the results of questionnaire distributed to the respondents.

Risk acceptance value = Risk probability value x Risk consequence value (1)

The level of assessment and risk acceptance of the construction of the Suai - Fatucai, Covalima toll road using using linkes scale are described in Table 4.

TABLE 4. The scale of risk acceptability.

Scale of Risk Value	Level of Risk Acceptability
$X \geq 15$	Unacceptable
$5 \leq X < 15$	Unexpected
$3 \leq X < 5$	Acceptable
$X < 3$	Neglected

Source: Suputra, 2005

The method for analyzing dominant risks can be determined based on unacceptable risks. These dominant risks are obtained from the multiplication of possible risks and risk consequences equal to or greater than 5. If the existence of dominant risks will have major effect on the implementation of highwayconstruction and dominant risks with high percentage indicate that the risks are unacceptable within the highwayconstruction as they might inhibit the process since they share negative impacts in terms of cost and time of project implementation.

Risks that are identified as dominant risks are risks that cannot be accepted and are unexpected risks are classified as major risk in the implementation of the construction of the Suai - Fatucai, Covalima highway. Therefore, it is necessary to mitigate or minimize those risks by regarding to the sources of the risks.

2.4 Risks Mitigation

Risk mitigation refers to any action taken to minimize or reduce the occurrence of the identified risks. Flanagan and Norman (1993) describe 4 ways of risk mitigation; bear the risk, reduce the risk, transfer the risk, and avoid the risk. Risk can be reduced through efforts or actions that are intended to reduce the consequences of the risks that are expected to occur, although there is a possibility that certain risks cannot be fully reduced. Yet, the action should be done to maintain the risk at an acceptable level of risk consequence.

III. RESULTSAND DISCUSSIONS

3.1. Risk Identification

This research was conducted in Timor Leste particularly in the site of Suai, Município Covalima highway construction, and this research was only carried out on the construction of the Suai - Fatucai, Covalima toll road project.

Research data were obtained from the field through respondents' answers upon the questionnaires based on risk sources and risk variables including the types of risk sources seen from various activities such as licensing stage, design, feasibility study, land acquisition, financing, implementation, equipment, force majure, operational phase and force majure in the implementation of the Suai - Fatucai, Município Covalima highway construction project. Source of risks based on activities and percentage of risk sources are presented in Figure 2 and Figure 3.

Gregorio Antero Varela Guterres, Yulvi Zaika, and Agus Suharyanto, "Risk Management in Suai Highway Construction Project, Município Covalima - Timor Leste," *International Research Journal of Advanced Engineering and Science*, Volume 3, Issue 4, pp. 33-38, 2018.

International Research Journal of Advanced Engineering and Science
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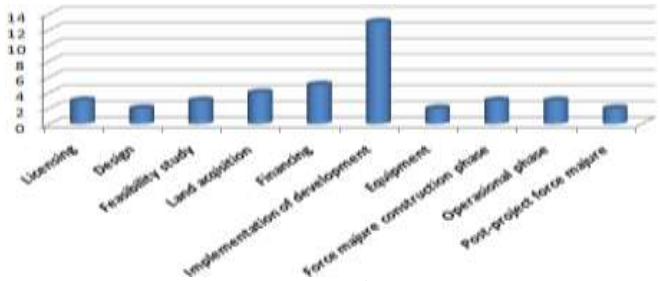

Fig. 2. The number of risk sources.

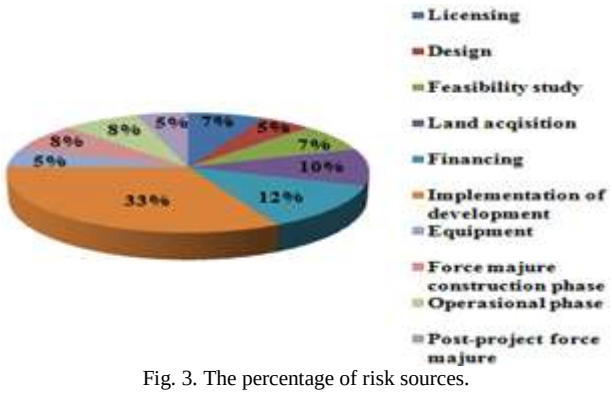

Fig. 3. The percentage of risk sources.

It can be seen in Figure 2 that out of 10 risk sources is the implementation of the construction project, financing and land acquisition had the biggest portion. When problems related to those aspects occur, it is often difficult for Contractors or Consultants in the field to deal with such problems. This is due to the fact that those problems trigger inappropriate results withthe predetermined specifications, difficulties in procuring materials, unsupportive weather conditions, changes in the economic condition, raises in the price of materials, late payment, conflicts against the community regarding to land tenure, the process of land acquisition and compensation.

3.2 The Level and Assessment on Risk Acceptability

The risk level and risk acceptance in the construction of Suai - Fatucai highway, Covalima are described as follows:

From the acceptance scale, the risk value and risk acceptance value in the construction of Suai - Fatucai, Covalima highway can be explained through risk assessment carried out by multiplying the value of possible risks with the risk consequences as shown in table 5.

Risk variables are analyzed based on 40 variables which sources are determined based on the questionnaires, allowing the risks to be analysed based on the appropriate variables and sources of risk. From the risk variables, dominant risks and other risk-free variables can be determined as the data analysis cannot measure the risk. Hence, the dominant variables in the risk source showed 30 identified risks, in which 13 variables or 32%are categorized unacceptable and 17 variables or 43% categorized unexpected risk.

TABLE 5. The level of risk assessment and risk acceptance.

No.	Risk Variable	Probability of Risk	Risk Consequence	Risk Value	Risk Acceptability
1	9	4(40%)	5 (40%)	20	Unacceptable risks
2	21	4 (50%)	5 (43%)	20	
3	26	2 (50%)	5 (44%)	20	
4	44	4 (37%)	5 (46%)	20	
5	35	4 (37%)	5 (47%)	20	
6	10	4 (50%)	4 (37%)	16	
7	12	4 (47%)	4 (30%)	16	
8	13	4 (43%)	4 (47%)	16	
9	16	4 (47%)	4 (47%)	16	
10	22	4 (40%)	4 (44%)	16	
11	30	4 (47%)	4 (50%)	16	
12	31	4 (57%)	4 (53%)	16	
13	32	4 (54%)	4 (44%)	16	
14	24	2 (80%)	3 (40%)	6	Undesriable Risks
15	29	2 (34%)	4 (40%)	8	
16	14	3 (44%)	3 (54%)	9	
17	20	3 (53%)	3 (53%)	9	
18	27	3 (44%)	3 (43%)	9	
19	36	3 (57%)	3 (54%)	9	
20	39	3 (50%)	3 (40%)	9	
21	40	3 (50%)	3 (40%)	9	
22	11	4 (36%)	4 (36%)	12	
23	15	3 (60%)	3 (60%)	12	
24	17	4 (50%)	3 (44%)	12	
25	18	4 (43%	3 (40%)	12	
26	19	4 (53%)	3 (40%)	12	
27	23	3 (60%)	4 (43%)	12	
28	25	4 (43%)	4 (43%)	12	
29	28	3 (40%)	4 (44%)	12	
30	33	3 (60%)	4 (50%)	12	

Source: Research result 2018

3.3 Dominant Risk (major risk)

Dominant risks (major risk) are risks that are unacceptable under the category of unexpected risk. These risks have dominant risk (risk acceptability) with the result of multiplication between risk probability and risk consequence equal to or greater than 5(five)

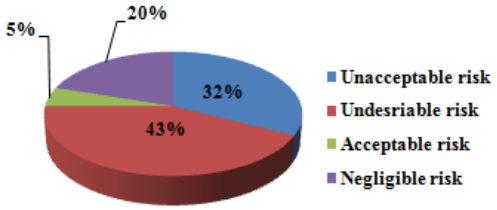

Fig. 4. The percentage of dominant risk acceptability value.

Of the 40 variables, 13 risks have been considered unacceptable with a risk percentage of 43% and 17 risks are identified unexpected risks with a risk percentage of 32%, both risks are considered dominant. Therefore, it can be understood that the construction of Suai – Fatucai highway in Covalima is a high-risk project since more than half of the identified risks are dominant risks that need special attention.

3.4 Risk Mitigation

The mitigation of unacceptable and unexpected risks in thehighway construction can lead to excessive project work in the field is described in Table 6 and Table 7.

Gregorio Antero Varela Guterres, Yulvi Zaika, and Agus Suharyanto, "Risk Management in Suai Highway Construction Project, Município Covalima - Timor Leste," *International Research Journal of Advanced Engineering and Science*, Volume 3, Issue 4, pp. 33-38, 2018.

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ISSN (Online): 2455-9024

TABLE 6. Mitigation of unacceptable risks.

Risk Value	Number of risk	Risk Source	Risk Mitigation
20	9	Land Acquisition	It is necessary to conduct continual negotiation between the government and land owner to reach a final solution.
	21	Implement ation	Material loss on site can be controlled in the beginning and after work in a day.
	26		Tight material control should be undertaken.
	34	Force Majure	Soil stability should be continually assessed.
	35		If the project is timely finished, politicians are expected to reach one agreement upon an opinion.
16	10	Land Acquisition	Compensation should be given to landowners based on landowners' requests and regulations.
	12		Transparency should be enhanced among project owners to prevent conflicts from occurring.
	13	Financing	To prevent any delay in the completion of a project, workers' wage should be paid on time.
	16		Contractors are required to hire professional workers to handle financial management of the project.
	22	Implement ation	To obtain quality construction as expected, tight control should be administered by consultants and technical consultants.
	30		To prevent any problems related to material delivery, material procurement should regard the location of the project.
	31	Tools	Well-experienced technicians should be hired to professionally fix and repair heavy equipment.
	32		Regarding to the lack of equipment, contractors should provide tools and equipment required in the completion of the project.

Source: Research 2018

IV. Conclusions and Suggestions

Conclusions

Regarding to the data analysis done in this study, conclusions are drawn as follows.

1. Risk sources in the construction of Suai - Fautcai highway, Covalima based on each activity at the stage of project implementation in the fieldinclude: Licensing step, project design, feasibility study, land acquisition, financing, construction, equipment, force majure stage construction, operational phase and post-stage force majure.
2. The most dominant risks are unacceptable risks and unexpected risks. Therefore,out of the two dominant risks, there are some most risky activities: Implementation of construction, financing and land acquisition.
3. Risk mitigation can be administered to minimize or reduce the negative impact of dominant risks. The risky activities include the inappropriate quality with the predetermined specifications, less-strict control by the consultant and consultant techniques, employee strikes, late wage payment, problems related to the government, conflict between government and contractors upon the land, and conflicts related to land acquisition against landowners. Those occurrences can cause delays in the construction of the Suai - Fatucai, Covalima - East Timor highway.

TABLE 7. The mitigation of unexpected risks.

Risk Value	Nu. of risk	Risk Source	Risk Mitigation
6	24	Implementati on	Contractors are expected to carry out the project as scheduled.
8	29		Technicians should be firm in conducting their jobs.
9	14	Financing	Field contractors are expected to make good anticipation over the fluctuate in material price.
	20	Construction Phase	It is necessary to allocate the fund for workers' wage in order to prevent workers from conducting any strike.
	27		Material selection and delivery should be conducted within the scheduled time.
	36	Operational Phase	Soil compaction should be properly done to meet the predetermined conditions.
	39	Major Force	It is necessary to re-specify the construction to prevent another risk from occurring.
	40		Thorough monitoring and tight control should be administered by consultants in order to avoid unnecessary repair.
12	11	Land Acquisition	Good and transparent negotiation should be administered with both land owners and the community.
	15	Financing	Contractors are expected to conduct the material procurement based on the predetermined schedule to avoid fluctuating material price.
	17		When weather does not support the work activities, the work should be postponed and done at night as overtime work.
	18	Construction	It is necessary to conduct appropriate survey to prevent any unexpected occurrences.
	19		The government is expected to keep the condition in the nation stable.
	23		Material delivery on site should be well-planned..
	25		Works that need special technical specification should be done appropriately.
	28		Warehouse should be built in such ways that it should be able to protect the materials form bad weather such as rain and wind.
	33	Major Forcewithin the Construction	Land slide should be handled by building block wall or by diverting the flood to other places that it would not disturb the construction job.

Source: Research 2018

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Suggestions

Regarding to the result of data analysis done in this research, some suggestions are proposed as follows.

1. Unacceptable risks should be mitigated to reduce the negative impactsin order to prevent the risks from occurring in the construction phase and in the amount of the costs required.
2. The risks identified in the construction of the Suai - Fatucai, Covalima toll road commonly occurwithin the job of Contractors. Hence, contractors must pay special attention to both unacceptable and unexpected risks.
3. The results of this study are expected to provide guidelines for risk identification and risk mitigation in further research. This research also provides valuable insights relevant parties in the construction of future toll road projects.

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