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Risk Management on Floodway Projects on Quality Performance

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ABSTRACT: One of the strategic steps taken by the government to overcome flooding is the construction of the floodway. This project is very important and innovative because it is the first river diversion in Indonesia that uses the Tunnel Boring Machine (TBM) technology. The complexity of the construction process, technical risks that have not been fully identified, and limited experience in implementing new technologies increase the chances of quality deviations. For this reason, a risk analysis is needed for the quality performance of this floodway project in order to understand the dominant risks that may arise, assess the level of impact on quality, and formulate appropriate responses or actions to reduce or eliminate the negative impacts of these risks. This study aims to identify, analyze and respond to the dominant risks in the implementation of the floodway construction on quality performance. This study is a qualitative study with data collection from literature studies and questionnaires with research steps of risk identification, risk analysis and response to risk. From the risk identification, there are 52 risks validated by experts into 43 risks, then in the risk analysis using Probability Index Matrix there are 2 risks with a moderate category, the first risk is poor geological, surface and soil properties, the second risk is inappropriate geotechnical analysis . Based on Ministry of Public Works and Housing, risks with a moderate category can be responded to with mitigation. Mitigation on the risk of incorrect geotechnical analysis is to verify and validate the results of the geotechnical analysis before work begins and mitigation on the risk of poor geological, surface and soil properties is to analyze the results of previously conducted soil tests and conduct soil investigations in the work area or along the work area that is considered lacking or inadequate.

KEYWORDS: Risk, Floodway, Quality Performance

I. INTRODUCTION

Flooding is a complex annual problem that is getting worse due to a combination of factors such as poor drainage systems, inadequate river capacity, and land subsidence. To overcome this, one of the strategic steps taken by the government is the construction of the floodway to the flood canal. This project is very important and innovative because it is the first river diversion in Indonesia that uses the Pipe Jacking method with Tunnel Boring Machine (TBM) technology of the Earth Pressure Balance (EPB) type. The key to the success of a project is proper planning and implementation. An effective planning mechanism for project implementation is needed. However, in its implementation, it certainly faces various challenges that affect time and cost performance, as well as other technical and administrative uncertainties that can impact the quality performance of construction projects.. The complexity of the construction process, technical risks that have not been fully identified, and limited experience in implementing new technologies increase the chances of quality deviations. Referring to these conditions, a risk analysis is needed for the quality performance of this canal project in order to understand the dominant risks that may arise, assess the level of impact on quality, and formulate appropriate responses or actions to reduce or even eliminate the negative impacts of these risks. This study aims to identify, analyze and respond to the dominant risks in the implementation of the construction of the Ciliwung River diversion in terms of quality performance.

II. LITERATURE REVIEW

Risk is an uncertain condition or event, if it occurs it will have a positive and negative effect on project objectives that impact project objectives that include scope, schedule, cost and quality. Project risks include threats to project objectives to improve those objectives (PMI, 2021)[1]. According to PMBOK in Sebayang, E., et al (2018)[2], Risk Management is a systematic process consisting of identifying, analyzing, responding to, and controlling risks on a project. The purpose of risk management is to improve project performance from start to finish by identifying, evaluating, and controlling those related to project risks. According to ISO 90001:2015[3], quality is defined as the overall characteristics and characteristics of a product or service that affect the ability of the product or service to meet established needs. According to KBBI[4], sodetan/diversion comes from the basic word sodet/sudet/divert which means a channel to drain water into another channel. The Floodway is a designated area that is intentionally kept clear to safely convey excess floodwaters during high flow events, which aims to protect infrastructure and settlements by providing natural or artificial paths for floodwaters so that water can flow without causing major damage.

III. RESEARCH METHODS

3.1 Data source

The primary data used in this study is the data from the distribution of questionnaires to project managers and engineers on the project. The questionnaire is a risk variable that has previously been validated by experts. The distribution of the questionnaire was carried out to obtain results regarding the impact and possible risks that occur on the project. The secondary data used is data derived from the results of studies from journals, previous research books, and phenomena on the project.

3.2 Research stages

The first step in this research is the research idea, followed by a literacy study of books, journals, and previous research to formulate the problem, research objectives and methods to be used. After the literacy study for the initial idea, the next step is to identify the risks that may occur in the floodway project with a literacy study of books, journals and previous research so that the instruments have been classified and ready to be submitted to experts (the first sample of the study). The experts validate the risk variables that have been prepared by the researchers previously. The results of this variable validation are the identification of risks to the floodway project. After identifying the risks that may occur, a risk analysis is carried out on the sample using a questionnaire, this questionnaire is to collect data on how often the risk occurs and the impact of the risk on the implementation of the floodway project. At this stage, data will be obtained on how much influence/ *impact* the risk is using a Likert scale with a very low, low, medium, high and very high index scale. At this stage the sample is a project manager to an engineer as many as 10 people. After analyzing the risks that occur, the next stage is to respond to the existing risks by responding to high and medium risks according to Ministry of Public Works and Housing[5]. The responses that are implemented can be done by accepting risks, reducing risks, transferring risks and avoiding risks. Risk responses are carried out by studying book literacy, journals and previous research by researchers and then validated by experts. The results of this risk response validation can be used as conclusions in this study.

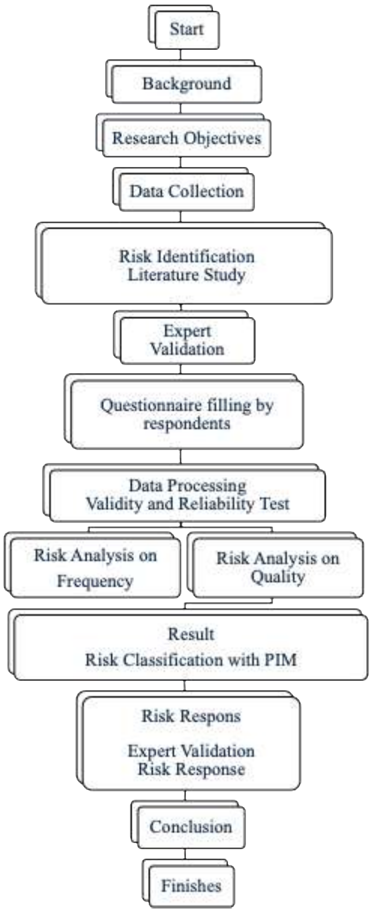

Figure 1. Research Steps

3.3 Data Processing Methods

3.3.1 Risk Identification

Data processing in risk identification begins with a literature study of books, journals and previous research related to the floodway project. The results of this literature study are then validated by experts. The results of data processing from filling out the questionnaire by experts stating that the risk is "accepted" or "not accepted" based on the choice of the most experts will be used as the next questionnaire in the risk analysis.

3.3.2 Risk Analysis

a) Validity Test

Instrument validity test is conducted to determine how far the research instrument is able to reflect the content according to the things and characteristics being measured, meaning that each item of the instrument has truly described the entire content or characteristics of the conceptual structure that is the basis for compiling the instrument. Validity test is conducted on the results of respondents filling in the frequency of risk and risk impact where an answer is said to be valid if the calculated r value is greater than the table r value with a significance value (p) of 0.05 (5%).

b) Reliability test

Reliability testing is a process to measure how consistent and stable the measurement results are using a particular measuring instrument. Reliability testing is important in research because it can ensure that the data produced is reliable.

c) Probability/possibility of Risk

Probability is assessed based on the number of potential events at each stage of activity which is divided into five (5) classes Likert scale (PUPR, 2016) [5]. The Likert scale for risk measurement is:

Table 3.1. Risk Probability Classification

Mark	Probability	Information
1	Highly Unlikely	Ignored/unlikely to happen
2	Unlikely	Very rare
3	Possible	The possibility of this happening is small
4	Likely	The possibility of this happening is high
5	Very Likely	Very likely/almost certain to happen

d) Risk Impact

The risk impact is divided into 5 classes with the following criteria:

Table 3. 2. Classification of Risk Impact on Quality

Mark	Impact	Information
1	No Impact	There are no deviations/quality defects <1%
2	Minor	There are 1-4% quality deviations/defects
3	Moderate	There are 4-7% quality deviations/defects
4	Mayor	There are 7-10% quality deviations/defects
5	Extebsive	There are deviations/ quality defects >10%

e) Assess the magnitude of the risk

To assess the magnitude of the risk in this study, it is classified based on the Probability and Impact Matrix (PIM) using the following equation.

R = P x I

Information:

R = Risk level

P = Probability *of* the risk occurring

I = Level of impact (*Impact*) of the risk that occurs

Table 3.3. Risk Classification

R= P x I	Risk Category	Symbol
≤5	Very low	
6-9	Low	
10-15	Moderate	
16-20	High	
>20	Very high	

Table 3.4. Risk Matrix

			Impact				
			No Impact	Minor	Moderat	Mayor	Extensive
			1	2	3	4	5
Probability	Highly Unlikely	1	1	2	3	4	5
	Unlikely	2	2	4	6	8	10
	Possible	3	3	6	9	12	15
	Likely	4	4	8	12	16	20
	Very Likely	5	5	10	15	20	25

3.3.3. Risk Response

After analyzing the risks that occur, the next stage is to respond to the dominant risks according to the risk response according to PUPR [5]. The response that is implemented can be done by accepting the risk, reducing the risk, transferring the risk and avoiding the risk. The risk response is carried out by studying the literature of books, journals and previous research by researchers and then validated by experts. The risk response according to PUPR [5] is as follows.

Table 3.5. Risk Response

	Risk Category	Risk Response
1-5	Very low (negligible)	Accepting the risk as it is. Based on the consideration of the probability and impact of the risk, no plans will be made but will accept all consequences when the risk occurs, including aspects of cost, scope, schedule, and quality.
6-9	Low	
10-15	Moderate	a. Mitigation , namely efforts to reduce the probability and/or impact of risk to acceptable conditions. b. Transfer, transferring negative impacts (responsibility and action) by paying third parties who are more competent in handling risks. For example, through insurance, performance bonds, incentive / disincentive clauses in contracts

16-25	High	Avoiding risks by changing the project plan to eliminate the risk. For example, by changing the scope, adding time, or adding resources.

IV. RESULTS AND DISCUSSION

4.1. Risk Identification

Initial research data were obtained from literature studies from previous studies related to risks in channel, diversion or tunnel projects using TBM and microtunneling (Pipe Jacking and Horizontal Directional Drilling). Based on this literature study, 52 risks were obtained related to risks in channel or tunnel projects.

4.2. Risk Identification by experts

After a literature study related to the channel or tunnel project, 52 risks were obtained, then the risks were validated by 3 experts with 15 years of experience in the construction world and had worked on water channels or tunnels. Based on expert validation, the results of risk identification obtained 12 risks that were not accepted, 40 risks were accepted and 3 risks suggested by experts to be added.

4.3. Risk Analysis

From this risk, the author then compiled a risk analysis questionnaire to be filled out by respondents. The questionnaire data was distributed to 10 respondents who had at least 5 years of experience working in the construction sector and had worked on the same or similar projects to the diversion project. After the respondents filled out the questionnaire, the next step was data analysis in the form of validation and reliability tests on the questionnaire.

Based on the risk frequency validation test, 10 answers were declared valid and the results of the *Cronbach Alpha reliability test* obtained an r11 value $_{of}$ 0.655, r11 $_{>}$ 0.600, so it is declared reliable. Based on the risk impact validation test, 10 answers were declared valid and the results of the *Cronbach Alpha reliability test* obtained an r11 value $_{of}$ 0.729, r11 $_{>}$ 0.600, so it was declared reliable.

Based on the filling of the questionnaire by 10 respondents, respondents filled in the risks based on their respective experiences and knowledge based on the projects they had worked on. Respondents filled in their risk analysis based on frequency and quality. The results of the risk analysis showed that the risk opportunities occurred as many as 3 risks in the very rare category, 25 risks in the rare category, 9 risks in the quite frequent category, 6 risks in the frequent category.

Next, risk classification is carried out, the risk classification is arranged based on the Probability and Impact Matrix (PIM) by multiplying the frequency value by the impact.

Table 4.1. Risk Impact Classification

Code	Risk	Probability	Impact	P x	Category
X1	Land acquisition delayed	2	1	2	Very Low
X2	Changes in government policy	2	1	2	Very Low
X3	Regional regulations that hinder implementation	2	1	2	Very Low
X4	Poor Geological, surface and soil conditions	3	4	12	Moderate
X5	Large underground water flow	2	2	4	Very Low
X6	Lack of socialization of environmental impacts to the community	2	1	2	Very Low
X7	Rocks with high abrasion rate	2	2	4	Very Low
X8	Noise from trucks and drill machines	3	1	3	Very Low
X9	Tool vibration	3	2	6	Low
X10	Damage to public facilities/buildings	2	1	2	Very Low
X11	Inacurate Geotechnical analysis	3	4	12	Moderate
X12	Design error	2	3	6	Low
X13	Escalation and inflation	2	2	4	Very Low
X14	Government policies and financing	2	2	4	Very Low
X15	Project contract changes	2	2	4	Very Low
X16	Earthquake	1	2	2	Very Low
X17	Storm	2	2	4	Very Low
X18	Landslide	2	2	4	Very Low

Code	Risk	Probability	Impact	P x	Category
X19	Flood	2	3	6	Low
X20	Bad weather	4	2	8	Low
X21	Water enters the excavation	3	2	6	Low
X22	Low rock drilling power	1	1	1	Very Low
X23	Dumping site further than planned	2	1	2	Very Low
X24	Machine operator immobility	2	1	2	Very Low
X25	Machine and plant failure	4	2	8	Low
X26	Segment damage due to high engine pressure	2	2	4	Very Low
X27	Drill machine initial position coordinate error	1	2	2	Very Low
X28	Delay in equipment mobilization	3	2	6	Low
X29	Delay in delivery of materials	3	2	6	Low
X30	Delay in approval	3	2	6	Low
X31	Engine out of center line	2	2	4	Very Low
X32	High groundwater level	3	2	6	Low
X33	Land dispute	2	1	2	Very Low
X34	Equipment is damaged	4	2	8	Low
X35	Job addition	4	1	4	Very Low
X36	The machine operator does not have the relevant certification	2	2	4	Very Low
X37	Strikes and labor disputes	2	1	2	Very Low
X38	Lack of HSE knowledge among drill machine operators	2	2	4	Very Low
X39	Security breach in the project	2	2	4	Very Low
X40	Limited work area	4	2	8	Low
X41	Residents access disrupted by project	4	1	4	Very Low
X42	Lack of safety signs in the work area	2	1	2	Very Low
X43	Workers do not obey HSE rules	2	1	2	Very Low

Based on the results of the risk impact analysis, the risk classification for the river diversion project is 29 risks in the very low impact category, 12 risks in the low category and 2 risks in the moderate category. The 2 risks included in the moderate category are poor geological, surface and soil properties; and inappropriate geotechnical analysis for further response.

4.4. Risk Response

Risk responses carried out on low category risks are acceptance *and* medium and high categories are responded to with mitigation . Medium category risks are inaccurate geotechnical analysis, and geological conditions, surfaces. The following are the responses to these risks, namely:

Table 4.2. Risk Response

No	Risk	Risk Category	Response Risk	Reason for Response
1	inaccurate Geotechnical Analysis	Moderate	Mitigation	These risks can be significantly reduced by more detailed geotechnical surveys, the use of experts, and validation of designs before work begins.
2	Poor Geological, Surface and Soil Properties	Moderate	Mitigation	These risks can be identified early and reduced by selecting appropriate working methods, geological

No	Risk	Risk Category	Response Risk	Reason for Response
				mapping and appropriate technical design.

This expert validation was conducted by 3 experts with more than 15 years of experience in the construction world and have worked on water channels or tunnels. Based on the validation results and input from the experts, the following are responses to the dominant risks.

Table 4.3. Risk Mitigation

No.	Risk	Case	Risk Mitigation
1	inaccurate Geotechnical analysis	1) Incomplete land survey 2) Land survey data is inaccurate	1) Verification and validation system for geotechnical analysis results before work begins. 2) Provide alternative design options (contingency plan) 3) Engaging external geotechnical consultants for audits 4) Include a design change clause if geotechnical data proves inaccurate after implementation.
2	Poor geological, surface and soil conditions	1) The work site has varying soil properties and no thorough geotechnical investigation was carried out. 2) The land data used is inaccurate or out of date 3) The project location is in an area with expansive clay or peat soil.	1) analyze previous soil test results 2) Conduct more soil investigations in the work area or along the work area. 3) Ensure the project has an environmental impact analysis document 4) Conduct *a Pre-Construction Survey* of all buildings adjacent to the perimeter of the project area.

V. CONCLUSION

The conclusion of this study based on risk identification that has been validated by experts, there are 43 risk variables in the floodway project, then an analysis of the impact of risk on frequency is carried out on the floodway project, there are 3 risks in the very rare category, 25 risks in the rare category, 9 risks in the fairly frequent category, 6 risks in the frequent category. In the risk analysis on quality, there are 15 risks in the very low impact category, 24 risks have a low impact category, 2 risks have a moderate impact category, and 2 risks have a high impact category. From the results of the frequency and quality impact analysis, the risks that affect quality are obtained with details of 29 risks in the very low impact category, 12 risks in the low category and 2 risks in the moderate category, the first risk is poor geological, surface and soil properties, the second risk is inaccurate geotechnical analysis. The response to these risks is through mitigation. Mitigation carried out on the risk of poor geological, surface and soil conditions is by conducting soil analysis, if the soil is in a soft/easily landslide condition, soil reinforcement can be carried out, things that can be done include improving soil strength or soil retention to minimize landslides when carrying out work. Mitigation carried out on the risk of inaccurate geotechnical analysis is to conduct a complete and comprehensive soil reanalysis on the project and review the design of the diversion.

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