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ANALYSIS MODEL AND FINANCIAL RISK MITIGATION STRATEGY IN DECISION MAKING FOR THE FEASIBILITY OF INVESTMENT IN THE DEVELOPMENT OF HYDROPELECTRIC POWER PLANT (PLTA) IN THE NORTH SUMATRA REGION

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Abstract

The success of implementing a construction project can be seen from the accuracy in maintaining triple constraints (cost, quality and time). Project risk analysis for long-term investment and successful project development planning is very important, model analysis is needed to mitigate risk due to the complexity of the problems faced in the development of power projects, especially power plants in North Sumatra Province with the development of hydroelectric power projects (PLTA). There are risk events that could hamper the smooth development of the 45 MW hydropower plant construction project in the North Sumatra region with an emphasis on investment financial risks. The following are risk events that were identified and then after measurement and analysis, risk priorities were obtained that must be managed first, including: project financing governance, cash flow management, detailed contract specifications, and difficulties in fulfilling materials. These risk events are managed by interpreting them in the management of risk mitigation against financial losses in the implementation of the construction of a 45 MW hydroelectric power plant in the North Sumatra region. The results of the risk mitigation analysis showed that Project Financing Management was the first risk priority, then Project Cash Flow Management was the second priority, Detailed Contract Specifications were the third priority, and Difficulty Fulfilling Materials was the fourth priority. Implementation of research findings, namely prioritization of risk reduction, requires identifying critical processes and immediately adopting approaches to provide alternative controls for identified critical processes. For example, if the total cost approach is a critical process, then procurement of hydroelectric plant materials is considered a critical process. An exploratory approach can be used to manage critical processes, namely by making contracts with material suppliers so that materials are ordered in advance (with or without a down payment) to arrive according to the project schedule. For other critical processes identified using other approaches, you can use the results of risk mitigation prioritization based on risk events. The application of this mitigation can be carried out flexibly according to further identification obtained.

Keywords: ***Mitigation Strategy, Decisions, Financial Risk and Investment Feasibility***

INTRODUCTION

The development of electricity infrastructure in the North Sumatra and Aceh region is the responsibility of PT PLN (Persero) UIP North Sumatra as one of the State-Owned Enterprises (BUMN) which operates in the electricity sector. In accordance with the 2021-2030 RUPTL, in the projected electricity needs in Aceh and North Sumatra Provinces, it is planned to build a hydroelectric power plant in the North Sumatra Region for the reliability of the electricity system in Aceh and North Sumatra and in accordance with the 2021 - 2028 RUPTL which is planned to be completed in 2025 with capacity 45 MW.

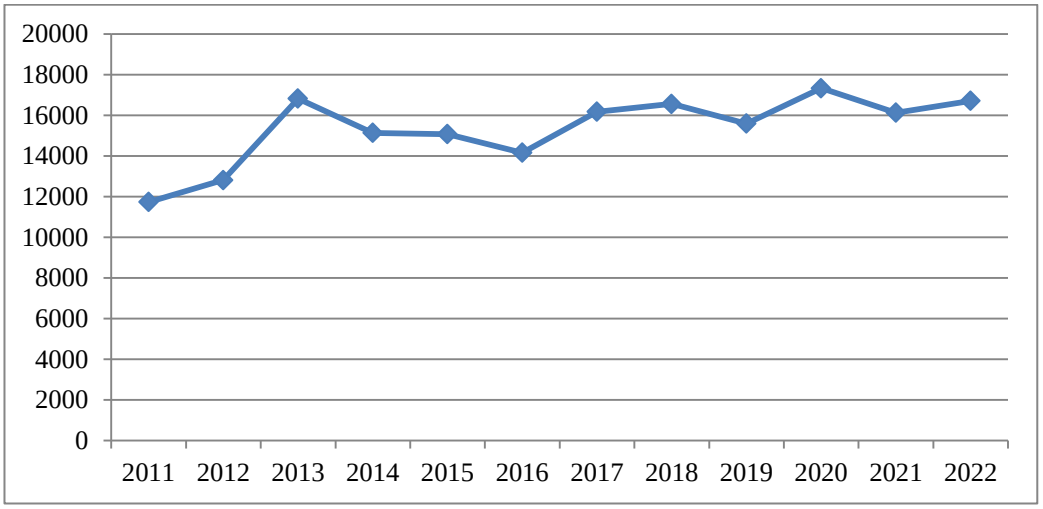
Table of 45 MW Hydroelectric Power Plant in North Sumatra in RUPTL

No	RUPTL	COD year	Capacity (MW)
1	2015-2024	2022	48
2	2016-2025	2023	48
3	2017-2026	2023	45
4	2018-2027	2022	45
5	2019-2028	2024	45
6	2021-2030	2025	45

The power plant construction project is a dynamic, strategic project and has various risks that can cause the project not to go according to plan. The risks that arise can affect the productivity and financial

costs of the project, both during the construction preparation stage, construction implementation, and after construction is completed, which is very important for the sustainability of the project. The success of a construction project can be seen by meeting three constraints (cost, quality and time) accurately. Risk analysis of a long-term investment project and the success of project development according to plan is very important, so it is necessary to carry out analytical modeling to reduce risks due to the complexity of problems faced during the construction of the power plant. Like several similar power plant construction projects located in North Sumatra and Aceh that have been carried out by PLN, there are problems that have become obstacles in the construction of these projects. Of course, these types of experiences become a reference in determining potential risks that might occur in future similar projects.

Apart from that, risks can also arise from project payment costs that use foreign currency (in this case Euros), while income from PLN is in rupiah. Foreign currency exchange risk can occur because PLN pays project costs using foreign currency. Fluctuations in the Rupiah exchange rate against the euro are at risk if project construction experiences delays because there will be an increase in payments using the Rupiah.



Source: BPS, 2023

Image of Euro Currency Exchange Rate Fluctuations Against the Rupiah

Identification of the probability of risks that may occur is the first step in controlling the achievement of targets as expected by measuring the level of each risk that may occur and mapping each risk level. Risk identification is a combination of deterministic, probability, and quantitative methods. Risk management is a coordinated activity to direct and control an organization in handling risks (ISO 31000:2018). Then proceed with the mitigation process and monitoring methods. This aims to increase the possibility of positive impacts and decision making by Management from events or activities carried out in development. Various potential risks can occur on a project. Proper mitigation will certainly bring benefits to the project. Proper identification and analysis of the factors that cause financial losses in completing the project will be able to maintain the triple constraints (cost, quality and time).

LITERATURE REVIEW

Frequency of Risk Events

Assessment of the frequency of risk occurrence within a certain time period

Impact of Risk Events

Assessment of the impact of risks on the total project value (project cost overrun)

Risk Event Mitigation

Actions to reduce or minimize the impact of risk events so that they become controllable (can be controlled)

RESEARCH METHOD

Place and time of research

This research was conducted at PT PLN (Persero) UIP North Sumatra (Sumbagut). The location of the project plan that will be analyzed in this research is in North Sumatra Province. This research period starts from May to December 2024.

Place and time of research

This study involved experts and structural employees of PT PLN (Persero) UIP Sumbagut. This

population is defined because projects have very unique characteristics, where each type of project has different risks from each other, so that the research results focus on the risk problems contained in the project, population data is taken from the same environment. The size of the research sample depends on the population studied: the larger the sample taken, the more it reflects the shape and nature of the population and the more it can be generalized. In this case, the research carried out uses the assumption that the research is correlational or related to obtaining influencing risks, so that the sample size is at least 30 subjects (sampling units) (Gay & Diehl, 1992).

RESULTS AND DISCUSSION

Risk Mitigation Design

Risk Mitigation Collection

To obtain mitigation steps related to the four high priority risk events identified above, a focus group discussion (FGD) was conducted and brainstorming was used as the initiation. This activity is carried out for parties who have adequate abilities both in terms of career level and work experience. Questionnaire II for this FGD was given to 4 people with structural officials and senior specialists within PLN. In the FGD it was agreed that risk events have a high area in the impact probability matrix, so discussions regarding mitigation measures are considered as the same risk event. Mitigation steps for each risk event obtained from this process can be presented in the table

Table of Calculation Results of Average Frequency x Impact of Risk Events

Items	Risk Mitigation	
K2- Project Financing Governance	A	There is a large difference in the risk of errors in cost estimates/initial estimates and actual prices
	B	Risk of a dispute occurring in the payment system/method used in the contract document
	C	Risk There is a change in equipment prices
	D	Risk: Difficulty in loan amendments following project conditions
	E	Risk of lack of financing capital by the contractor
	F	Risk of limited sources of internal company financing (owner)
K4 - Project Cash Flow Management	G	Risk of Delay in Billing by Contractor
	H	Risk of late payment by the owner
	I	Risk: The ceiling for Cash Loan facilities from the Bank is insufficient
	J	Risk of poor cash flow planning
K7 - Difficulty Fulfilling Materials	K	Risk of Fluctuating Material Prices
	L	Project Material Complexity Risk
	m	Risk of Material Delay
	N	Material Risk requires certain specifications and quality
K9 - Contract Detail Specifications	O	Risk of Determining Job Specifications that are Unclear
	P	Risk of Inappropriate Calculation of Material Requirements
	Q	Risk of design/drawing changes during construction
	R	Risk of inaccurate contract planning resulting in additional work resulting in additional costs
	S	Risk of errors in selecting the contract standards used

Source: Brainstorming and FGD Form

The table above explains what steps can be taken to manage risk events in the hope of reducing the magnitude of the risk to a lower level than before. Mitigation is a sub-attribute of a risk event, so there is the possibility of mitigating in detail according to the sub-attribute of the risk event, but still within the risk reduction sub-attribute. The mitigation steps presented in Table 4.5 are not ordered based on importance or order of need, so further data processing is needed to determine the mitigation sequence based on the level of mitigation priority. The AHP model is used in data processing.

Determining Mitigation Step Priorities with AHP

By using the AHP model, researchers will determine the mitigation sequence model based on priority levels. The AHP model begins by creating Questionnaire II based on previous mitigation steps which aims to determine the priority order of mitigation steps that need to be completed. Questionnaire II was prepared using a pairwise comparison matrix and distributed to respondents in Questionnaire I. Questionnaire II consisted of 4 parts, Part A was a pairwise matrix to determine the priority ranking of mitigation measures for the three identified risk events. Parts B, C, D and E respectively to assess the

priority of mitigation actions for each risk event. Questionnaire II was distributed to 4 managers who had the ability and experience, such as having previously carried out similar power generation projects and who were also responsible for the project that was planned to be implemented. Below are the steps.

I. Determine Risk Event Priorities

From the results of data processing in Questionnaire II, the data for determining priorities for risk events was obtained as follows:

Table of Calculation Results of Average Frequency x Impact of Risk Events

		K2	K4	K7	K9
Geometric Mean	K2	1	1	2.2	1.5
	K4	1	1	1.4	1.3
	K7	0.5	0.7	1	0.8
	K9	0.7	0.8	1.2	1
Amount		3.11	3.47	5.85	4.66

Source: Questionnaire data processing II

In this case, the pairwise comparison matrix between risk event attributes has an order of 4 x 4, while the J column and I row are represented by attribute types, respectively 1) represented by attribute K2, 2) represented by attribute K4, 3) represented by attribute K7 and 4) are represented by the attribute K9. The next step is to carry out priority weighting of elements in the i-th row and j-column which have been normalized.

If C1 is the number of comparison scales in column 1, then the total value in Table 4. 6 then becomes the Ci value, so that C1 = 3.11, C2 = 3.47, C3 = 5.85 and C4 = 4.66. After determining the Ci value, the next step is to determine the normal weight value of the attribute, by dividing the value by Ci, so that the weighting matrix is obtained as follows:

Pairwise Comparison Matrix Normalization Table Between Attributes

	K2	K4	K7	K9	Amount	Weight
K2	0.32	0.29	0.38	0.33	1.32	0.33
K4	0.32	0.29	0.24	0.28	1.13	0.28
K7	0.15	0.20	0.17	0.18	0.70	0.17
K9	0.21	0.22	0.21	0.21	0.85	0.21
Amount					4.00	1.00

Source: Questionnaire data processing II

After all pairwise comparisons have been carried out, the next step is to check the consistency coefficient, namely confirmation of the respondent's compliance with the questionnaire given. The following is the calculation to obtain the Consistency Ratio (CR) by following the procedure explained in the Literature Review above:

a. The first step is to get the maximum eigenvalue (λ max) as follows:
λmax = (C1 x W1) + (C2 x W2) + (C3 x W3) + (C4 x W4) = 4.017

b. The second step is to calculate the consistency index (CI), namely:
$CI = (\lambda maks - n)/n - 1 = (4.017) - 4)/4 - 1 = 0.005$

c. Furthermore, after the consistency index is known, the new consistency ratio (CR) can be determined as below.
$CR = CI/RI = 0.005/0.9 = 0.006$
RI = random index value for n = 4 then RI = 0.9.

d. The conclusion is that the CR value = 0.006 or less than 0.1, so the results of the pairwise comparison matrix assessment are consistent.

According to the results of calculating the normal weight values for attributes in Table 4.11 and checking the consistency values, it is known that respondents determine the weighting values for risk priorities for risk events sequentially placing the priority order for mitigating risk events as follows:

1. Project Financing Governance (with a weight of 0.33).
2. Project Cash Flow Governance (with a weight of 0.28).
3. Contract Detail Specifications (with a weight of 0.21).
4. Difficulty Fulfilling Materials (with a weight of 0.17).

Based on the weighting above, project financing management is a risk event that has the highest priority compared to other risk events. For the second priority, there is a difference in the priority order for mitigating risk events compared to calculating the priority of risk events using the risk index method

in Table 4.3. This is because in assessing the weight of severity and events in each section it is assessed by different respondents, and there are subjective assessments and perceptions from each respondent, causing differences in the assessment of the weight of each risk event.

Determining the Priority of Mitigation Steps on Risk Event Subattributes Project Financing Governance (K2)

Based on the results of Questionnaire II data processing, the data for determining priorities for risk events was obtained as follows:

Table of Calculation Results of Average Frequency x Impact of Risk Events for Project Financing Governance

		A	B	C	D	E	F
Geometric Mean	A	1	2.2	0.9	1.6	1.7	1.2
	B	0.5	1	0.9	1.4	0.8	1
	C	1.1	1.1	1	1.1	1.2	1.2
	D	0.6	0.7	0.9	1	1.0	0.9
	E	0.6	1.3	0.8	1	1	0.9
	F	0.8	1	0.8	1.1	1.1	1
Amount		4.54	7.27	5.38	7.22	6.80	5.39

Source: Questionnaire data processing II

The table presents a pairwise comparison matrix between sub-attributes of project financing governance risk events, the matrix has an order of 6 x 6 while the J column and I row are represented by attribute types. The next step is to carry out priority weighting of elements in the first row and jth column which have been normalized. If C1 is the number of the comparison scale in the 1st column, then the total value in Table 4.12 then becomes the Ci value, so that C1 = 4.54, C2 = 7.27, C3 = 5.38, C4 = 7.22, C5 = 6.80, C6 = 5.39 and . After determining the Ci value, the next step is to determine the normal weight value of the attribute, by dividing the value by Ci, so that the weighting matrix is obtained as follows.

Pairwise Comparison Matrix Normalization Table Between Risk Event Attributes for Project Financing Governance

	A	B	C	D	E	F	Amount	Weight
A	0.22	0.30	0.18	0.22	0.25	0.19	1.37	0.23
B	0.10	0.14	0.17	0.20	0.12	0.16	0.88	0.15
C	0.23	0.15	0.19	0.15	0.18	0.19	1.10	0.18
D	0.14	0.10	0.17	0.14	0.14	0.14	0.83	0.14
E	0.13	0.17	0.15	0.14	0.15	0.15	0.89	0.15
F	0.18	0.13	0.15	0.15	0.16	0.16	0.93	0.16
Amount							6.00	1.00

Source: Questionnaire data processing II

After carrying out all pairwise comparisons, the next step is to analyze the consistency ratio, which is a validation of the respondent's consistency with the questionnaire that has been given. The following is the calculation to obtain the consistency ratio (CR) according to the procedure outlined above in the Literature Review:

a. The first step is to get the maximum eigenvalue (λmax) as follows:
λmax = (C1 x W1) + (C2 x W2) + (C3 x W3) + (C4 x W4) + (C5 x W5) + (C6 x W6) = 6.075

b. The second step is to calculate the consistency index (CI), namely:
$CI = (\lambda maks - n)/n - 1 = (6.075 - 6)/6 - 1 = 0.0151$

c. Furthermore, after the consistency index is known, the new consistency ratio (CR) can be determined as below.
$CR = CI/RI = 0.0151/1.24 = 0.0121$
RI = random index value for n = 6 then RI = 1.24.

d. The conclusion is that the CR value = 0.0121 or less than 0.1, so the results of the pairwise comparison matrix assessment are consistent.

According to the results of calculating the normal weight values for attributes in Table 4.9 and checking the consistency values, it is known that respondents determined the weighting values for risk priorities for sub-attributes of project financing governance (K2) risk events in sequence as follows:

1. There is a large difference in the risk of error in the initial estimate and actual price estimate (with a weight of 0.23).
2. Risk of changes in equipment prices (with a weight of 0.18).
3. Risk of limited sources of internal financing for the company (owner) (with a weight of 0.16).
4. Risk of lack of financing capital by the contractor (with a weight of 0.15).
5. Risk of a dispute occurring in the payment system/method used in the contract document (with a weight of 0.15).
6. Risk: Difficulty in loan amendments following project conditions (with a weight of 0.14).

Determining the Priority of Mitigation Steps on Risk Event Subattributes
Project Cash Flow Management (K4)

Based on the results of Questionnaire II data processing, the data for determining priorities for risk events was obtained as follows:

Table of Calculation Results of Average Frequency x Impact of Risk Events for Project Cash Flow Management

		G	H	I	J
Geometric Mean	G	1	0.7	0.7	0.5
	H	1.5	1	1.6	0.7
	I	1.5	0.6	1	0.6
	J	2.0	1.4	1.7	1
Amount		6.03	3.64	4.92	2.83

Source: Questionnaire data processing II

The table presents a pairwise comparison matrix between sub-attributes of project financing governance risk events, the matrix has an order of 4 x 4 while the J column and I row are represented by attribute types. The next step is to carry out priority weighting of elements in the first row and jth column which have been normalized. If C1 is the number of the comparison scale in the 1st column, then the total value in Table 4.14 then becomes the Ci value, so that C1 = 6.03, C2 = 3.64, C3 = 4.92, C4 = 2.83. After determining the Ci value, the next step is to determine the normal weight value of the attribute, by dividing the value by Ci, so that the weighting matrix is obtained as follows.

Pairwise Comparison Matrix Normalization Table Between Risk Event Attributes for Project Cash Flow Management

	K2	K4	K7	K9	Amount	Weight
K2	0.17	0.18	0.14	0.18	0.66	0.16
K4	0.25	0.27	0.32	0.26	1.11	0.28
K7	0.25	0.18	0.20	0.21	0.84	0.21
K9	0.33	0.37	0.34	0.35	1.40	0.35
Amount					4.00	1.00

Source: Questionnaire data processing II

After carrying out all pairwise comparisons, the next step is to analyze the consistency ratio, which is a validation of the respondent's consistency with the questionnaire that has been given. The following is the calculation to obtain the consistency ratio (CR) according to the procedure outlined above in the Literature Review:

a. The first step is to get the maximum eigenvalue (λmax) as follows:
   λmax = (C1 x W1) + (C2 x W2) + (C3 x W3) + (C4 x W4) = 4.018
b. The second step is to calculate the consistency index (CI), namely:
   $CI = (\lambda maks - n)/n - 1 = (4.018 - 4)/4 - 1 = 0.006$
c. Furthermore, after the consistency index is known, the new consistency ratio (CR) can be determined as below.
   $CR = CI/RI = 0.006/0.9 = 0.0067$
   RI = random index value for n = 4 then RI = 0.90.
d. The conclusion is that the CR value = 0.0067 or less than 0.1, so the results of the pairwise comparison matrix assessment are consistent.

According to the results of calculating the normal weight values for attributes in Table 4.15 and checking the consistency values, it is known that respondents determined the weighting values for risk priorities for sub-attributes of project cash flow governance (K4) risk events in sequence as follows:

1. Risk of poor cash flow planning (with a weight of 0.35).
2. Risk of Late Payment by Owner (with a weight of 0.28).
3. Risk: The ceiling for Cash Loan facilities from the Bank is insufficient. (with a weight of 0.21).
4. Risk of Late Billing by the Contractor (with a weight of 0.16).

Determining the Priority of Mitigation Steps on Risk Event Subattributes Difficulty Fulfilling Materials (K7)

Based on the results of Questionnaire II data processing, the data for determining priorities for risk events was obtained as follows:

Table of Calculation Results of Average Frequency x Impact of Risk Events for Difficulty Fulfilling Materials

		K	L	m	N
Geometric Mean	K	1	1.0	0.7	0.8
	L	1.0	1	0.6	0.6
	m	1.4	1.7	1	1.1
	N	1.3	1.7	0.9	1
Amount		4.69	5.40	3.20	3.48

The table presents a pairwise comparison matrix between sub-attributes of project financing governance risk events, the matrix has an order of 4 x 4 while the J column and I row are represented by attribute types. The next step is to carry out priority weighting of elements in the first row and jth column which have been normalized. If C1 is the number of comparison scales in column 1, then the total value in Table 4.14 then becomes the Ci value, so that C1 = 4.69, C2 = 5.40, C3 = 3.20, C4 = 3.48. After determining the Ci value, the next step is to determine the normal weight value of the attribute, by dividing the value by Ci, so that the weighting matrix is obtained as follows.

Pairwise Comparison Matrix Normalization Table Between Risk Event Attributes Difficulty Fulfilling Materials

	K2	K4	K7	K9	Amount	Weight
K2	0.21	0.19	0.22	0.23	0.84	0.21
K4	0.21	0.19	0.18	0.17	0.75	0.19
K7	0.30	0.31	0.31	0.32	1.25	0.31
K9	0.27	0.31	0.28	0.29	1.16	0.29
Amount					4.00	1.00

Source: Questionnaire data processing II

After carrying out all pairwise comparisons, the next step is to analyze the consistency ratio, which is a validation of the respondent's consistency with the questionnaire that has been given. The following is the calculation to obtain the consistency ratio (CR) according to the procedure outlined above in the Literature Review:

a. The first step is to get the maximum eigenvalue (λmax) as follows:
λmax = (C1 x W1) + (C2 x W2) + (C3 x W3) + (C4 x W4) = 4.008

b. The second step is to calculate the consistency index (CI), namely:
$CI = (\lambda maks - n)/n - 1 = (4.008 - 4)/4 - 1 = 0.002$

c. Furthermore, after the consistency index is known, the new consistency ratio (CR) can be determined as below.
$CR = CI/RI = 0.002/0.90 = 0.003$
RI = random index value for n = 4 then RI = 0.90.

d. The conclusion is that the CR value = 0.003 or less than 0.1, so the results of the pairwise comparison matrix assessment are consistent.

According to the results of calculating the normal weight values for attributes in Table 4.17 and checking the consistency values, it is known that respondents determined the weighting values for risk priorities for sub-attributes of material fulfillment difficulties (K7) risk events in sequence as follows:

1. Risk of Material Delay (with a weight of 0.31).
2. Material risks require certain specifications and quality (with a weight of 0.29).
3. Risk of Fluctuating Material Prices (with a weight of 0.21).
4. Project Material Complexity Risk (with a weight of 0.19).

Determining the Priority of Mitigation Steps on Risk Event Subattributes Contract Detail Specifications (K9)

Based on the results of Questionnaire II data processing, the data for determining priorities for risk events was obtained as follows:

Table of Calculation Results of Average Frequency x Impact of Risk Events Contract Detail Specifications

		O	P	Q	R	S
Geometric Mean	O	1	1	0.7	0.5	0.9
	P	1	1	0.7	0.5	1.2
	Q	1.5	1.4	1	1.1	1.5
	R	1.9	2.1	0.9	1	1.7
	S	1.1	0.9	0.7	0.6	1
Amount		6.54	6.33	3.97	3.72	6.20

Source: Questionnaire data processing II

The table presents a pairwise comparison matrix between sub-attributes of project financing governance risk events, the matrix has an order of 5 x 5 while the J column and I row are represented by attribute types. The next step is to carry out priority weighting of elements in the first row and jth column which have been normalized. If C1 is the number of comparison scales in the 1st column, then the total value in Table 4.14 then becomes the Ci value, so that C1 = 6.54, C2 = 6.33, C3 = 3.97, C4 = 3.72, C5 = 6.20. After determining the Ci value, the next step is to determine the normal weight value of the attribute, by dividing the value by Ci, so that the weighting matrix is obtained as follows.

Pairwise Comparison Matrix Normalization Table Between Risk Event Attributes Contract Detail Specifications

	O	P	Q	R	S	Amount	Weight
O	0.15	0.16	0.17	0.14	0.14	0.76	0.15
P	0.15	0.16	0.19	0.13	0.19	0.81	0.16
Q	0.23	0.21	0.25	0.30	0.24	1.24	0.25
R	0.29	0.33	0.22	0.27	0.27	1.39	0.28
S	0.17	0.14	0.17	0.16	0.16	0.80	0.16
Amount						5.00	1.00

Source: Questionnaire data processing II

After carrying out all pairwise comparisons, the next step is to analyze the consistency ratio, which is a validation of the respondent's consistency with the questionnaire that has been given. The following is the calculation to obtain the consistency ratio (CR) according to the procedure outlined above in the Literature Review:

a. The first step is to get the maximum eigenvalue (λmax) as follows:
λmax = (C1 x W1) + (C2 x W2) + (C3 x W3) + (C4 x W4) + (C5 x W5)
= 5.032

b. The second step is to calculate the consistency index (CI), namely:
$CI = (\lambda maks - n)/n - 1 = (5.032 - 5)/5 - 1 = 0.008$

c. Furthermore, after the consistency index is known, the new consistency ratio (CR) can be determined as below.
$CR = CI/RI = 0.008/1.12 = 0.007$
RI = random index value for n = 5 then RI = 1.12.

d. The conclusion is that the CR value = 0.007 or less than 0.1, so the results of the pairwise comparison matrix assessment are consistent.

According to the results of calculating the normal weight values for attributes in Table 4.19 and checking the consistency values, it is known that respondents determined the weighting values for risk priorities for the detailed contract specification (K9) risk event sub-attributes in sequence as follows:

1. Risk of inaccurate contract planning resulting in additional work resulting in additional costs (with a weight of 0.28).
2. Risk of design/drawing changes during construction (with a weight of 0.25).
3. Risk of Inappropriate Calculation of Material Requirements (with a weight of 0.16).
4. Risk of error in selecting the contract standard used (with a weight of 0.16).
5. Risk of Determining Job Specifications that are Unclear (with a weight of 0.15).

Prioritization of Mitigation Steps

Based on the results of questionnaire II data processing using the AHP method, the following is attached.

Table of Priority List of Mitigation Steps for Risk Events Risk Events

Risk Events		Risk Prioritization	Risk Mitigation	Mitigation Steps	
K2	Project Financing Governance	1	0.23	A	There is a large difference in the risk of errors in cost estimates/initial estimates and actual prices
			0.18	C	Risk There is a change in equipment prices
			0.16	F	Risk of limited sources of internal company financing (owner)
			0.15	E	Risk of lack of financing capital by the contractor
			0.15	B	Risk of a dispute occurring in the payment system/method used in the contract document
			0.14	D	Risk: Difficulty in loan amendments following project conditions
K4	Project Cash Flow Management	2	0.35	J	Risk of poor cash flow planning
			0.28	H	Risk of late payment by the owner
			0.21	I	Risk: The ceiling for Cash Loan facilities from the Bank is insufficient.
			0.16	G	Risk of Delay in Billing by Contractor
K9	Contract Detail Specifications	3	0.28	R	Risk of inaccurate contract planning resulting in additional work resulting in additional costs
			0.25	Q	Risk of design/drawing changes during construction
			0.16	P	Risk of Inappropriate Calculation of Material Requirements
			0.16	S	Risk of errors in selecting the contract standards used
			0.15	O	Risk of Determining Job Specifications that are Unclear
K7	Difficulty Fulfilling Materials	4	0.31	m	Risk of Material Delay
			0.29	N	Material Risk requires certain specifications and quality
			0.21	K	Risk of Fluctuating Material Prices
			0.19	L	Project Material Complexity Risk.

Source: Questionnaire data processing II

Based on Table 4.23, it is known that the risk of project financing management with the first priority mitigation step is the risk of errors in cost estimates/preliminary estimates and actual prices, there is a large difference. Project cash flow management The first risk mitigation step is the risk of poor cash flow planning. Risk of detailed contract specifications The first risk mitigation step is the risk of inaccurate contract planning resulting in additional work resulting in additional costs. Difficulty Fulfilling Materials The first risk mitigation step is the Risk of Material Delays.

Managerial Implications of Hydropower Development Project Plans

Each project has its own characteristics, even projects that have the same process form have different critical processes, this is greatly influenced by various processes that depend on each other. Therefore, further analysis is required to identify all critical processes. One technique that can be used is to assign a score to each running process, where a process with a high score is a critical process. Another way that can be done is to determine the existence of alternative processes, where processes that do not have alternatives are critical processes.

Civil work has the highest value compared to other activities, so it can be called a critical process. The risk mitigation process in this critical process can be identified as a risk event related to material delivery difficulties (K7), where the solution that can be implemented is to apply first priority to this risk event, namely by providing a contract with the material party. supplier. that materials are ordered in advance (with or without down payment) to arrive on the project schedule. On the other hand, the construction process is not very valuable, but based on several records of similar projects, this process often becomes an obstacle, causing additional costs and delays to the entire project. From the research above, it is known that this risk can be mitigated through good project planning, so it is hoped that the current detailed technical specifications can accommodate the entire development project so that the process can be controlled.

The next process that can be classified as critical is project cash flow management. In this category, we divide it into 2 (two) categories, namely financial management when raising project financing and the second is financial management when the hydropower development project begins to be implemented. The importance of managerial financial management in securing project financing is to carefully plan project financing needs by implementing ISO 9001:2015 quality management. Apart from determining the need for funds to cover all costs incurred, it is also necessary to consider determining the ability to pay for the hydropower project so that the process of returning investment funds can be of good value. This activity can also be helped by starting to document costs and finance procurement management properly. The importance of managerial financial management when a hydroelectric power plant development project is being implemented is creating and implementing a planning schedule to check and control the budget. This has a dual purpose, namely monitoring the payment process as well as monitoring the progress of construction and implementation of hydroelectric power projects. material whose main purpose is to avoid delays in project implementation.

CONCLUSION

Based on the results of research and discussion, the following conclusions can be drawn:

1. There are risk events that could hamper the smooth development of the 45 MW hydropower plant construction project in the North Sumatra region with an emphasis on investment financial risks. The following are risk events that were identified and then after measurement and analysis, risk priorities were obtained that must be managed first, including: project financing governance, cash flow management, detailed contract specifications, and difficulties in fulfilling materials.
2. These risk events are managed by interpreting them in the management of risk mitigation against financial losses in the implementation of the construction of a 45 MW hydroelectric power plant in the North Sumatra region. The risk mitigation results show that Project Financing governance is the first source of risk with the risk of errors in initial and actual estimated costs/prices having a large difference being the biggest source of risk compared to other sub-risks. Furthermore, Project Cash Flow management becomes the second source of risk events with the risk of poor cash flow planning being the sub-risk that has the largest risk value. Contract Detail Specifications are the third risk event with the risk of inaccurate contract planning resulting in additional work resulting in additional costs becoming the largest sub-source of risk. Finally, difficulties in fulfilling materials are the fourth source of risk events with the risk of material delays being the largest sub-source of risk compared to the other sub-sources.

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