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Risk Analysis of Time in Building Development Viewed from the Contractor's Side in Jayapura

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Abstract: ***Jayapura City has an area of 940 km2 which is divided into 4 sub-districts with Jayapura as its capital. There are many obstacles faced in implementing projects in Jayapura, the obstacles faced are not only due to the ineffective and efficient performance of the contractors during implementation, there are also risks of geographical conditions, security and customary issues in Jayapura, Jayapura climate is also one of the challenges (risks) that must be faced by actors in the world of construction because Jayapura is included in a tropical rain forest climate where the rainfall is still high for some time and the costly index is very high for building infrastructure because material sources still have to be imported from outside Jayapura. The purpose of the study was to analyze the characteristics of risk assessment that affect building construction in Jayapura, to analyze risk management in building construction in Jayapura and to formulate strategies to respond to risks that occur in road infrastructure development in Jayapura. Data collection was carried out at several construction service companies in Jayapura. Jayapura. The data used are primary data and secondary data. Primary data is based on questionnaires, field surveys and interviews, while secondary data is based on data collected from various agencies, both government and private agencies. namely the Public Works Office, the Central Bureau of Statistics, and others. The study in this research is in the form of risk level assessment analysis and risk management analysis in the form of risk response and risk allocation. By using the Severity Index and Promethee Methods.***

Keywords: building construction risks in Jayapura, severity index, Promethee

1. Introduction

Along with the implementation of Law Number 21 of 2001 concerning Special Autonomy for Papua Province, its development activities are also growing. Especially in Jayapura City, which is the center of government, the development of building construction is getting faster[1]

There are many risks faced by construction service companies in building construction in Jayapura. In other cases, construction risk, such as building quality, or price risk, such as increasing building prices often occur. Without a clear contract agreement, it will be detrimental to both parties, so that the principle of justice cannot be achieved.

As in the case of an increase in fuel prices which will automatically be accompanied by an increase in building material prices. Will raise the issue of price, increase funding, or reduce volume or it will affect the quality of the project. It is different only with large-scale projects, where everything will be seen in the contract agreement, because in every agreement between the service provider and the service user, a number of clauses will definitely be listed. For example, what if a natural disaster occurs, and a number of other clauses.

Large contractors are usually long-term projects bound in a price escalation (adjustment) agreement in the event of things beyond their capabilities. However, this is not the case with small group contractors who work on short-term projects. Small contractors, when participating in tenders, must be able to take into account risk factors, including in the event of an increase in prices.

From the events that have developed as above, it has resulted in several contracts that were late in completion and could even have an impact on the failure of construction, so there needs to be a special study of how construction service companies face the risks in Jayapura. The purpose of this study:

1) To identify the characteristics of potential risks that occur in building infrastructure development in Jayapura
2) To analyze and determine risk management in building construction in Jayapura

2. Risk Management

Risk has several different definitions from different experts, including the following:

a) Risk is a potential event, which can be avoided or reduced to a minimum, so that the impact is at least as planned or that we can accept within the tolerable limits allowed, and does not significantly interfere with the targets that have been set.
b) Risk is the likelihood (probability) of occurring events beyond those expected.
c) Risk is a threat or opportunity, where it can give a very unpleasant result or vice versa to the achievement of a project goal made.
d) Risk is the possibility of an event that has an undesirable

effect on goals, strategies, objectives and/or targets[2]

Risk management stages [3]:

2.1 Risk Identification

Risk identification is a process of analyzing to find systematically and continuously the risks (potential losses) that challenge the company. The identification of contractor business risks can be done through two approaches, namely based on the source and based on the challenges for the company.

2.2 Risk Analysis

All risk identifications that have been identified for the cause, need to look for levels for priority handling. The risk level group is divided into four, namely: high (H), significant (S), medium (M), and low (L). Determination of the risk level (risk level), is determined based on two criteria, namely as follows:

a) Frequency of occurrence (probability)
b) Impact of the event (impact/severity)

After the risk analysis is carried out, the next step is to decide on the priority of these risks in providing responses and treatment.

2.3 Risk Response

Responses and risk treatment include the following:

a) Avoid

One of the ways to avoid risk is by avoiding property, people, or activities from exposure to risk by refusing to own, accept, or carry out these activities even if only temporarily and resubmit the risk that has already been received, or immediately stop activities when known to carry risks.

b) Transferred (transfer)

Transfer of negative risk management to third parties. This transfer of responsibility is the most effective way when considering costs. These third parties include subcontractors and insurance companies.

c) Less (mitigate)

This policy is carried out by reducing the possibility and reducing the consequences.

d) Accepted

This policy is usually taken when the impact of these risks is small, even though the probability is large, that is, by including the costs due to these risks into the budget.

3. Research Methods

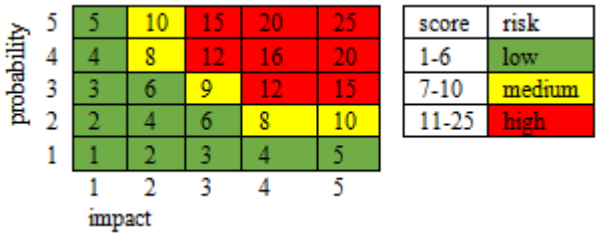
Table 1 shows the profile of the respondent who will fill out the questionnaire.

Table 1: Respondent Profile

Respondent profile		
Position	Education	Work Experience
Director	Bachelor degree/S2	>15 years
manager	Bachelor degree/S2	10-15 years
Site manager	Bachelor degree/S2	5-10 years
implementers	Bachelor degree	<5 years

3.1 Severity Index Concept

This concept is used to determine the value of P



(Probability) and I (Impact). The concept of Severity Index is a way to determine the level of risk by multiplying the probability with the impact entered into the probability matrix and the impact of the excellence of the severity index concept is that it can make classification easier [4].

Figure 1: Probability and impact matrix
Source: PMBOK guide, 2013

3.2 PROMETHEE Method

PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluation) method to determine which risks have the most influence on the project. PROMETHEE is a method of prioritizing the use of predictive values for the dominance of criteria in outranking relationships.

4. Results

4.1 Respondent Profile

From these data, it was found that 1 respondent had taken a Masters degree and 11 respondents had taken a Bachelor degree. The frequency of education level of respondents can be seen in Figure 2.

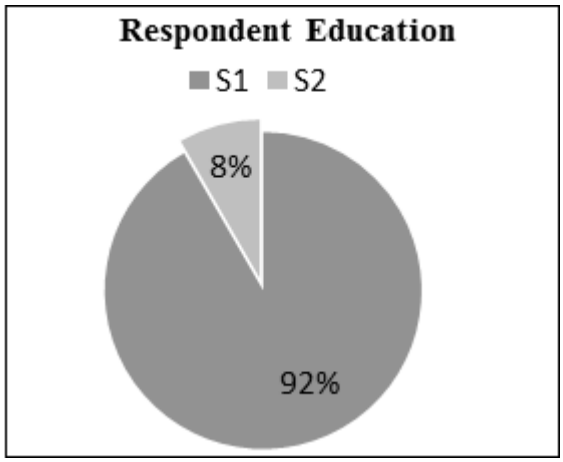


Figure 2: Frequency of Respondents Education Level

From this preliminary survey data, data on the respondents' experiences in handling the project were also obtained. From

the data obtained 3 respondents who have <5 years experience, 4 respondents who have 5-10 years experience, 1 respondent who has 10-15 years experience, and 4 respondents who have >15 years experience. This respondent's experience can be seen in Figure 3.

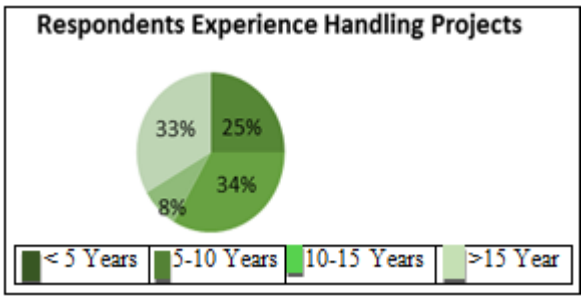


Figure 3: Respondents experience handling projects

4.1 Analysis of Risk Classification Based on the Severity Index (SI) Method

In the assessment of the probability the scale information for the probability assessment is as follows:
Very Low (SR) = <20%
Low (R) => 20 - 40%
Medium / Enough (C) => 40 - 60%
Height (T) => 60 - 80%
Very High (ST) => 80%

An example of calculation using the severity index method is as follows:

From the data obtained from the main questionnaire, it was found that respondents' assessment of the probability of the occurrence of risk variables. Delays in obtaining planning approval, namely 6 respondents stated that the probability of occurrence of small fires, 4 respondents stated that the probability of occurrence of delays in obtaining planning approval was Moderate, 1 respondent stated that the probability of occurrence of delays in obtaining a large planning approval, and 1 more respondent stated that the probability of the occurrence of delays in obtaining planning approval is very large, then the severity index (SI) value is:

$$SI = \frac{\sum_{i=0}^{4} a_i x_i}{4\sum_{i=0}^{4} x_i} \times 100\%$$

$$SI = \frac{(0x0)+(1x6)+(2x4)+(3x1)+(4x1)}{4x12} \times 100\%$$

$$SI = \frac{21}{48} = 43,75\%$$

Obtained a severity index value of 43.75%, then the probability category of the risk variable. The delay in obtaining planning approval is moderate. Calculations for the assessment of probability against time also use the same method as above.

Following are the results of the analysis of the probability assessment using the severity index method in Table 2.

Table 2: Probability Assessment

NO	Risk variables	Against the Aspect of Time					Total	SI (%)	Category
		A	B	C	D	E			
		(1)	(2)	(3)	(4)	(5)			
1	Delays in obtaining planning approval	0	6	4	1	1	12	43,75	Medium
2	Unexpected soil / location conditions	1	2	3	7	0	13	60,42	High
3	Inaccurate environmental studies related to socio-economy.	1	2	4	3	2	12	56,25	Medium
4	The public consultation period was not properly completed due to a lack of coordination and socialization	1	6	4	1	0	12	35,42	Low
5	Inaccurate land acquisition study	3	2	1	5	1	12	47,92	Medium
6	Flaws in designs and specifications	2	4	2	4	0	12	41,67	Medium
7	Does not meet the applicable building design	6	4	1	1	0	12	18,75	Very low
8	Design cost estimation error	4	3	3	1	1	12	33,33	Low
9	Poor planning performance is related to consultant ability	3	5	2	1	1	12	33,33	Low
10	Lack of coordination between projects causes delays	0	3	5	2	2	12	56,25	Medium
11	Late payment by the owner	1	6	1	1	3	12	47,92	Medium
12	Unexpected technical problems in construction	2	3	2	4	1	12	47,92	Medium
13	Material does not meet design and construction specifications	4	3	3	2	0	12	31,25	Low
14	Limited availability of materials	0	3	2	5	2	12	62,5	High
15	Delays in supply of materials by suppliers	0	5		4	3	12	60,42	High
16	Lack of control and supervision of material	1	4	4	2	1	12	45,83	Medium
17	The increase in fuel prices triggers an increase in direct and indirect costs	1	3	4	1	3	12	54,17	Medium
18	Lack of equipment availability	1	4	1	5	1	12	52,08	Medium
19	Heavy equipment failure	2	3	3	3	1	12	45,83	Medium
20	Low productivity of labor and equipment.	1	4	3	3	1	12	47,92	Medium
21	Lack of availability of competent workforce	1	3	3	4	1	12	52,08	Medium
22	Access to sites that are difficult	2	7	1	2	0	12	31,25	Low
23	Quality does not meet (physical) specifications regarding the performance of contractors/ subcontractors	4	3	2	3	0	12	33,33	Low
24	Unavailability of expert subcontractors required for existing work	3	3	2	4	0	12	39,58	Low
25	Inflation rate on construction costs during the construction period	1	3	3	5	0	12	50	Medium

NO	Risk variables	Against the Aspect of Time					Total	SI (%)	Category
		A	B	C	D	E			
		(1)	(2)	(3)	(4)	(5)			
26	Limited work space / location available	6	0	4	2	0	12	29,17	Low
27	Unforeseen project site conditions	3	2	4	2	1	12	41,67	Medium
28	Accidents during construction	3	4	2	1	2	12	39,58	Medium
29	Delayed settlement related to natural disasters	2	2	4	1	3	12	52,08	Medium
30	Cost overruns associated with the monetary crisis	2	4	3	2	1	12	41,67	Medium
31	Delay in obtaining permits	1	6	0	4	1	12	45,83	Medium
32	The project is late due to land acquisition	1	5	2	1	3	12	50	Medium
33	Technical operating tests leading to the discovery of design errors prior to commencement of the operating life.	3	4	4	0	1	12	33,33	Low

Risk Impact Assessment on Time Aspects

The criteria for determining the scale of impact on time are carried out by the researcher themselves. These criteria are based on the respondent's assessment of the frequency of incidents that will later affect the smooth running of the project, where the smoothness of the project will be disrupted if there are more than 5 events. The following is a description of the scale of impact on time:

Very Low (SR) = <20%
Low (R) => 20 - 40%
Medium / Enough (C) => 40 - 60%
Height (T) => 60 - 80%
Very High (ST) => 80%

An example of calculating the impact of risk on the time aspect using the severity index method is as follows: for example, the risk variable. Delay in obtaining planning approval, 1 respondent answered very low, 5 respondents answered Low, 2 respondents answered Medium, and 4 respondents answered High. then the severity index value is:

$$SI = \frac{\sum_{i=0}^{1} a_i x_i}{4 \sum_{i=0}^{1} x_i} \times 100\%$$

$$SI = \frac{(0x1)+(1x5)+(2x2)+(3x4)+(4x0)}{4x12} \times 100\%$$

$$SI = \frac{21}{48} = 43{,}75\%$$

From the results of these calculations, the severity index (SI) value is 43.75%, so this risk is included in the "moderate" category. The following is the analysis result of the risk impact assessment on the time aspect using the severity index method in the table 3.

Table 3: Time Impact Assessment

NO	Risk Variables	Against the Aspect of Time					Total	SI (%)	Category
		A	B	C	D	E			
		(1)	(2)	(3)	(4)	(5)			
1	Delays in obtaining planning approval	0	6	4	1	1	12	43,75	Medium
2	Unexpected soil / location conditions	1	2	3	7	0	13	60,42	High
3	Inaccurate environmental studies related to socio-economy.	1	2	4	3	2	12	60,42	Medium
4	The public consultation period was not properly completed due to a lack of coordination and socialization	1	6	4	1	0	12	45,83	Low
5	Inaccurate land acquisition study	3	2	1	5	1	12	56,25	Medium
6	Flaws in designs and specifications	2	4	2	4	0	12	47,92	Medium
7	Does not meet the applicable building design	6	4	1	1	0	12	27,08	Very low
8	Design cost estimation error	4	3	3	1	1	12	47,92	Low
9	Poor planning performance is related to consultant ability	3	5	2	1	1	12	50	Low
10	Lack of coordination between projects causes delays	0	3	5	2	2	12	56,25	Medium
11	Late payment by the owner	1	6	1	1	3	12	60,42	Medium
12	Unexpected technical problems in construction	2	3	2	4	1	12	45,83	Medium
13	Material does not meet design and construction specifications	4	3	3	2	0	12	39,58	Low
14	Limited availability of materials	0	3	2	5	2	12	62,5	High
15	Delays in supply of materials by suppliers	0	5		4	3	12	54,17	High
16	Lack of control and supervision of material	1	4	4	2	1	12	54,17	Medium
17	The increase in fuel prices triggers an increase in direct and indirect costs	1	3	4	1	3	12	62,5	Medium
18	Lack of equipment availability	1	4	1	5	1	12	39,58	Medium
19	Heavy equipment failure	2	3	3	3	1	12	39,58	Medium
20	Low productivity of labor and equipment.	1	4	3	3	1	12	52,08	Medium
21	Lack of availability of competent workforce	1	3	3	4	1	12	54,17	Medium
22	Access to sites that are difficult	2	7	1	2	0	12	33,33	Low
23	Quality does not meet (physical) specifications regarding the performance of	4	3	2	3	0	12	37,5	Low

NO	Risk Variables	Against the Aspect of Time					Total	SI (%)	Category
		A	B	C	D	E			
		(1)	(2)	(3)	(4)	(5)			
	contractors/ subcontractors								
24	Unavailability of expert subcontractors required for existing work	3	3	2	4	0	12	43,75	Low
25	Inflation rate on construction costs during the construction period	1	3	3	5	0	12	58,33	Medium
26	Limited work space / location available	6	0	4	2	0	12	25	Low
27	Unforeseen project site conditions	3	2	4	2	1	12	45,83	Medium
28	Accidents during construction	3	4	2	1	2	12	41,67	Medium
29	Delayed settlement related to natural disasters	2	2	4	1	3	12	52,08	Medium
30	Cost overruns associated with the monetary crisis	2	4	3	2	1	12	47,92	Medium
31	Delay in obtaining permits	1	6	0	4	1	12	47,92	Medium
32	The project is late due to land acquisition	1	5	2	1	3	12	58,33	Medium
33	Technical operating tests leading to the discovery of design errors prior to commencement of the operating life.	3	4	4	0	1	12	39,58	Low

4.2 Risk Category Analysis Using the RBS (Risk Breakdown Structure) Method Based on a Contractor's Perspective

The criteria for determining the scale of probability and impact on time are based on the respondent's assessment of the frequent level of events which will later affect the smooth running of the project, where the smooth running of the project will be disrupted if it occurs on a scale of 4 to 5. The following is an explanation of the probability scale and impact on the time aspect as well as cost. This analysis is carried out from the perspective of the contractor by assessing the probability and impact of risk on the time aspect. An example of calculating the impact of risk on the time aspect uses the probability and impact multiplication method as follows: for example the contractor answers the probability of the risk variable The delay in obtaining planning approval is moderate with a weight of 3, and the impact on the time the contractor answers the risk is moderate with a weight of 3, then the risk level values are:
Risk Level = Probability x Impact
= 3 x 3 = 9

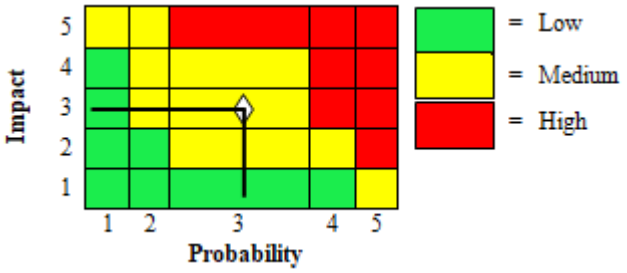


Figure 4: Risk Matrics

There are three categories of probability and impact, namely low, medium, and high. The following is an example of plotting the probability and impact values into the matrix, for example the probability value obtained from the risk variable. The delay in obtaining planning approval is 3 while the impact on the cost aspect is 3.

With the same calculation using the Risk Breakdown Structure (RBS) method, the risk level and risk category of the contractor's perspective on time aspects are obtained as shown in Table 4 below:

Table 4: Risk level and risk category of the contractor's perspective on the time aspect

No	Risk Variables	Against the Aspect of Time			
		Probability	Impact	Risk Level	Risk Category
(1)	(2)	(3)	(4)	(5)	(6)
1	Delays in obtaining planning approval	3	3	9	Medium
2	Unexpected soil / location conditions	4	4	16	High
3	Inaccurate environmental studies related to socio-economy.	3	4	12	Medium
4	The public consultation period was not properly completed due to a lack of coordination and socialization	2	3	6	Medium
5	Inaccurate land acquisition study	3	3	9	Medium
6	Flaws in designs and specifications	3	3	9	Medium
7	Does not meet the applicable building design	1	2	2	Low
8	Design cost estimation error	2	3	6	Medium
9	Poor planning performance is related to consultant ability	2	3	6	Medium
10	Lack of coordination between projects causes delays	3	3	9	Medium
11	Late payment by the owner	3	4	12	Medium
12	Unexpected technical problems in construction	3	3	9	Medium
13	Material does not meet design and construction specifications	2	2	4	Medium
14	Limited availability of materials	4	4	16	High
15	Delays in supply of materials by suppliers	4	3	12	High
16	Lack of control and supervision of material	3	3	9	Medium
17	The increase in fuel prices triggers an increase in direct and indirect costs	3	4	12	Medium

No	Risk Variables	Against the Aspect of Time			
		Probability	Impact	Risk Level	Risk Category
18	Lack of equipment availability	3	2	6	Medium
19	Heavy equipment failure	3	2	6	Medium
20	Low productivity of labor and equipment.	3	3	9	Medium
21	Lack of availability of competent workforce	3	3	9	Medium
22	Access to sites that are difficult	2	2	4	Low
23	Quality does not meet (physical) specifications regarding the performance of contractors/ subcontractors	2	2	4	Low
24	Unavailability of expert subcontractors required for existing work	2	3	6	Medium
25	Inflation rate on construction costs during the construction period	3	3	9	Medium
26	Limited work space / location available	2	2	4	Low
27	Unforeseen project site conditions	3	3	9	Medium
28	Accidents during construction	3	3	9	Medium
29	Delayed settlement related to natural disasters	3	3	9	Medium
30	Cost overruns associated with the monetary crisis	3	3	9	Medium
31	Delay in obtaining permits	3	3	9	Medium
32	The project is late due to land acquisition	3	3	9	Medium
33	Technical operating tests leading to the discovery of design errors prior to commencement of the operating life.	2	2	4	Low

4.3 Main Risk Rank Analysis Using the PROMETHEE Method

Following up on the results of the Risk Breakdown Structure method, for risk level analysis using the PROMETHEE method, only risk categories that are considered high are taken. The results of the probability impact matrix analysis on the time aspect obtained 19 (nineteen) high-category risks. These risks are then analyzed using the PROMETHEE Method for determining the highest risk.

Score	Very low	Low	Medium	High	Very High
	10	20	30	40	50

Before PROMETHEE analysis, it is necessary to record the opinions of respondents regarding the impact of risk on the cost and time criteria according to the weight in the table determining the criteria above. The weights obtained from each respondent are shown in Table 5 below:

Table 6: Contractor's Perspective Mean Scores

No	Risk Variable	A1												Mean
		r1	r2	r3	r4	r5	r6	r7	r8	r9	r10	r11	r12	
R1	Unexpected soil/location conditions	20	50	50	40	40	40	40	40	30	10	30	20	**34**
R2	Limited availability of materials	20	40	50	40	50	30	40	30	40	20	40	40	**37**
R3	Delays in supply of materials by suppliers	20	40	50	30	50	40	40	30	20	20	20	20	**32**

A1: Impact on Time Criteria
r: Respondent (Contractor)

According to respondent 2 (r1) the weight of the risk of delay in obtaining planning approval (R1) is 20, according to respondent 2 (r2) the weight of the risk of Delay in obtaining planning approval (R1) is 50. And so on until respondent 12. Respondents were then averaged so that an average of 34 was obtained against the time criteria for the risk of delay in obtaining planning approval (R1). Next (R1) is then filled in the recapitulation table. The same calculation is carried out on the risk of R2 to R3 by respondent 2 to respondent 12 as in Table 6 below:

Table 6: Recapitulation of Mean Value for Time Criteria

No	Risk Variable	A1
R1	Unexpected soil/location conditions	34
R2	Limited availability of materials	37
R3	Delays in supply of materials by suppliers	32

Table 6 shows the results of respondents' answers to the PROMETHEE questionnaire. The filling of the criteria for each risk is based on the respondent's answer to the related question.

1) Evaluation Table

In conducting the policy determination process using PROMETHEE, the first step that must be taken is to create an Evaluation Table. The evaluation table is a table that contains the criteria, type of preference, and also the parameters of the selected criteria type.

The value of the degree of preference H (d) is carried out by evaluating the value of the absolute deviation of the parameter (q, p) and the appropriate type of criterion for each criterion based on the maximization/minimization function.

The time criterion in this analysis is defined as type I criteria, which means that if the risk is influential then the value is 1, if it does not affect it then the value is 0. So for type I criteria there is no parameter.

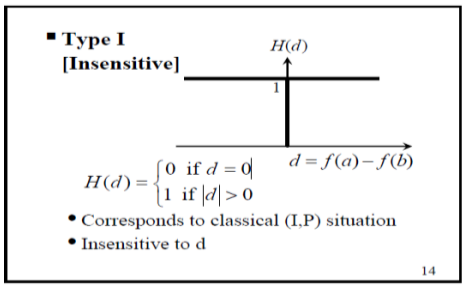


Figure 5: Type I Insensitive for Time Criteria

H (d) = 0 if d = 0
H (d) = 1 if d ≠ 0

The following table 4.5 shows the criteria, type of preference, and also the parameters of the selected preference type, while the values R1 to R3 are filled based on the table recapitulation of the criteria values.

Criteria	Min/Max	Risk		
		R1	R2	R3
A1	Max	34	37	32

A1: Time Criteria,
R1: Unexpected soil / location conditions
R2: Limited availability of material
R3: Delay in supply of materials by suppliers
Assume wi = 1/2 = 0.5

In the second column, there are entries for the max and min columns. The meaning of max and min depends on the criteria we set. For example, given a max value on the A1 criterion (time), it means that the greater / longer the risk that occurs, the risk will dominate the other risks. Likewise for the min. The figures, starting from the third row of the second column to the second row of the next column, are obtained from the results of the questionnaire in the field.

Then the meaning of max in column A1-R2 is the risk that has the greatest value to dominate other risks. For example, in A1-R1 it is 34 and A1-R2 is 37; This means that the risk of R2 is considered more risky than the risk of R1 according to the respondents.

2) Determination of Preference Value

The preference value used in PROMETHEE is used to determine the level of preference for one criterion against other criteria. This includes all of the criteria contained in risk selection. The calculation of the preference value is carried out in pairs between the two types of risk.

The following is an example of calculating the paired preference value for each risk. Delay in obtaining planning approval (R1) and risk of unexpected land / location conditions (R2).

The filling in of columns and rows is according to the dominance of one risk over another based on the Evaluation Table.

Examples on P (R1, R2) and P (R2, R1)
By looking at Table 4.4 Evaluation Table, then:

a) At A1 (max) the value of R1 = 34, the value of R2 = 37; meaning that R1 does not dominate R2 because the value of R1 <R2 (max category) then the value is 0.
b) At A1 (max) the value of R2 = 37, the value of R1 = 34; meaning that R2 dominates R1 because the value of R2> R1 (max category) then the value is 1.
c) The values are then presented in Table 7 below.

Table 7: Paired Preference Value (P) R1 and R2

	P(R1,R2)	P(R2,R1)
A1	0	1
SUM	0	1

d) For filling P (R1, R3) and so on the method is the same as filling P (R1, R2). More details can be seen in Appendix 4.
e) The sum of all Preference values is then multiplied by wi of 0.5 and entered into the Preference Table (i, j).
f) Then the values are added horizontally and vertically.
g) Values added horizontally are subtracted from values added vertically.
h) From these results then ranked, and obtained the most dominating risk.

With the same calculation method, a matrix table of the overall preference values of the risks in Table 4.7 is obtained as follows:

Table 5.1: Preferensi (i, j)

	R1	R2	R3	Ø⁺	Ø	Rangking
R1	0	0	0,5	**0,5**	**0**	**2**
R2	0,5	0	0,5	**1**	**1**	**1**
R3	0	0	0	**0**	**-1**	**3**
Ø⁻	**0,5**	**0**	**1**			

Ø^+ : Positive outranking flow
Ø^(-): Negative outranking flow

From the Preference Table (i, j) it can be determined that the risk that dominates the most. The results obtained are ranked in the top 3 (three) rankings as follows:

1) Risk R2 (limited availability of materials) scores 1 and ranks 1
2) Risk R1 (Unexpected land/location conditions) gets a value of 0 and ranks 2.
3) Risk R3 (delays in supply of materials by suppliers) gets a value of -1 and ranks 3.

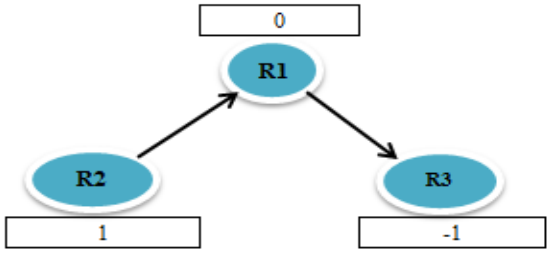


Figure 6: Diagram of PROMETHEE Analysis Results

4.4 Recommendations for Managing Risks in Building Construction in Jayapura

Research recommendations in the form of handling (mitigation) this risk on 3 indicators of high risk variables in building construction in Jayapura obtained from the results of direct interviews with several professionals are as follows:

1) At the risk of limited availability of materials, the mitigation steps taken are at the beginning of the implementation of the work, then first ensure that the materials will be imported from and prepare the materials needed at the job site as needed.
2) At the risk of unexpected land/location conditions, the mitigation step taken is to coordinate with the project owner to use professional experts to investigate the type of soil in the project to be implemented so that it can determine what method is appropriate to solve the problem of the soil condition ugly.
3) At the risk of delays in the supply of materials by the supplier, the mitigation steps taken are at the beginning of the implementation of the work, then first prepare the materials needed at the work location according to the needs and prepare a place on the job site to store material supplies in an appropriate amount.

5. Conclusion

Based on the results of the analysis of the risk analysis research on the time of building construction in terms of the contractor in Jayapura, it can be concluded as follows:
1. The characteristics of the potential risk that occurs in building infrastructure construction in Jayapura are the highest risk variable for the limited availability of materials, which score 1 and rank 1. The risk of unexpected land / location conditions gets a value of 0 and ranks 2. As well as the risk of delays in material supply by suppliers get a value of -1 and rank 3.

2. The highest risk management in building construction in Jayapura is for the risk of limited availability of materials, so the mitigation steps taken are at the beginning of the implementation of the work, then first ensure the materials will be imported from where and prepare the materials needed at the work site as needed. The risk of unpredictable land/location conditions, the mitigation step taken is to coordinate with the project owner to use professional experts to investigate the type of soil in the project to be implemented so that it can determine what method is appropriate to solve the problem of poor soil conditions. And the risk of delays in the supply of materials by suppliers, the mitigation steps taken are at the beginning of the implementation of the work, then first prepare the materials needed at the work location according to the needs and prepare a place on the job site to store material supplies according to the amount needed.

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Insert/Break/Continuous.

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