Conceptual Framework For Supply Chain Risk Management Study on Breakwater Project in Indonesia Case Study : Makassar New Port Breakwater Development Project

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Conceptual Framework For Supply Chain Risk Management Study on Breakwater Project in Indonesia Case Study : Makassar New Port Breakwater Development Project

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Abstract. In carrying out its supply chain activities, a project often experiences problems starting from the procurement, production, to delivery processes. Likewise, the Makassar New Port Breakwater development project must consider its risks in planning, implementation and operations. This study aims to determine the risks that could potentially occur in supply chain activities at the Breakwater Makassar New Port development project in Indonesia. Furthermore, it will provide information on which risks fall into the high and low categories. Moreover, the research will provide the results of the mitigation options for each risk. An essential contribution of this research is that the results will give a lesson learned and initial data to determine future risks in the breakwater project. Based on the research conducted, the identified risks in the supply chain of the Makassar New Port Breakwater development project are 38 risks where the dominant risk factor in the material supply chain that influences the implementation of the Makassar New Port Breakwater development project is variable C6, namely the amount of production that does not match the target. In the moderate risk category. From the results of data analysis, it is known that the contractors and suppliers make efforts to reduce the dominant risk either preventively or curatively so that these risks do not interfere and cause a significant impact on the project objectives.

1. Introduction

The industry that produces construction services is a sector that plays an essential role in determining the pace of activity for the economy and advancing the other sectors. However, according to Ganesh (2021), usually managing construction projects, many project constraints are found, such as quality that is not achieved and the time to complete the project being late. In addition, the construction services industry is one of the most dynamic industries compared to other sectors due to the ever-changing market conditions, the relatively short construction period, and fluctuations in material prices which are very difficult to predict, as well as intense competition between service providers, subcontractors, suppliers and other parties [9].

The challenges in construction projects are increasingly complex, so increasing production results in terms of quality and completion time is very important for companies to continue to be competitive and survive. According to Briscoe and Dainty (2005), O'Brian et al. (2009) and Ahmed (2017) explained that supply chain management is essential to improve the performance of construction projects where in the construction supply chain management cycle changes are inevitable and may have an impact towards the project. Changes will continue to occur and may impact project timelines and cost overruns. According to Dainty (2007), supply chain management has proven strategic in managing projects involving many stakeholders, suppliers and materials.
In performing its supply chain activities, a project often encounters problems from the procurement, production and delivery processes. Similarly, the Makassar New Port Breakwater Development Project needs to consider the risks that will arise in its planning, implementation and operations. This

development project has many risks because it uses heavy equipment in the supply of materials and involves a lot of human resources that require attention, especially to avoid troubles.

This study aims to determine what risks will be identified in the supply chain of the Makassar New Port Breakwater Development project. From this analysis, it is also possible to predict the dominant risks that will occur in the future and provide risk responses to reduce or anticipate these dominant risks.

2. Methodology

2.1 The project overview and Location

This research was conducted on the Makassar New Port Breakwater construction project, located on New Makassar Port Street, Makassar, South Sulawesi.

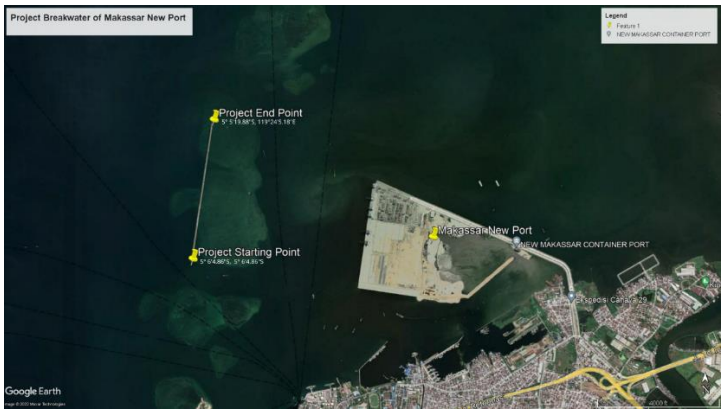

Figure 1. Research Site

2.2 Research Design

The research was conducted on the Makassar New Port Breakwater Development project with a qualitative descriptive research method. The qualitative descriptive method aims to make a systematic, factual and accurate description or description of a phenomenon or the relationship between the phenomena being investigated. The qualitative descriptive method used is the interview and survey method which aims to obtain opinions from experts and respondents regarding the risks that may occur in the supply chain activities of the Makassar New Port Breakwater Development project.

2.3 Conceptual Framework

The research was carried out in several stages, as shown in Figure 2.

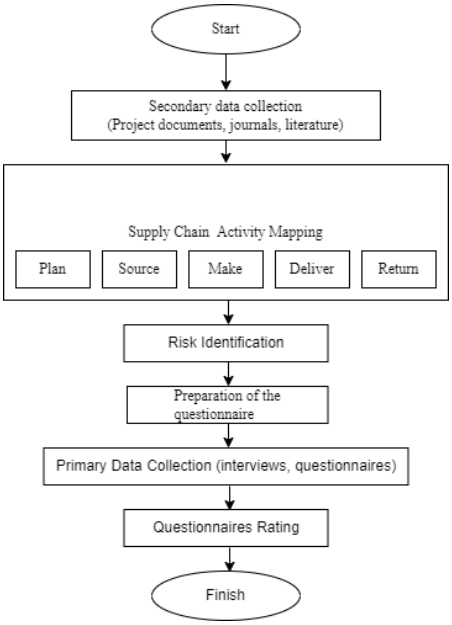

Figure 2. Conceptual Framework

The conceptual framework starts by collecting secondary data and mapping supply chain activities using the Supply Chain Operation Reference model (source, make, plan, deliver and return). Furthermore, identifying risks that may occur and potentially occur in supply chain activities, namely by collecting primary data through registering (listing) risks that may arise as much as possible through field surveys, interviews and questionnaires. The final stage is analysis and assessment to predict the dominant risks that will occur in the future and can provide risk responses to reduce or anticipate these dominant risks. Risk analysis is carried out using the Severity Index (SI) method. The goal is to get the results of a combination of probability assessment and risk impact on time and cost aspects. The formula calculates the Severity Index (SI):

$$SI = \frac{\sum_{i=}^{4} aixi}{a\sum_{i=0}^{4} xi} x100\% \quad (1)$$

2.4 Data Analysis

There are two types of data used in this study, namely:

1. Primary data is data obtained from distributing questionnaires and interviews to respondents who are involved in the Makassar New Port breakwater construction project.
2. Secondary data is general data on project implementation sourced from documents, journals, literature and previous related studies.

2.5 Respondents of the Research

Respondents in this study had a detailed and thorough understanding of the actual conditions of the project and had been directly involved in the Makassar New Port Breakwater Development Project (Package C). Respondents who were designated as samples in this study amounted to 20 people, where the respondents consisted of 3 service users (PT. Pelabuhan Indonesia IV (Persero), 12 service providers (implementing contractors), and 5 consultant work supervisors.

2.6 Instrument of the Research

A research instrument is a tool used to collect data and information from the questionnaire. The research instrument used was a questionnaire with a qualitative perception scale in the form of a scale ranging from 1 to 5. The scale used in the preparation of the questionnaire is the ordinal for the probability of a

risk and the impact that will be caused. For example, supply chain activities could use the following rating scale:

- Probability/risk probability assessment scale (Duffel, 2003):
  Very Low = Rarely occurs, only under certain conditions 20%
  Low = Sometimes occurs in certain conditions >20–40%
  Moderate = Occurs under certain conditions >40-60%
  High = Often occurs in certain conditions >60-80%
  Very High = Always occurs in conditions >80-100%
- The risk impact assessment scale on implementation costs (Knight & Fayek, 2002):
  Very Low = <10 million rupiah
  Low = >10-25 million rupiah
  Medium = >25-100 million rupiah
  Height = >100 million – 1 billion rupiah
  Very High = >1 billion rupiah
- Risk impact assessment scale over time (Kerzner, 2006):
  Very Low = No impact on project schedule, 1 day project duration
  Low = There is a delay in the project schedule, >1-3 days project duration
  Medium = There is a delay in the project schedule, > 3-7 days project duration
  High = There is a delay in the project schedule, > 7-30 days project duration
  Very High = There is a delay in the project schedule > 30 days project duration

3. Result and Discussion

The results of the research describe that there will be risks that have the potential to occur in supply chain activities at the Makassar New Port Breakwater development project in Indonesia. Furthermore, it will provide information on which risks fall into the high and low categories. Moreover, the research will provide the results of the mitigation options for each risk. Finally, an essential contribution of this research is that the results of this study will provide a lesson learned and initial data to determine the risks that occur in the breakwater project in the future.

3.1 Risk Identification

Risk identification is determining what events affect the agency and documenting the risk's character. The risk identification results will be used for qualitative analysis and risk response processes. It could be identified based on direct observations in the field and brainstorming with related parties competent in providing input.

In this preliminary survey, there were 38 identified risks consisting of 8 risk variables in the Source activity, seven risk variables in the Plan activity, nine risk variables in the Make activity, eight risk variables in the Deliver activity and six risk variables in the Return activity. Identification of risks that occur in the Makassar New Port Breakwater Development Project. The identified risks can be described in table 1 as follows:

Tabel 1 Risk Identification

Activity	Code	Risk Identification
Source	A1	Error choosing supplier
	A2	Not evaluating supplier performance
	A3	Delay in picking up raw materials
	A4	Raw materials received do not match the quantity requested
	A5	The type/item of the raw material received does not match the request
	A6	There are raw materials that do not match the quality
	A7	There is no evaluation of raw materials from the company
	A8	Raw material pick-up schedule error
Plan	B1	Error planning quantity availability for raw materials
	B2	Incompatibility of raw material planning with financial planning
	B3	Error planning scheduling of taking raw materials
	B4	Production scheduling plan error
	B5	There is a change in the plan in the production system
	B6	Error in estimating the number of material requests
	B7	Incompatibility of distribution planning with production planning
Make	C1	Error in production scheduling
	C2	There was a delay in the production process
	C3	Insufficient raw materials for production
	C4	The production process is not according to the SOP
	C5	Error in product storage
	C6	The amount of production does not meet the target
	C7	Non-conformance of materials produced with customer orders
	C8	The production machine is broken
	C9	Not checking the quality of the products
Deliver	D1	No material quality check (before delivery)
	D2	Lack of material delivery capacity
	D3	Lack of means of transportation
	D4	Lack of material at the supplier
	D5	There was an error in the shipping process that damaged the material
	D6	The material error sent to the customer
	D7	Material delivery schedule error to customer
	D8	Delay in delivery of materials to customers
Return	E1	Material is returned to the supplier for some reason
	E2	Complaints from customers
	E3	Delay in the return process from supplier to customer
	E4	No returns for some reason
	E5	No management of inappropriate material results (return)
	E6	No handling is carried out for processes or material results that are not in accordance with (return)

3.2 Variable Risk Analysis

After conducting a preliminary survey and obtaining relevant risk variables related to the supply chain in the Makassar New Port Breakwater development project, this primary survey aims to determine the probability of risk that can occur and the impact of the risk that is caused when the risk occurs. This primary survey contains perceptions or points of view on each risk variable by determining the probability and impact value/score. Risk variable analyses were carried out to analyze the primary

survey. The analysis is carried out on the risk probability and risk impact assessment. This analysis is calculated by the Severity Index (SI) method. The results of the probability assessment of supply chain activities for the Makassar New Port Breakwater development project are shown in Table 2.

Tabel 2 Probability Assessment

Code	1	2	3	4	5	Total	SI (%)	Category	Grade
	VL	L	M	H	VH				
A1	8	2	4	2	1	17	29,41%	**Low**	**2**
A2	6	6	2	3	0	17	27,94%	**Low**	**2**
A3	5	4	6	1	1	17	33,82%	**Low**	**2**
A4	4	4	4	5	0	17	39,71%	**Low**	**2**
A5	4	6	2	5	0	17	36,76%	**Low**	**2**
A6	5	4	2	5	1	17	39,71%	**Low**	**2**
A7	8	3	3	2	1	17	27,94%	**Low**	**2**
A8	6	5	4	1	1	17	29,41%	**Low**	**2**
B1	6	5	2	4	0	17	30,88%	**Low**	**2**
B2	7	5	1	4	0	17	27,94%	**Low**	**2**
B3	6	5	3	3	0	17	29,41%	**Low**	**2**
B4	6	5	3	3	0	17	29,41%	**Low**	**2**
B5	6	1	9	1	0	17	32,35%	**Low**	**2**
B6	6	4	6	1	0	17	27,94%	**Low**	**2**
B7	7	3	3	4	0	17	30,88%	**Low**	**2**
C1	8	3	3	3	0	17	26,47%	**Low**	**2**
C2	6	4	2	4	1	17	35,29%	**Low**	**2**
C3	7	4	3	2	1	17	29,41%	**Low**	**2**
C4	8	2	5	1	1	17	27,94%	**Low**	**2**
C5	8	2	4	2	1	17	29,41%	**Low**	**2**
C6	5	3	3	5	1	17	41,18%	**Moderate**	**3**
C7	5	6	4	1	1	17	30,88%	**Low**	**2**
C8	5	1	8	2	1	17	39,71%	**Low**	**2**
C9	9	2	3	2	1	17	26,47%	**Low**	**2**
D1	9	3	2	2	1	17	25,00%	**Low**	**2**
D2	6	3	7	1	0	17	29,41%	**Low**	**2**
D3	6	4	5	2	0	17	29,41%	**Low**	**2**
D4	6	4	4	3	0	17	30,88%	**Low**	**2**
D5	7	5	3	1	1	17	26,47%	**Low**	**2**
D6	5	7	4	0	1	17	27,94%	**Low**	**2**
D7	6	6	4	1	0	17	25,00%	**Low**	**2**
D8	5	6	2	4	0	17	32,35%	**Low**	**2**
E1	6	4	6	1	0	17	27,94%	**Low**	**2**
E2	5	4	6	1	1	17	33,82%	**Low**	**2**
E3	6	6	4	1	0	17	25,00%	**Low**	**2**
E4	6	3	8	0	0	17	27,94%	**Low**	**2**
E5	8	1	5	1	2	17	32,35%	**Low**	**2**
E6	9	1	4	0	3	17	30,88%	**Low**	**2**

Table 2 for probability assessment shows that 1 (one) Middle category contained in code C6, which is a Make activity with risk identification. The amount of production does not meet the target with an SI value of 41.18%. As for the identification of other risks in the Low category.

The following are the results of the risk impact analysis based on the cost aspect from the contractor's perspective on supply chain activities for the Makassar New Port Breakwater development project, which can be seen in Table 3.

Tabel 3 Assessment of Risk Impact on Cost Aspect

Code	1	2	3	4	5	Total	SI (%)	Category	Grade
	VL	L	M	H	VH				
A1	7	1	4	4	1	17	37%	**Low**	**2**
A2	7	2	3	4	1	17	35%	**Low**	**2**
A3	5	3	6	2	1	17	37%	**Low**	**2**
A4	5	3	5	3	1	17	38%	**Low**	**2**
A5	5	3	4	3	2	17	41%	**Medium**	**3**
A6	5	3	3	5	1	17	41%	**Medium**	**3**
A7	5	3	4	4	1	17	40%	**Low**	**2**
A8	4	6	4	2	1	17	35%	**Low**	**2**
B1	7	2	4	4	0	17	32%	**Low**	**2**
B2	6	3	3	2	3	17	40%	**Low**	**2**
B3	7	3	4	3	0	17	29%	**Low**	**2**
B4	5	5	2	5	0	17	35%	**Low**	**2**
B5	5	4	5	1	2	17	37%	**Low**	**2**
B6	6	4	1	2	4	17	41%	**Medium**	**3**
B7	6	2	4	5	0	17	37%	**Low**	**2**
C1	6	4	5	2	0	17	29%	**Low**	**2**
C2	5	4	6	1	1	17	34%	**Low**	**2**
C3	5	4	4	2	2	17	38%	**Low**	**2**
C4	5	4	2	4	2	17	41%	**Medium**	**3**
C5	6	4	2	3	2	17	37%	**Low**	**2**
C6	5	2	4	4	2	17	44%	**Medium**	**3**
C7	6	1	3	4	3	17	46%	**Medium**	**3**
C8	5	0	5	5	2	17	49%	**Medium**	**3**
C9	6	3	4	3	1	17	35%	**Low**	**2**
D1	8	1	5	2	1	17	31%	**Low**	**2**
D2	2	5	5	3	2	17	47%	**Medium**	**3**
D3	5	3	6	3	0	17	35%	**Low**	**2**
D4	6	4	4	2	1	17	32%	**Low**	**2**
D5	6	4	4	2	1	17	32%	**Low**	**2**
D6	6	1	6	0	4	17	43%	**Medium**	**3**
D7	5	4	4	1	3	17	40%	**Low**	**2**
D8	5	4	4	2	2	17	38%	**Low**	**2**
E1	5	3	4	4	1	17	40%	**Low**	**2**
E2	5	3	6	1	2	17	38%	**Low**	**2**
E3	6	4	6	1	0	17	28%	**Low**	**2**
E4	6	4	7	0	0	17	26%	**Low**	**2**
E5	5	3	6	3	0	17	35%	**Low**	**2**
E6	4	3	7	1	2	17	41%	**Medium**	**3**

Table 3 for assessing the risk impact on costs shows that for the Middle category with a value of 3, there are 10 (ten) codes A5, A6, B6, C4, C6, C7, C8, D2, D6, and E6. As for the Low category, with a value of 2, as many as 28 (twenty-eight) risk identification codes.

The following are the results of the risk impact analysis based on the time aspect from the contractor's perspective on supply chain activities for the Makassar New Port Breakwater development project, which can be seen in Table 4.

Tabel 4 Assessment of Risk Impact on Time Aspect

Code	1	2	3	4	5	Total	SI (%)	Kategori	Nilai
	VL	L	M	H	VH				
A1	6	3	5	0	3	17	37%	Low	2
A2	6	4	3	2	2	17	35%	Low	2
A3	5	2	3	4	1	15	40%	Low	2
A4	5	3	2	7	0	17	41%	Middle	3
A5	6	2	3	5	1	17	40%	Low	2
A6	5	3	4	3	2	17	41%	Middle	3
A7	6	4	2	4	1	17	35%	Low	2
A8	5	3	4	3	2	17	41%	Middle	3
B1	5	2	4	4	2	17	44%	Middle	3
B2	4	3	4	5	1	17	44%	Middle	3
B3	5	5	3	2	2	17	37%	Low	2
B4	6	2	5	2	2	17	38%	Low	2
B5	6	1	6	1	3	17	41%	Middle	3
B6	5	4	1	6	1	17	41%	Middle	3
B7	6	1	4	3	3	17	44%	Middle	3
C1	6	1	5	3	2	17	41%	Middle	3
C2	5	2	5	3	2	17	43%	Middle	3
C3	5	2	3	4	3	17	47%	Middle	3
C4	7	0	5	3	2	17	40%	Low	2
C5	6	5	2	2	2	17	34%	Low	2
C6	5	2	3	5	1	16	42%	Middle	3
C7	6	2	4	3	2	17	40%	Low	2
C8	4	2	2	6	3	17	53%	Middle	3
C9	5	4	3	4	1	17	38%	Low	2
D1	6	4	3	3	1	17	34%	Low	2
D2	4	3	6	4	0	17	40%	Low	2
D3	4	4	5	4	0	17	38%	Low	2
D4	4	4	4	4	1	17	41%	Middle	3
D5	4	5	4	3	1	17	38%	Low	2
D6	4	4	6	1	2	17	40%	Low	2
D7	5	4	3	4	1	17	38%	Low	2
D8	4	4	4	4	1	17	41%	Middle	3
E1	4	4	8	1	0	17	34%	Low	2
E2	4	3	6	3	1	17	41%	Middle	3
E3	6	4	4	3	0	17	31%	Low	2
E4	5	6	5	1	0	17	28%	Low	2
E5	3	5	5	4	0	17	40%	Low	2
E6	4	5	6	2	0	17	34%	Low	2

Based on table 4 for the assessment of the impact of risk on the time aspect shows that there are 22 (twenty-two) risk identifications in the Low category and 16 (sixteen) risk identifications in the Middle category.

3.3 Risk Assesment

The risk value is obtained by plotting the value on the probability and impact matrix. The categories of probability and impact consist of three categories: high, medium, and low. Then, risk analysis on cost and time is carried out by multiplying the results of the probability assessment (P) with the impact assessment (I) on the cost and time of each risk variable. The results of the calculation of the risk analysis on the cost and time aspects can be seen in table 5.

Table 5 Assessment of Risk Categories Against Cost and Time Aspects

Code	Significant risk assesment of cost				Significant risk assesment of time			
	Probability (P)	Cost Impact (I)	P x I	Risk	Probability (P)	Time Impact (I)	P x I	Risk
A1	2	2	4	Low	2	2	4	Low
A2	2	2	4	Low	2	2	4	Low
A3	2	2	4	Low	2	2	4	Low
A4	2	2	4	Low	2	3	6	Low
A5	2	3	6	Low	2	2	4	Low
A6	2	3	6	Low	2	3	6	Low
A7	2	2	4	Low	2	2	4	Low
A8	2	2	4	Low	2	3	6	Low
B1	2	2	4	Low	2	3	6	Low
B2	2	2	4	Low	2	3	6	Low
B3	2	2	4	Low	2	2	4	Low
B4	2	2	4	Low	2	2	4	Low
B5	2	2	4	Low	2	3	6	Low
B6	2	3	6	Low	2	3	6	Low
B7	2	2	4	Low	2	3	6	Low
C1	2	2	4	Low	2	3	6	Low
C2	2	2	4	Low	2	3	6	Low
C3	2	2	4	Low	2	3	6	Low
C4	2	3	6	Low	2	2	4	Low
C5	2	2	4	Low	2	2	4	Low
C6	3	3	9	Middle	3	3	9	Middle
C7	2	3	6	Low	2	2	4	Low
C8	2	3	6	Low	2	3	6	Low
C9	2	2	4	Low	2	2	4	Low
D1	2	2	4	Low	2	2	4	Low
D2	2	3	6	Low	2	2	4	Low
D3	2	2	4	Low	2	2	4	Low
D4	2	2	4	Low	2	3	6	Low
D5	2	2	4	Low	2	2	4	Low
D6	2	3	6	Low	2	2	4	Low
D7	2	2	4	Low	2	2	4	Low
D8	2	2	4	Low	2	3	6	Low
E1	2	2	4	Low	2	2	4	Low
E2	2	2	4	Low	2	3	6	Low
E3	2	2	4	Low	2	2	4	Low
E4	2	2	4	Low	2	2	4	Low
E5	2	2	4	Low	2	2	4	Low
E6	2	3	6	Low	2	2	4	Low

Based on table 5, the risk variables are categorized as medium and low. Therefore, one medium risk variable and 37 standard category risk variables were obtained in the analysis.

3.4 Risk Management

It is done by plotting the value on the probability and impact matrix to get the risk value and the categories of probability and impact consisting of three categories: high, medium, and low. Then, risk analysis on cost and time is carried out by multiplying the results of the probability assessment (P) with the impact assessment (I) on the cost and time of each risk variable. The results of the calculation of the risk analysis on the cost and time aspects can be seen in table 5.

From the analysis results from table 5, it is obtained that the risk variables have the dominant risk, namely the risk with a medium category that impacts cost and time. These risks are likely to have a significant impact on project implementation. The risk variable category analysis is carried out using the PMBOK risk matrix, where as shown in Figure 3, there is one medium category risk variable, code C6, with the type of risk, namely the number of producing results that are not on target. Table 6 shows some mitigation that can be done to overcome the moderate risk obtained.

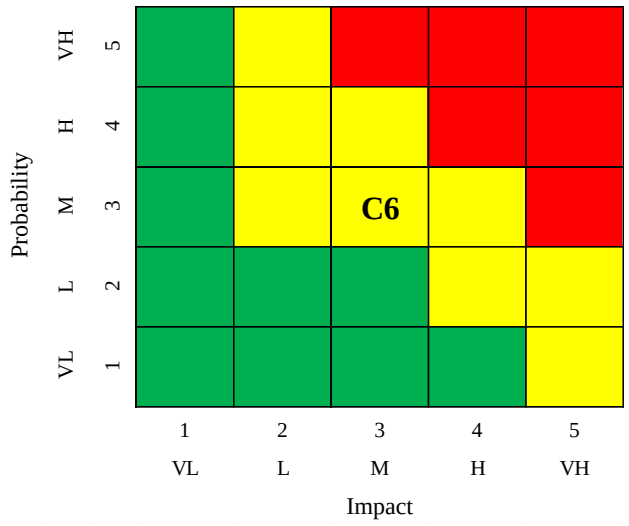

Figure 3 Risk Matrix Assessment (PMBOK)

Table 6 Management of the dominant risk of cost and time

Code	Risk Type	Risk Management
C6	The amount of production does not meet the target	Using previous historical data analysis to estimate production results to achieve the target
		Quality Control from both parties must also always be careful in checking the materials to be sent and those that have been sent
		Always communicate with the supplier to ensure the material to be produced is according to specifications
		Prepare a list of backup suppliers to anticipate suppliers who are lacking in sending materials

4. Conclusion

Based on the research and the results of the analysis carried out, it can be concluded:

- The identified risks in the supply chain of the Makassar New Port Breakwater development project are 38 risks consisting of 8 risk variables in the Source activity, seven risk variables in the Plan activity, nine risk variables in the Make activity, eight risk variables in the Deliver activity and six risk variables on the Return activity.
- The dominant risk factor in the material supply chain that affects the implementation of the Makassar New Port Breakwater development project is variable C6, namely the amount of production that is not on target with a moderate risk category.
- The risk response to the dominant risk is in the form of corrective actions, namely: using previous historical data analysis to estimate production results so that they can reach the target. Quality control from both parties must also always be careful in checking the materials to be sent and those that have been delivered. So sent, always communicate with suppliers to ensure the material to be produced is according to specifications, and prepare a list of backup suppliers to anticipate suppliers who are lacking in sending materials.

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