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Implementation of ISO 31000:2018-Based Enterprise Risk Management in the Belawan Wharf Phase 2 Remedial Works Project

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ABSTRACT

Construction projects have various potential risks that can affect the time, cost, and quality of work. However, the implementation of risk management in completed projects is often not carried out systematically in accordance with applicable standards. Therefore, this study examines the implementation of the ISO 31000:2018 standard and analyzes the risks in the completed Belawan Wharf Phase 2 Remedial Works Project using the Severity Index method to identify dominant risks and their risk levels. This study employed a quantitative approach, with data collected through questionnaires distributed to respondents involved in the Belawan Wharf Phase 2 Remedial Works Project. Total sampling was used, involving 18 respondents who met the predetermined research criteria. The research stages included risk identification, risk analysis, and risk evaluation. In the analysis stage, the Severity Index is used to measure the level of likelihood and impact of each risk based on respondents' perceptions. The research results indicate that the implementation of risk management in the completed Belawan Wharf Phase 2 Remedial Works Project has covered the basic stages in accordance with ISO 31000:2018, but has not been fully implemented systematically, particularly in the areas of risk control and documentation. Furthermore, The final risk classification identified two high-risk variables, fourteen medium-risk variables, three low-risk variables, and no extreme-risk variables.The Severity Index method has proven to be able to quantitatively measure risk levels and assist in determining risk management priorities. Based on the research findings, it is recommended that the implementation of risk management in future projects be more structured and sustainable, and that the risk evaluation results can be used as learning materials to improve future project performance.

Keywords: *Construction Projects, ISO 31000:2018, Risk Management, Risk Matrix, Severity Index*

1. Introduction

Construction projects face various challenges and obstacles that may affect the implementation of Enterprise Risk Management (ERM). Effective Enterprise Risk Management (ERM) implementation requires strong commitment from top management [1]. During the implementation of the Belawan Wharf Phase 2 Remedial Works Project, several issues posed potential risks to project performance, including changes in field conditions, material delays, design changes, equipment damage, and uncertain weather conditions. In previous

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studies, most studies analyzed the maturity level of ERM in general construction or large contractors, but rarely explored implementation in dock projects with unique risks such as extreme weather and marine conditions. There has been no in-depth case study on PT. NINDYA KARYA for dock remedial projects, where management commitment and ERM integration are often obstacles [13].

The Belawan Wharf Phase 2 Remedial Works Project is a rehabilitation project aimed at improving the structural performance and operational safety of the existing wharf facilities. The project included concrete repair works, structural strengthening, marine construction activities, and supporting infrastructure improvements. Because the project had been completed, this study retrospectively evaluated risk management implementation using historical project documents and the experiences of personnel directly involved in the project.

In previous research, most studies analyzed the maturity level of ERM in state-owned general construction companies or large contractors, but rarely explored implementation in dock projects with unique risks such as extreme weather and sea conditions. Previous studies on ISO 31000 in Indonesian construction projects have rarely incorporated Severity Index analysis for risks specific to wharf rehabilitation projects or developed integrated mitigation strategies.There has been no in-depth case study on PT. NINDYA KARYA for dock remediation projects, where management commitment and ERM integration are often obstacles. Although there is research on the level of ERM implementation in large contractors, there has been no empirical study on the Belawan dock project. These studies have not combined the Severity Index with ISO 31000 to identify implementation deficiencies in PT. NINDYA KARYA.

Previous studies have generally focused on risk management implementation in building and highway construction projects. However, limited studies have evaluated the implementation of ISO 31000:2018 in completed marine construction projects using the Severity Index approach. Therefore, this study addresses this gap by evaluating Enterprise Risk Management implementation in a completed wharf remedial project and identifying dominant risks to provide lessons learned for future marine construction projects[13].

2. Method

1. Identify Risks
   Risk identification is the process of determining, recognizing, and providing an overview of risks[7]. This activity is useful for finding, realizing and explaining risks that may prevent companies from achieving their goals[13].
2. Risk Analysis
   Risk analysis is carried out to determine the level of likelihood of risk occurrence and the magnitude of the impact on the project. This process helps in determining the priority of risks that need more attention. To determine the level of likelihood of risk occurrence in the project, a risk probability assessment scale based on respondents' perceptions was used using *a Likert* scale of 1-5. The scale of the level of risk probability can be seen in Table 1.

Table 1 Risk Probability Level

Scale	Categories	Degree of possibility
1	Very Low	Almost never happens
2	Small	Rare
3	Medium	Quite often
4	Large	Frequent
5	Very Large	Very common

In addition to probability, this study also assesses the level of risk impact on project implementation. The scale of the risk impact assessment can be seen in Table 2.

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Table 2 Risk Impact Level

Scale	Categories	Degree of impact
1	Very Light	No significant impact on the project
2	Light	Impact is small and still tolerable
3	Medium	It has a significant impact and needs attention
4	Heavy	Has a major impact on cost, time, or quality
5	Very Heavy	It has a huge impact and disrupts the course of the project

After the probability and impact values are obtained, the risk level is determined based on the combination of these two values. The classification of risk levels can be seen in Table 3.

Table 3 Risk Level

Scale	Remarks
1 – 4	*Low*
5 – 9	*Medium*
10 – 16	*High*
17 - 25	*Extreme*

3. Risk Evaluation
   Risk evaluation aims to understand and measure potential threats and opportunities that can affect the success of a project. The risk levels are illustrated in Figure 1.

LIKELIHOOD	**Sangat Besar (5)**	Medium (5)	High (10)	Extreme (15)	Extreme (20)	Extreme (25)
	Besar (4)	Low (4)	Medium (8)	High (12)	Extreme (16)	Extreme (20)
	Sedang (3)	Low (3)	Medium (6)	High (9)	High (12)	Extreme (15)
	Kecil (2)	Low (2)	Low (4)	Medium (6)	High (8)	High (10)
	Sangat Kecil (1)	Low (1)	Low (2)	Low (3)	High (4)	High (5)
		Sangat Ringan (1)	**Ringan (2)**	**Sedang (3)**	**Berat (4)**	**Sangat Berat (5)**
		IMPACT				

Figure 1 Risk Matrix

Description :

The colors in the risk matrix represent the level and priority of the identified risks. Each color indicates a different level of risk, as follows:

Red : *Extreme*
Orange : *high*
Yellow : *Medium*

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Green : *low*

4. *Severity Index*

The Severity Index *(SI)* is a quantitative method used to measure the severity of risk variables based on respondents' perceptions. In this study, the SI wa calculated separately for the probability and impact of each identified risk. The Severity Index was Calculated using Equation (2.1):

$$SI = \frac{\sum(a_i \,.\, x_i)}{5N} \times 100 \qquad (2.1)$$

where:

SI = *Severity Index*
a_i = Weight of rating *i*
x_i = Number of respondents selecting rating *i*
i = Rating scale from 1 to 5
N = Total number of respondents

Example:

For Risk A1 (Payment Delay), the Severity Index was calculated separately for the probability and impact assessments based on the responses from 18 respondents.

For the probability assessment**,** five respondents rated the probability as *Very Small* (rating 1), five respondents rated it as *Small* (rating 2), five respondents rated it as *Medium* (rating 3), one respondent rated it as *Large* (rating 4), and two respondents rated it as *Very Large* (rating 5). The weighted scores were therefore calculated by multiplying each rating by the number of respondents selecting that rating. the Severity Index for the probability of Risk A1 was calculated as:

$$SI\ (P) = \frac{(1)(5)+(2)(5)+(3)(5)+(4)(1)+(5)(2)}{5(18)} \times 100$$

$$SI\ (P) = 48.89\%$$

This result indicates that the probability of the Payment Delay risk received a Severity Index value of 48.89%

For the impact assessment, seven respondents rated the impact as *Very Small* (rating 1), six respondents rated it as *Small* (rating 2), two respondents rated it as *Medium* (rating 3), one respondent rated it as *Large* (rating 4), and two respondents rated it as *Very Large* (rating 5). Therefore, the Severity Index for the impact of Risk A1 was calculated as:

$$SI\ (I) = \frac{(1)(7)+(2)(6)+(3)(2)+(4)(1)+(5)(2)}{5(18)} \times 100$$

$$SI\ (I) = 43.33\%$$

This result indicates that the impact of the Payment Delay risk received a Severity Index value of 43.33%

The resulting Severity Index values were then converted into probability and impact ratings based on the predetermined classification scale. These ratings were subsequently used to determine the risk level of Risk A1 using the risk matrix.

Based on the Severity Index calculations above, the resulting percentage values are then interpreted according to the predetermined Severity Index classification scale to determine the corresponding probability and impact ratings.

Explanation:

Value a_i is the weight of each assessment category, namely:
1 = Very small
2 = Small

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3 = Medium
4 = Large
5 = Very large

The results of the *severity index* (SI) calculation are converted into percentages. This percentage value is then used to determine the probability and impact categories of risk according to a predetermined scale.

Table 4 Severity Index *(SI)* Scale

Description	Code	Scale	*Severity Index* (SI%)
Very Small	VS	1	0.00% - 12.5%
Small	S	2	12.5% - 37.5%
Medium	M	3	37.5% - 62.5%
Large	L	4	62.5% - 87.5%
Very Large	VL	5	87.5% - 100%

5. *Risk Matrix*

The risk matrix was used to evaluate and prioritize risks based on their probability and impact scores. The risk level was calculated using Equation (2.2):

$$R = P \times I \tag{2.2}$$

Description :

R = Risk level, representing the overall level of risk obtained from the combination of probability and impact.

P = Probability (likelihood of risk), representing the likelihood or frequency of a risk event occurring.

I = Impact, representing the extent or severity of the consequences that may arise if the risk event occurs.

The risk level is determined by multiplying the probability score by the impact score. A higher risk level indicates a greater potential risk and requires greater attention in determining the appropriate risk response.

$$Mean = \frac{\sum probabilitas}{\sum peristiwa\ risiko} \tag{2.3}$$

$$Mean = \frac{\sum impact}{\sum peristiwa\ risiko} \tag{2.4}$$

Example :

Based on the results of the Severity Index calculation, Risk A1 (Payment Delay) obtained a probability rating of 3 (Medium) and an impact rating of 3 (Medium)**.** The risk level was then determined by multiplying the probability score by the impact score using Equation (2.2).

Therefore, the risk level of Risk A1 was calculated as follows:

R = P × I
R = 3 × 3
R = 9

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The calculation resulted in a risk level of 9, which indicates that Risk A1 is classified according to the predetermined risk matrix criteria. The resulting risk level is then used to evaluate the priority of the identified risk and determine the appropriate risk response.

6. Validity and Reliability Tests
    1. Validity Test
       The validity test was carried out to determine the extent to which the research instrument in the form of a questionnaire was able to measure the variables studied. In this study, the validity test was carried out using *the Corrected item – Total Correlation* (SPSS) method. The r-value of the table was determined based on the number of respondents used in the study as well as the 95% confidence level ($\alpha = 0{,}05$).
    2. Reliability Test
       The reliability test aims to determine the level of consistency of the research instrument. In this study, the reliability test was carried out using *Cronbach's Alpha method*.
       The reliability testing criteria are as follows:
       - If *Cronbach's value is Alpha* $\geq 0{,}60$, then the instrument is declared reliable
       - If *Cronbach's value is Alpha* $< 0{,}60$, then the instrument is declared unreliable

3. Result and Discussion

3.1 Respondent characteristics

The 18 respondents were selected using total sampling because all personnel who met the predetermined eligibility criteria and were directly involved in the project were included in the study. The criteria included direct involvement in project implementation and sufficient knowledge or experience relevant to project risk management. Respondent characteristics used in this study include:
1. Age
2. Gender
3. Position
4. Length of work experience

Based on the established criteria, all respondents in this study were deemed to have met the requirements and possessed relevant competencies. Therefore, the data obtained can be used to analyze the implementation of ISO 31000:2018-based Enterprise Risk Management in the Remedial Works Phase 2 project at Belawan Pier.

3.2 Respondent profile

Table 5. Respondent profile

Name	Age	Gender	Position	Length of work
Ardhika Saputra	38	Male	Project Manager	15 years
Tadeus Satria	35	Male	Manager HSE	6 years
Fadli Fuadi	36	Male	Site Engineer Manager	10 years
Erwin p.	44	Male	Site Construction Manager	15 years
Dedek Cahya	30	Female	Office Engineer Manager	8 years
M. Dio Mujahid	26	Male	Quantity Surveyor	3 years
Eko Bagus Setiawan	32	Male	Quality Control	11 years

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Name	Age	Gender	Position	Length of work
Ahmad Muzakkir	24	Male	Quality Control	1 years
Ahmad Fahrudin	39	Male	Site Inspector	20 years
Fahrizal H	36	Male	Hse Officer	5 years
Putra Ramadhan	30	Male	Financial Manager	6 years
Jeri Karel I.B	31	Male	Procurement	11 years
Kaharuddin	50	Male	Implementation	15 years
Kusminto	48	Male	Implementation	20 years
Ashraf N	28	Male	Logistics	2 years
Muflih	23	Male	Surveyor	2 years 5 months
Lukman	30	Male	Mekanik	7 years
Amat Misno	48	Male	Equipment	15 years

3.3 Data Analysis Results

1. Validity Test

Validity was assessed using the Corrected Item–Total Correlation, while reliability was evaluated using Cronbach's Alpha. All questionnaire items were valid because their calculated correlation coefficients exceeded the critical value of 0.468 and their p-values were below 0.05. Cronbach's Alpha values were 0.933 for probability and 0.980 for impact, indicating high internal consistency. The results of the validity test for 19 research variables are presented in the following table:

Table 6. Probability Validity Test

Variable	Value r Calculate	Value r Table	Sig. p-value	Value Significance	Remarks
A1	0,5035	0,468	0.033	0.05	**Valid**
A2	0,6047	0,468	0.008	0.05	**Valid**
A3	0,5162	0,468	0.028	0.05	**Valid**
B1	0,6395	0,468	0.004	0.05	**Valid**
B2	0,6067	0,468	0.008	0.05	**Valid**
B3	0,6948	0,468	0.001	0.05	**Valid**
C1	0,6718	0,468	0.002	0.05	**Valid**
C2	0,6718	0,468	0.002	0.05	**Valid**
E1	0,5144	0,468	0.029	0.05	**Valid**
E2	0,8561	0,468	0.001	0.05	**Valid**
F1	0,8969	0,468	0.001	0.05	**Valid**
F2	0,9174	0,468	0.001	0.05	**Valid**
G1	0,6573	0,468	0.003	0.05	**Valid**
G2	0,6057	0,468	0.008	0.05	**Valid**
G3	0,7040	0,468	0.001	0.05	**Valid**
H1	0,8664	0,468	0.001	0.05	**Valid**
H2	0,7379	0,468	0.001	0.05	**Valid**
H3	0,7727	0,468	0.001	0.05	**Valid**
H4	0,5979	0,468	0.009	0.05	**Valid**

Table 7. Impact Validity Test

Variable	Value r	Value r	Sig.	Value	Remarks

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	Calculate	Table	p-value	Significance	
A1	0,6419	0,468	0.004	0.05	**Valid**
A2	0,8697	0,468	0.001	0.05	**Valid**
A3	0,8295	0,468	0.001	0.05	**Valid**
B1	0,7141	0,468	0.001	0.05	**Valid**
B2	0,6464	0,468	0.004	0.05	**Valid**
B3	0,7515	0,468	0.001	0.05	**Valid**
C1	0,8575	0,468	0.001	0.05	**Valid**
C2	0,9226	0,468	0.001	0.05	**Valid**
E1	0,8483	0,468	0.001	0.05	**Valid**
E2	0,9414	0,468	0.001	0.05	**Valid**
F1	0,9464	0,468	0.001	0.05	**Valid**
F2	0,9477	0,468	0.001	0.05	**Valid**
G1	0,8924	0,468	0.001	0.05	**Valid**
G2	0,9665	0,468	0.001	0.05	**Valid**
G3	0,9122	0,468	0.001	0.05	**Valid**
H1	0,9107	0,468	0.001	0.05	**Valid**
H2	0,9401	0,468	0.001	0.05	**Valid**
H3	0,9529	0,468	0.001	0.05	**Valid**
H4	0,8609	0,468	0.001	0.05	**Valid**

The test results indicate that all statement items in the questionnaire have a correlation coefficient value (r-calculated) greater than 0.468 and a significance value of less than 0.05. Consequently, the entire questionnaire is deemed valid and suitable for use in the subsequent analysis stage.

2. Reliability Test

The reliability test was conducted using Cronbach's Alpha to assess the internal consistency of the research instrument. An instrument is considered reliable when Cronbach's Alpha is greater than or equal to the predetermined minimum threshold. Based on the test results, Cronbach's Alpha values of 0.933 for the probability variable and 0.980 for the impact variable were obtained. These results indicate high internal consistency, confirming that the research instrument was reliable for data collection.

3.4 Risk Assessment

1. Identify Risks

The purpose of risk identification is to find out the various risk factors related to construction projects. The identified risk variables are then used as the basis for the preparation of a preliminary questionnaire that will be distributed to respondents.

Table 8. Risk Variables

Risk Code	Risk Type	Risk Events
A1	Financial Risk	Late payment
A2		Rising material prices
A3		Increase in Workers' Wages
B1	Environmental Risks	Disruption of loading and unloading activities
B2		Prolonged bad weather
B3		Changes in field conditions
C1	Design Risks	Design changes at the time of implementation
C2		The results of the work are not in accordance with the owner's wishes

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E1	Implementation Risks	Damage to work equipment
E2		The quantity and quality of concrete are not in accordance with technical specifications
F1	Risk Management	Time and cost estimation errors
F2		Delays in the decision-making process
G1	K3 Risks	Occurrence of work accidents
G2		The work area has no safety signs
G3		Workers do not comply with the provisions of K3
H1	Human Resources Risk	Lack of labor
H2		Low worker productivity
H3		Lack of communication with workers in the field
H4		Labor Strikes

2. Risk Analysis

The risk analysis in this study begins with the calculation of *the Severity Index* using a predetermined formula, which integrates the probability and impact values of each risk that has been identified. The *Severity Index* method is used as an approach to measure the level of risk based on respondents' perception of the likelihood of risk occurring and the magnitude of the impact caused. The calculation *of the Severity Index* was carried out by considering the assessment contributions of all respondents, resulting in a more representative value in describing the level of risk.

Table 9. Accumulated Respondent Answers

Risk Code	Risk Events	Probability					*Impact*				
		1	2	3	4	5	1	2	3	4	5
A1	Late payment	5	5	5	1	2	7	6	2	1	2
A2	Rising material prices	1	6	5	5	1	4	4	5	3	2
A3	Increase in Workers' Wages	3	4	7	4	0	5	8	1	3	1
B1	Disruption of loading and unloading activities	4	3	4	3	4	4	4	5	1	4
B2	Prolonged bad weather	2	2	6	5	3	3	2	7	3	3
B3	Changes in field conditions	1	3	7	3	4	5	4	5	0	4
C1	Design changes at the time of implementation	1	5	5	5	2	6	3	4	2	3
C2	The results of the work are not in accordance with the owner's wishes	9	6	0	3	0	9	6	0	1	2
E1	Damage to work equipment	3	9	2	3	1	4	5	3	2	4
E2	The quantity and quality of concrete are not in accordance with technical specifications	10	4	1	3	0	9	4	3	1	1
F1	Time and cost estimation errors	10	4	0	4	0	9	5	1	1	2
F2	Delays in the decision-making process	10	4	3	1	0	10	3	3	1	1
G1	Occurrence of work accidents	13	4	1	0	0	12	2	0	2	2
G2	The work area has no safety signs	15	2	1	0	0	12	1	2	3	0
G3	Workers do not comply with the provisions of K3	10	5	2	1	0	10	3	1	4	0
H1	Lack of labor	9	3	3	1	2	11	1	3	3	0
H2	Low worker productivity	9	7	2	0	0	11	2	1	2	2
H3	Lack of communication with workers in the field	12	3	3	0	0	11	3	1	2	1
H4	Labor Strikes	15	1	2	0	0	13	2	0	2	1

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Thus, the calculation of *the Severity index* based on equation 2.1 can be described as follows:

$$\text{SI (P)} = \frac{(1\times5)+(2\times5)+(3\times5)+(4\times1)+(5\times2)}{5\times18} \times 100\%$$

$$\text{SI (P)} = \frac{44}{90} \times 100\% = 48.89\%$$

$$\text{SI (I)} = \frac{(1\times7)+(2\times6)+(3\times2)+(4\times1)+(5\times2)}{5\times18}$$

$$\text{SI (I)} = \frac{39}{80} \times 100\% = 43.33\%$$

The results of the conversion *of the Severity Index* value for the A1 risk variable "Late Payment" are presented in the following table.

Table 10. SI Conversion on Risk Variable A1

Description	Code	Scale	*Severity Index* (SI%)
Very Small	VS	1	0.00% - 12.5%
Small	S	2	12.5% - 37.5%
Medium	M	3	37.5% - 62.5%
Large	L	4	62.5% - 87.5%
Very Large	VL	5	87.5% - 100%

Furthermore, the probability values (P) and impact (I) that have been converted into *the Likert* scale are analyzed to determine the level of risk. The risk level calculation is carried out by multiplying the probability value (P) by the impact value (I) according to equation 2.2. The calculation is used as the basis for determining the risk for each variable.

$$R = P \times I$$

$$R = 3 \times 3$$

$$R = 9$$

Based on Table 9, variable "A", namely Financial Risk, consists of three risk events. The probability value of A1 has a scale of 3, A2 has a scale of 3, and A3 has a scale of 3. Furthermore, the value is used in the calculation of the average with reference to the following Equation 2.3.

$$Mean = \frac{3+3+3}{3}$$

$$Mean = 3$$

Meanwhile, the impact value of A1 has a scale of 3, A2 has a scale of 3, and A3 has a scale of 3. Furthermore, the value is used in the calculation of the average with reference to the following Equation 2.4:

$$Mean = \frac{3+3+3}{3}$$

$$Mean = 3$$

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3. Risk Evaluation

Risk evaluation is a stage that aims to support the decision-making process based on the results of the risk analysis that has been carried out. This process is carried out through a comparison between the results of the risk analysis and the risk criteria that have been set, so that the level of risk and the priority of handling can be determined. In addition, at this stage, a recapitulation of various risks that occur during the implementation of the project is carried out as a basis for evaluating and learning to improve performance in the next project.

The risk-level mapping for the Belawan Wharf Phase 2 Remedial Works Project is presented in Table 11.

Table 11. Risk Level Mapping

Risk Code	Risk Type	Risk Events	P	I	*Risk Matrix*
A1	Financial Risk	Late payment	3	3	Medium
A2		Rising material prices	3	3	Medium
A3		Increase in Workers' Wages	3	3	Medium
B1	Environmental Risks	Disruption of loading and unloading activities	3	3	Medium
B2		Prolonged bad weather	4	3	High
B3		Changes in field conditions	4	3	High
C1	Design Risks	Design changes at the time of implementation	3	3	Medium
C2		The results of the work are not in accordance with the owner's wishes	2	3	Medium
E1	Implementation Risks	Damage to work equipment	3	3	Medium
E2		The quantity and quality of concrete are not in accordance with technical specifications	2	3	Medium
F1	Risk Management	Time and cost estimation errors	3	3	Medium
F2		Delays in the decision-making process	2	3	Medium
G1	K3 Risks	Occurrence of work accidents	2	3	Medium
G2		The work area has no safety signs	2	2	Low
G3		Workers do not comply with the provisions of K3	2	3	Medium
H1	Human Resources Risk	Lack of labor	3	3	Medium
H2		Low worker productivity	2	3	Medium
H3		Lack of communication with workers in the field	2	2	Low
H4		Labor Strikes	2	2	Low

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Furthermore, the risk level results presented in Table 11 are grouped into the risk level matrix as shown in Figure 1 below.

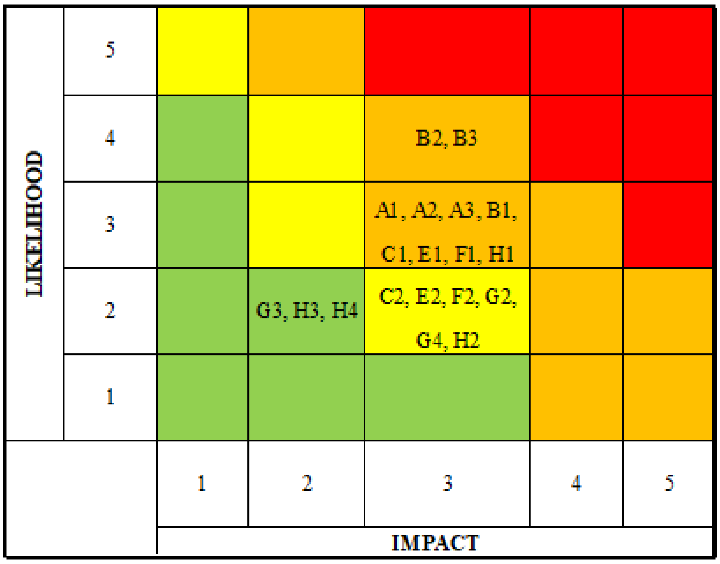

Figure 2 Risk Matrix Result

Description:
Red : *Extreme*
Orange : *High*
Yellow : *Medium*
Green : *low*

3.5 ISO 31000 evaluation

Based on the research findings, the implementation of ISO 31000:2018 in the Belawan Wharf Phase 2 Remedial Works Project covered the basic processes of risk identification, risk analysis, and risk evaluation. Risk identification was conducted through project documentation, interviews, and questionnaires involving personnel directly engaged in the project. Risk analysis was performed using the Severity Index method to determine the likelihood and impact of each identified risk. Subsequently, risk evaluation was carried out using a risk matrix to prioritize risks requiring immediate attention.

However, the implementation was not yet fully aligned with ISO 31000:2018. The study found limited evidence of systematic documentation, continuous monitoring, and structured risk treatment plans. These findings indicate that although the project applied several essential principles of ISO 31000, further improvements are required to establish a comprehensive Enterprise Risk Management system.

3.6 Discussion based on ISO 31000

The findings indicate that the implementation of Enterprise Risk Management in the Belawan Wharf Phase 2 Remedial Works Project has generally followed the main stages of ISO 31000:2018, namely risk identification, risk analysis, and risk evaluation. Risk identification was conducted by reviewing project documents, previous studies, and distributing questionnaires to personnel directly involved in the project, resulting in the identification of nineteen potential risk events classified into financial, environmental, design, implementation, management, occupational safety and health, and human resource risks. Subsequently, risk analysis was performed using the Severity Index method to measure the probability and impact of each identified risk based on respondents' perceptions. The calculated Severity Index values were then converted into Likert scale scores and evaluated using a risk matrix to determine the priority level of each risk. This systematic process is consistent with the ISO 31000:2018 framework, which emphasizes a structured approach to identifying, analyzing, and

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evaluating risks as the basis for decision-making [2], [7].

The results also demonstrate that several risks, particularly financial risks, environmental risks, implementation risks, and human resource risks, require greater attention because they have the greatest potential to affect project cost, schedule, and quality. From the perspective of ISO 31000:2018, these findings indicate that the project team was able to recognize and prioritize the most significant risks encountered during project execution. However, the study also found that the implementation of risk management had not yet been fully integrated into a comprehensive Enterprise Risk Management system. This conclusion is based on the limited evidence of systematic risk documentation, continuous monitoring, and structured risk treatment records throughout the project lifecycle. Since this research was conducted on a completed project, the evaluation relied on historical project documents and the experiences of project personnel, making the study valuable as a lessons-learned assessment for improving future projects. Therefore, strengthening documentation practices, periodic risk monitoring, and formal risk treatment planning is recommended to achieve a more comprehensive implementation of ISO 31000:2018 in future marine construction projects. This study has several limitations. First, it was conducted on only one completed wharf rehabilitation project, which limits the generalizability of the findings. Second, the analysis involved 18 respondents, and part of the assessment relied on their retrospective perceptions and previous project experience. Therefore, the findings should be interpreted as project-specific results and not as generalized conclusions for all marine construction projects.

3.7 Risk Mitigation Recommendation

Table 12. Practical Recommendations

Dominant Risk	Recommended Mitigation
Prolonged bad weather	Prepare flexible work schedules based on weather forecasts and establish contingency plans for adverse weather conditions.
Changes in field conditions	Conduct additional field investigations and adequate condition assessments prior to implementation; then, use the results to review the design against credible worst-case scenarios and prepare alternative details or reinforcement measures that can be implemented if actual conditions prove worse than assumed.

Based on the identified high-priority risks and risks with significant potential impacts on project performance, several mitigation strategies are recommended.

4. Conclusion

The implementation of risk management in the Belawan Wharf Phase 2 Remedial Works Project, when evaluated based on ISO 31000:2018, covered the main stages of risk identification, risk analysis, and risk evaluation. A total of 19 risk variables were identified and assessed using the Severity Index method and a risk matrix. Based on the final risk classification, two variables were categorized as high risk, namely prolonged bad weather (B2) and changes in field conditions (B3). Fourteen variables were categorized as medium risk, three variables were categorized as low risk, and no variables were categorized as extreme risk. The findings indicate that the Severity Index and risk matrix can support systematic risk evaluation and prioritization. However, the implementation of risk management in the completed project was not fully integrated into a comprehensive Enterprise Risk Management system, particularly in terms of risk documentation, periodic monitoring, and formal risk treatment planning. Therefore, future marine construction projects should

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strengthen risk documentation, establish periodic monitoring mechanisms, and prepare structured mitigation plans for high-priority risks.

This study is limited by its focus on one completed wharf rehabilitation project and 18 respondents whose assessments partly relied on retrospective experience. Future research should evaluate ongoing marine construction projects or compare multiple projects to improve the generalizability of the findings.

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6. Conflict of Interest

The author states that there is no conflict of interest related to the publication of this paper. This research was conducted independently for academic purposes. All data presented in this study were obtained and analyzed objectively in accordance with academic research standards.

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