# Operational Risk Analysis of Sea Export Activities Using Failure Mode and Effect Analysis (FMEA) at PT XYZ

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**ABSTRACT**

Sea export activities are one of PT XYZ's main services. In its implementation, there is a complex operational process so that various operational risks and potential risks that can hinder the smooth export process are still found. These risks can cause delays in delivery, document errors, and losses for the company. Therefore, an operational risk analysis is needed to determine the level of risk and determine priority improvements in sea route export activities. This study aims to analyze potential operational risks, determine the level of risk, and set improvement priorities for sea route export activities at PT XYZ. This study uses a qualitative method with a descriptive approach. Data was obtained through observation, interviews, and documentation of informants directly involved in the export process, then analyzed using the FMEA method through *severity*, *occurrence*, and *detection* assessments to obtain *a Risk Priority Number* (RPN) value. The results showed that there were 13 operational risks identified, with the risk of delayed cancellation of PEB as the highest priority risk with an RPN value of 405. The results of the study show that there are 13 operational risks in sea export activities at PT XYZ. The risk analysis using the FMEA method resulted in the highest *Risk Priority Number* (RPN) value of 405 at the risk of late cancellation of PEB and the lowest RPN value of 36 at the risk of late *submission of outward manifest*. Based on the risk limit of 150, four priority risks were obtained, namely the difficulty of obtaining trucks when picking up empty containers at the depot (RPN 320), the unavailability of empty containers at the depot (RPN 224), the use of unsuitable containers (RPN 225), and the delay in canceling PEB as the highest priority risk (RPN 405).

**Keywords**: Operational Risk, Sea Route Exports, FMEA
**JEL Classification:**

## 1. INTRODUCTION

Indonesia as an archipelagic country has a high dependenceon sea transportation to support goods distribution activities, including export activities. Export activities are one of the most important foreign exchange contributors for the country because it allows an increase in the amount of production that supports economic growth. If a country exports goods, it can take advantage of new market opportunities abroad, which will increase the country's domestic market, investment, and foreign exchange (Hodijah & Angelina, 2021). There are several modes of transportation that can be used for export, such as sea, land, air, post, and pipeline. Meanwhile, in Indonesia, sea transportation is still the most widely used means of export activities. Romli et. al (2024) stated that the dominance of sea transportation modes for export in Indonesia is determined based on various factors such as the large volume of goods transported, the cost used is more affordable, and the existence of certain goods that are required to be transported through sea transportation. Mandasari et al. (2021) argue that exporters do not handle the overall logistics activities due to limited time and knowledge, so they focus more on the production of export goods and leave logistics and documents to third parties, parties with experience related to exports. These parties are commonly known as *freight forwarders* and EMKL.

PT XYZ is one of the companies engaged in *freight forwarding*. The *freight forwarding services* offered are in the form of handling exports and imports, starting from document management, transportation fleet selection, customs, and ensuring that the goods sent can be received in good condition by the party concerned. Based on the results of initial observations, sea route export services are one of the services that have a fairly high activity intensity at PT XYZ. The complexity of the process involving various parties in these activities causes high potential operational risks that can hinder the smooth operation of exports. Therefore, sea route export activities were chosen as the focus of the research. The results of the observation also show that there are still various operational risks, including:

**Table 1. 1 Problems in handling PT XYZ's sea route exports**

| Yes | Identify Problems in Handling Sea Route Exports | Impact | Frequency of Occurrence (per year) | Expected Occurrence Standards (per year) |
|---|---|---|---|---|
| 1. | Lack of structured risk management | Risks are not well identified, difficult to prioritize risk management, and have the potential to cause operational losses. | 1 time | 0 times |
| 2. | Leaking containers | There is a cost of repairing the container in case of minor damage, as well as the cost of returning the container to the depot. | 2 times | 0 times |
| 3. | Miscommunication between staff | Misinformation, process delays, and decreased teamwork efficiency. | 12 times | 0 times |
| 4. | Omission of cancellation of PEB | Arising of fines from Customs | 1 time | 0 times |
| 5. | Revision of the shipper*'s documents* after the ship departs | Causing additional administrative costs due to document revisions. | 2 times | 0 times |
| 6. | Differences in perception in document input | Data mismatches, repetitive document revisions, and delivery delays | 1 time | 0 times |
| 7. | No empty containers available at the depot | Delay in the delivery process | 1 time | 0 times |
| 8. | Truck fleet limitations | Delays in container pickup, stuffing schedules and, shipping | 8 times | 0 times |
| 9. | Disruption of the CEISA System | Delayed input *and* submission process | 2 times | 0 times |

Source: Researcher's processed data, 2026

Based on the table of identifying problems in handling sea exports, it is known that there are several operational problems that have the potential to hinder the smooth export process. These problems have different levels of frequency and impact on the company's operational activities. Based on the results of interviews with related parties, some of the most common problems include the absence of structured risk management, leaky containers, miscommunication between staff, negligence in PEB cancellation, revision of documents from shippers after the ship departs, differences in perception in document input, lack of empty containers at the depot, the limitation of the truck fleet, and the disruption of the CEISA system. These problems can cause delays in the delivery process of goods and increased operational costs.

According to Shodiqin et al. (2020), problem solving is not only seen as a method, but also as a way of thinking that includes a series of systematic steps, starting from the data collection process to the conclusion stage and arranged to find the right solution according to the problem. The researcher uses *the Failure Mode and Effect Analysis* (FMEA) method to overcome problems or risks at PT XYZ related to sea route export activities. The selection of the method was carried out on the basis that the FMEA method is able to assess each failure mode using three parameters, namely *severity*, probability of occurrence, and possibility of detection failure, as well as risk level measurement. So that operational risks that require special attention and preventive measures can be obtained.

### 1.1 Problem Formulation

a. What are the potential operational risks that occur in sea export activities at PT XYZ?
b. How to analyze the level of operational risk in sea route export activities using *the Failure Mode and Effect Analysis* (FMEA) method?
c. What operational risks are priority improvements based on the *Risk Priority Number* (RPN) value in sea export activities at PT XYZ?

### 1.2 Research Objectives

a. Analyze potential operational risks that occur in sea route export activities at PT XYZ.
b. Analyzing the level of operational risk in sea route export activities using *the Failure Mode and Effect Analysis* (FMEA) method.

c. Analyze operational risks that are priority for improvement based on the *Risk Priority Number* (RPN) value in sea route export activities at PT XYZ.

## 2. LITERATURE REVIEW

### 2.1 Risk Management

According to ISO 310000:2018, risk management is a process that is carried out in a structured manner to provide direction and control to organizations in dealing with risks.

### 2.2 Operational Risk

According to Nugrahini and Akbar (2022), operational risk is defined as a risk that usually comes from problems within the company and often arises due to a lack of a strong *management control system* implemented by the company.

### 2.3 Failure Mode and Effect Analysis (FMEA)

According to Stamatis (2019), *Failure Mode and Effect Analysis* (FMEA) is a tool used to identify, prioritize, and prevent potential failures in a system, design, or process before the failure impacts customers. This method aims to eliminate the cause of failure or minimize the risks it poses.

## 3. METHOD

The method applied in this study is a qualitative method with a descriptive approach that has a focus on inductive thinking analysis to answer and solve problems related to the application of risk analysis to support sea route export activities at PT XYZ. The data sources used in this study include primary data and secondary data, which are obtained through data collection techniques in the form of interviews, observations, and documentation. The data analysis techniquesin this study include data collection, data reduction, data presentation, and conclusion drawing by validation through source triangulation.

## 4. RESULTS AND DISCUSSION

### 4.1 Potential operational risks that occur in sea route export activities at PT XYZ

At the risk identification stage, based on the results of observations and interviews, there are several potential operational risks found in the company's export activity process. The following are the identification of the main potential operational risks based on the results of the interview:

**Table 4. 1 Identify Potential Risks**

| Sea Route Export Process | Code | Potential Risks (*Faillure Mode*) | Risk Impact (*Effect of Faillure*) | Potential Causes (*Potential Cause*) |
|---|---|---|---|---|
| Arrange *for the payment of the elevator on* and the collection of empty containers from the depot. | R1 | Difficulty getting a truck when picking up empty containers at the depot | Delays in container pickup, stuffing schedules and, shipping | Limited truck fleet availability and high demand for trucks |
| | R2 | Damage to the truck fleet | Container delivery delays, operational disruptions in the field, and potential additional costs (repairs) | Fleet condition is not excellent and there is a lack of pre-operational checks |
| | R3 | No empty containers available at the depot | Delay in the delivery process | Limited container stock and high container demand |
| | R4 | Containers used in unusable conditions. | The appearance of the cost of repairing or returning the container to the depot. | Omissions in the container selection process. |
| Making and submitting Export Notification of Goods (PEB) until the issuance of an | R5 | Data input error on PEB | Need to be revised (Notes) | Lack of precision, time pressure, and data changes from shippers |
| | R6 | Delay in cancellation of PEB | The appearance of fines | Employee negligence, lack of status monitoring, |

| | | | | |
|---|---|---|---|---|
| Export Service Memorandum (NPE). | | | | miscommunication between parties |
| | R7 | Disruption of the CEISA system | Delayed input and *submission* process | Server technical glitches |
| Submit data to the shipping to get a *draft Sea Waybill.* | R8 | Delay in *submitting* data to shipping | Potential fines | Employee negligence and data from late *shippers* |
| | R9 | Differences in perception in document input | Items cannot be *customized* in the POD | Differences in data interpretation and lack of communication |
| | R10 | Repeated revisions after data is *submitted* | Decreased accuracy, increased processing time, and risk of document missynchronization | Recurring changes from *shipper* |
| Submit *an outward manifest* through CEISA. | R11 | Delay in *submitting outward manifest* | Potential fines | Employee negligence and incomplete data |
| | R12 | Disruption of the CEISA system | Delayed input *and* submission process | Server technical glitches |
| | R13 | Data changes after exit BC 1.1 | More complex revision processes and increased time and workload | Data changes from shippers |

Source: Author's processed data, 2026

The results of the identification show that there are 13 operational risks in sea export activities. These risks are then mapped based on operational problems that have been identified to determine the relationship between the source of the problem and the risks that arise. The mapping results can be seen in the following table:

**Table 4. 2 Mapping Problem Identification to Operational Risk**

| Yes | Problem Identification | Risk Code |
|---|---|---|
| 1. | Lack of structured risk management | R1-R13 |
| 2. | Leaking containers | R4 |
| 3. | Miscommunication between staff | R5, R6, R9 |
| 4. | Omission of cancellation of PEB | R6 |

| | | |
|---|---|---|
| 5. | Revision of the shipper*'s documents* after the ship departs | R5, R10, R13 |
| 6. | Differences in perception in document input | R8, R9, R11 |
| 7. | No empty containers available at the depot | R3 |
| 8. | Truck fleet limitations | R1, R2 |
| 9. | Disruption of the CEISA System | R7, R12 |

Source: Author's processed data, 2026

The mapping results show that several operational issues contribute to the emergence of more than one risk. This condition indicates the need for more optimal control of the dominant problem to minimize obstacles in sea export activities.

4.2 Analysis of operational risk levels in sea route export activities using *the Failure Mode and Effect Analysis* (FMEA) method

Operational risk analysis was carried out using the FMEA method through *Severity* (S), *Occurrence* (O), and *Detection* (D) assessments to obtain *a Risk Priority Number* (RPN) value. The RPN value is used to determine risk priorities and the basis for preparing corrective actions. The results of the calculation are presented in the following table:

**Table 4. 3 Calculation *Risk Priority Number* (RPN)**

| Code | Risk (*Faillure Mode*) | S | O | D | RPN |
|---|---|---|---|---|---|
| R1 | Difficulty getting a truck when picking up empty containers at the depot | 8 | 8 | 5 | 320 |
| R2 | Damage to the truck fleet | 7 | 2 | 3 | 42 |
| R3 | No empty containers available at the depot | 8 | 4 | 7 | 224 |
| R4 | Containers used in unsuitable conditions | 9 | 5 | 5 | 225 |
| R5 | Data input error on PEB | 8 | 4 | 4 | 128 |
| R6 | Delay in cancellation of PEB | 9 | 5 | 9 | 405 |
| R7 | Disruption of the CEISA system | 4 | 4 | 9 | 144 |
| R8 | Delay in *submitting* data to shipping | 9 | 2 | 3 | 54 |
| R9 | Differences in perception in document input | 7 | 4 | 3 | 84 |
| R10 | Repeated revisions after data is *submitted* | 6 | 6 | 2 | 72 |
| R11 | Delay in *submitting outward manifest* | 9 | 2 | 2 | 36 |
| R12 | Disruption of the CEISA system | 4 | 4 | 9 | 144 |
| R13 | Data changes after exit BC 1.1 | 6 | 4 | 3 | 72 |

| | |
|---|---|
| TOTAL | 1950 |

Source: Author's processed data, 2026

4.3 Operational risks that are priority for improvement based on *the Risk Priority Number* (RPN) value in sea route export activities at PT XYZ

Risk priority is determined based on the *Risk Priority Number* (RPN) value of FMEA analysis. The average RPN value is used as a risk limit, which is 150, to identify risks that require priority handling. Based on these results, there are four risks that fall into the priority category, as presented in Table 4.4.

**Table 4. 4 Potential Priority Risks**

| Code | Risk (*Faillure Mode*) | RPN Value |
|---|---|---|
| R6 | Delay in cancellation of PEB | 405 |
| R1 | Difficulty getting a truck when picking up empty containers at the depot | 320 |
| R4 | Containers used in unfit conditions (damaged/leaking) | 225 |
| R3 | No empty containers available at the depot | 224 |

Source: Author's processed data, 2026

Risk control recommendations are focused on priority risks by considering the company's condition to minimize the impact caused. The proposed action is presented in Table 4.5.

**Table 4. 5 Priority Potential Risk Control**

| Code | Risk (*Faillure Mode*) | Potential Risk Control Measures |
|---|---|---|
| R6 | Delay in cancellation of PEB | 1. Issue the *PEB Status Monitoring Checklist* as an operational standard that includes recording PEB data, monitoring export status, identification of failed PEB, and follow-up cancellation.<br>2. Improve coordination between members in a team. |

| | | |
|---|---|---|
| R1 | Difficulty getting a truck when picking up empty containers at the depot | 1. Establish cooperation with trusted *trucking* vendors as a backup resource when the fleet is unavailable.<br>2. Allocating additional fleets so that all incoming requests can be met. |
| R4 | Containers used in unfit conditions (damaged/leaking) | 1. Collaborating with several container depots to simplify and speed up the process of finding the required containers.<br>2. Prepare monitoring schedules and update of container stock data from various depots on a regular basis as an internal recording system. |
| R3 | No empty containers available at the depot | 1. Organizing training for staff related to the container selection process.<br>2. Perform a physical inspection of the container before use.<br>3. Coordinate with the depot to ensure that the quality of containers remains up to standard. |

Source: Author's processed data, 2026

Based on table 4.5, it is known that each operational risk has a different form of control according to the causes and impacts caused. The control is recommended as an effort to minimize the possibility of risk and reduce the impact of losses on the company's operational activities.

## 5. CONCLUSION

The identification results showed that there were 13 operational risks in sea route export activities at PT XYZ. The risk analysis using the FMEA method resulted in *the highest Risk Priority Number* (RPN) value of 405 at the risk of late cancellation of PEB and the lowest RPN value of 36 at the risk of late *submission of outward manifest*. The results are used to determine the risks that require priority handling. Based on the risk limit of 150, four priority risks were obtained, namely the difficulty of obtaining trucks when picking up empty containers at the depot (RPN 320), the unavailability of empty containers at the depot (RPN 224), the use of unsuitable containers (RPN 225), and the delay in canceling PEB as the highest priority risk (RPN 405).

## 6. IMPLICATIONS, LIMITATIONS, AND FUTURE RESEARCH

The findings of this study provide practical implications for companies in developing operational risk control in sea export activities. However, this study is limited to one object of FMEA research and assessment that still relies on informant perception. Further research is recommended to use other risk analysis methods, involve more informants and research objects, and examine the effectiveness of the application of risk control and risk control in other modes and logistics activities to obtain more comprehensive results.

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