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# Ecosystem-based merchant ship ballast water management strategy in Soekarno Hatta Port Makassar, Indonesia

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**Abstract**
Soekarno Hatta International Port is located in Makassar city, South Sulawesi province. Many national and international ships carry out operational activities at the port. Ballast water on ships is used as ballast to maintain ship stability when the cargo is empty or half filled. Ballast water exchange is still carried out when the ship is docked and carrying out operational activities at the port. This process has potential environmental impacts, because the disposal of ship ballast water is classified as waste. Ship ballast water often contains contaminated oil, harmful pathogens, and the exchange of marine organisms that have different habitats. The purpose of this study is to determine the appropriate alternative strategy in the management of ship ballast water in port of Soekarno Hatta. This research is descriptive qualitative, which is research that intends to describe a phenomenon and the research technique used is SWOT analysis. Based on the SWOT analysis, the management of commercial ship ballast water at Soekarno Hatta Port Makassar is in the first quadrant, namely the aggressive strategy. The position of internal and external factors in the ballast water management sub-sector in this quadrant shows that strengths and opportunities are more dominant than weaknesses and threats. The resulting strategies include: carrying out training and training for ship crews on the importance of commercial ship ballast water management, checking ballast water carried out regularly by stakeholders, socializing the management of commercial ship ballast water by stakeholders, and confirming the rules related to the management of commercial ship ballast water at Soekarno Hatta Port in order to maintain its ecosystem.

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**Keywords:** Ballast water, Port, Strategy, SWOT analysis

## Introduction

The sea is an area rich in natural resources, namely the diversity of biological resources that can be utilized for the prosperity and welfare of society, so that the sea can be said to be an important part of human survival (Basri, 2021) [2]. Sea transportation is a part that has an important role in development. The role of sea transportation is as a link between islands because geographically Indonesia is an archipelago surrounded by oceans (Pujiastuti *et al.*, 2019) [6].

Transportation using sea lanes is still chosen because it is more economical than air transportation services. Indonesia is very strategic as a world trade and shipping route, making traffic in the archipelago waters busy. The crowded shipping lanes navigated by ships can result in potential pollution resulting from the operational activities of ships (Pujiastuti *et al.*, 2019) [6].

On ocean-going ships when the ship is loading and unloading goods or passengers, the ship will experience a slope or trim, so a ballast system is used. On ships in a forward trim state, so that the propeller can work properly in the sense that the propeller remains in the water, ballast water is usually used. The process of filling ballast water into the ship is known as "ballasting". The

tank filled with ballast water on this ship is commonly called a ballast tank (Bela, 2019) [3]. Ballast water can be freshwater or seawater depending on the ship (Carney *et al.*, 2017) [4]. Ballast water which is seawater obtained from the origin of the ship's port of origin or the port where the ship departs to the loading port.

According to Harumanti (2015) [5], the ballast water system is a very important system on a ship. The ballast water system is used as a ship counterweight when the cargo is empty. This has an important effect in dealing with bad weather when the ship is sailing in the middle of the Ocean. The larger the size of the ship also affects the amount of ballast water that will be filled in the ballast tank. Ballast water systems on commercial ships usually use seawater pumps (ballast pumps) used to fill and remove seawater from the ballast tank.

The disposal and filling of ship ballast water is usually carried out in the harbor area when the ship is unloading. This process has potential environmental impacts, as the disposal of ship ballast water is classified as waste. Ship ballast water often contains contaminated oil, harmful pathogens, and the exchange of marine organisms that have different habitats. In general, ballast water is known to cause very serious environmental problems, because it results in the transfer of other organisms (Harumanti, 2015) [5].

The Indonesian government has actually regulated this ballast water in Government Regulation (PP) Number 21 of 2010 concerning Maritime Environmental Protection, in the PP it is stated that environmental pollution is one of them from ballast water and ships are prohibited from discharging waste and other materials (including ballast water, hazardous and toxic chemicals, materials containing ozone-depleting substances). Waste and other materials must be treated on board and transferred to storage facilities. In Article 6, it is not clearly stated how to dispose of ballast water (where to exchange ballast water, by what method), only the distance of disposal, the volume of discharge and the quality of discharge.

To reduce the impact of ballast water resulting from ship operations, the International Convention for the Control and Management of Ship Ballast Water and Sediments - adopted in 2004 and entered into force on September 8, 2017 - sets limits on the concentration of living organisms that can be discharged in ballast water (regulation D-2). (International Maritime Organization, 2004; Sarah *et al.*, 2022) [8]. With regard to this, this study aims to determine the appropriate alternative strategy in the management of ship ballast water in Soekarno Hatta Harbor Makassar.

## Materials and Methods

### Location and Time of Research

This research was conducted at Soekarno Hatta Port located in Makassar City, South Sulawesi Province, Indonesia. Data collection was carried out in March-July 2023.

### Research Methods

This research method is descriptive qualitative, which is research that intends to describe a phenomenon, Sugiyono (2017) [10]. Descriptive research type, does not use and does not test hypotheses so that in its research steps there is no need to formulate a hypothesis, Zaki & Saiman (2021) [14].

**This research method uses SWOT analysis This data collection technique is as follows**

1. In this study the data used are primary data and secondary data. To obtain primary data using data collection techniques through direct interviews on research targets by providing a structured list of questions in the form of questionnaires to respondents.
2. Conducting interviews with relevant agencies about ship ballast water management facilities and infrastructure at Soekarno Hatta Port Makassar.
3. Secondary data obtained from several ships in the form of ship ballast water management data, ballast water related documents, research publications and various references related to the research.
4. Identifying strengths, weaknesses, opportunities and threats, (Rangkuti, 2014) [7].

## Result

The formulation of ecosystem-based commercial ship ballast water management was analyzed with SWOT. SWOT analysis is a systematic identification of various factors to formulate management strategies based on logic that can maximize strengths (Strengths) and opportunities (Opportunities), but can simultaneously minimize weaknesses (Weaknesses) and threats (Threats). In determining the SWOT matrix, it is necessary to know the internal strategic factors (Internal Strategic Factor Analysis Summary/IFAS) and external strategic factors (External Strategic Factor Analysis Summary/EFAS). Determination of various factors, the weight of each factor and the level of importance are obtained from interviews with people who are competent in their fields and adjusted to field conditions (Rangkuti, 2014) [7].

The SWOT matrix essentially combines opportunities, threats, strengths, and weaknesses in a matrix. Thus the matrix consists of four quadrants, where each quadrant contains each strategy (Utami, 2012) [12]. After determining the IFAS and EFAS assessment matrix, the next step is to formulate management strategies using a SWOT matrix that combines internal and external factors. The SWOT matrix generally produces four alternative strategies that can be used as consideration in the management of Ecosystem-Based Commercial Vessel Ballast Water. The standard SWOT combination matrix is presented in Table 1.

**Table 1:** SWOT Matrix

| **(IFAS) / (EFAS)** | **Strengths (S) Internal factors** | **Weakness (W) External factors** |
|---|---|---|
| **Opportunities (O)** | **Strategy (SO)** | **Strategy (WO)** |
| External opportunity factors | Create a strategy here that use strengths to take advantage of opportunities | Create a strategy here that capitalize on opportunities overcome threats |
| Threats (T) | Strategy (ST) | Strategy (WT) |
| External threat factors | Create a strategy here that use strengths to overcome threats | Create a strategy that minimize weaknesses and avoid threats |

***Source***: (Rangkuti, 2014) [7]

Ballast water management strategies are carried out by collecting data and information on ballast water management and then analyzed for the formulation of quantitative model strategies, so as to obtain the right strategic model for ecosystem-based commercial ship ballast water management at Soekarno Hatta Port Makassar. The first meaning is the identification of internal and external factors, the following is a description of each factor.

**1. Internal Factors**

The internal factors of ecosystem-based commercial ship ballast water management include two components, namely the strength component and the weakness component. The internal factors that are part of the strengths are as follows:

a. Crew knowledge of ballast water management procedures
b. Crew knowledge of ballast water management regulations
c. No oil and grease content in ballast water

**Internal factors that are part of weaknesses are as follows**

a. Ballast water disposal is still carried out at the dock when the ship is docked at the port
b. The level of compliance of the crew / ABK of the ship is still low with the applicable rules
c. Facilities and infrastructure that are less supportive related to applicable regulation.

**2. External Factors**

External factors on components from outside include two components, namely the opportunities component and the threats component of ecosystem-based commercial ship ballast water management. The external factors part of the opportunities are as follows:

a. Existence of regulations governing ballast water management
b. Ballast water management planning in accordance with BWM
c. Fulfillment of MARPOL 73/78 and BWM regulations

**The external factors part of the threats are as follows**

a. There is no supervision related to ballast water regulations set by the government
b. The absence of stakeholder attention to ballast water management at Soekarno Hatta Port Makassar
c. Erratic changes in government policy

**3. Matrix Internal Factor Evaluation (IFE)**

Matrix Internal Factor Evaluation (IFE) Factors are used to evaluate and analyze the internal factors of ecosystem-based commercial ship ballast water management at Soekarno Hatta Port Makassar. The next step after factor identification is the calculation of weights and ratings that serve as the basis for determining ship ballast water management strategies. This is important to know as the basis for determining management to carry out ballast water management strategies that are in accordance with conditions at the port (Wiagustini and Permatawati, 2015) [13]. Rating from 1 - 4, the most influential has a rating of 4, while rating 1 is the least influential. The determination of the rating is based on discussions with the company owner. The weight and score of each element are summed up. Strengths are summed with weaknesses, while opportunities are summed with threats (Saragih, 2014) [9]. Determination of the weight and ranking of strengths and weaknesses is carried out using the paired comparison method, so as to obtain the weight of each internal variable along with the rating value and score. The following internal factor matrix is presented in the following table.

**Table 2:** Internal Factor Matrix

| Code | Internal Strategy | Bobot (A) | Rating (B) | Score (A x B) |
|---|---|---|---|---|
| | **Strenght** | | | |
| S1 | Crew members' knowledge of ballast water management procedures | 0.207 | 3 | 0.612 |
| S2 | Crew knowledge of ballast water management regulations | 0.246 | 4 | 0.865 |
| S3 | No oil and grease content in ballast water | 0.193 | 3 | 0.532 |
| | Total | | | 2.009 |
| | **Weakness** | | | |
| W1 | Ballast water disposal is still done at the dock when the ship is docked at the port. | 0.128 | 2 | 0.236 |
| W2 | The level of compliance of the crew / ABK of the ship is still low with the applicable rules | 0.103 | 1 | 0.153 |
| W3 | Facilities and infrastructure that are less supportive related to applicable regulations | 0.123 | 2 | 0.216 |
| | Total | 1 | | 0.606 |

Based on the results of the analysis, the strength factor has a total value score of 2,009. The strength of the internal factors shows that the crew's knowledge of ship ballast water management regulations with a value of 0.246. The weakness factor has a total value of 0.606 with ballast water disposal still carried out at the dock when the ship is docked at the port being the biggest weakness with a value of 0.128.

**4. Matrix Ekternal Factor Evaluation (EFE)**

The External Factor Evaluation (EFE) matrix is used to evaluate and analyze the external factors of ecosystem-based commercial ship ballast water management at Soekarno Hatta Port Makassar. The method used is the same as IFE so that it will obtain the weight of each internal variable along with the rating value and score. The following external factor matrix can be seen in the following table.

**Tabel 3:** Matriks Faktor Eksternal

| Code | Internal Strategy | Bobot (A) | Rating (B) | Score (A x B) |
|---|---|---|---|---|
| | **Oppoertunities** | | | |
| O1 | Existence of regulations governing ballast water management | 0.187 | 4 | 0.664 |
| O2 | Ballast water management planning in accordance with BWM | 0.178 | 3 | 0.606 |
| O3 | Fulfillment of MARPOL 73/78 and BWM regulations | 0.170 | 3 | 0.550 |
| | Total | | | 1.820 |
| | **Threats** | | | |
| T1 | There is no supervision related to ballast water regulations set by the government | 0.155 | 3 | 0.459 |
| T2 | No stakeholder attention to ballast water management at Soekarno Hatta Port Makassar | 0.151 | 3 | 0.435 |
| T3 | Erratic changes in government policy | 0.159 | 3 | 0.484 |
| | Total | 1 | | 0.442 |

The value of external factors in the opportunity variable has a value of 1.820 with the highest opportunity score being the existence of regulations governing ballast water management with a value of 0.187. There are threats that need to be watched out for, namely uncertain changes in government policy. From the SWOT matrix, 4 main strategies can be developed, namely S-O, W-O, S-T, and W-T. Each of these strategies has its own characteristics and should be implemented together and support each other (Tjoe and Sarjono, 2010) [11].

1. S-O (Strengths - Opportunities) Strategy. This category contains various alternative strategies that take advantage of opportunities by utilizing their strengths / strengths.
2. W-O Strategy (Weaknesses - Opportunities) A category that takes advantage of external opportunities to overcome weaknesses.
3. S-T Strategy (Strengths-Threats) Alternative categories of strategies that utilize strengths to overcome threats.
4. W-T Strategy (Weaknesses-Threats) Alternative strategy categories as a solution to the assessment of weaknesses and threats faced, or efforts to avoid threats to overcome weaknesses.

The following SWOT matrix analysis as an effort to manage ecosystem-based commercial ship ballast water at Soekarno Hatta Port Makassar is presented in the following table.

**Table 4:** SWOT Analysis Matrix

| Internal Factors / External Factors | Strenght | Weakness |
|---|---|---|
| | ▪ Crew knowledge of ballast water management procedures<br>▪ Crew knowledge of ballast water management regulations<br>▪ No oil and grease content in ballast water | ▪ Ballast water disposal is still carried out at the dock when the ship is docked at the port<br>▪ Low level of crew / ship crew compliance with applicable regulations<br>▪ Supportive facilities and infrastructure related to applicable regulations |
| **Opportunities** | **Strategi S-O** | **Strategi S-W** |
| ▪ Existence of regulations governing ballast water management<br>▪ Ballast water management planning in accordance with BWM<br>▪ Compliance with MARPOL 73/78 and BWM regulations | ▪ Conduct training and education for ship crews/ABKs on the importance of ship ballast water management<br>▪ Conduct socialization of commercial ship ballast water management by stakeholders<br>▪ Enforcement of rules related to the management of commercial ship ballast water at Soekarno Hatta Port Makassar | ▪ Create ballast water inspection techniques<br>▪ Increase awareness of crew/ship crew regarding the importance of ship ballast water management<br>▪ Development of port facilities and infrastructure in order to support all activities and efficiency of ballast water management |
| **Threats** | **Strategi W-O** | **Strategi W-T** |
| ▪ Lack of supervision related to ballast water regulations set by the government<br>▪ Lack of stakeholder attention to ballast water management at Soekarno Hatta Port Makassar<br>▪ Erratic government policy changes | ▪ Strengthening monitoring and enforcement of laws and regulations regarding ballast water management in waters, especially in Soekarno Hatta Port Makassar<br>▪ Increased supervision of ship ballast water management | ▪ Optimizing the supervision of commercial ship ballast water management at Soekarno Hatta Port Makassar<br>▪ Increasing awareness of the importance of protecting the ocean and its ecosystems<br>▪ Socialization and understanding of government programs regarding environmental protection |

Determination of ecosystem-based commercial ship ballast water management strategies at Soekarno Hatta Port Makassar with the value obtained from the internal factor matrix (IFAS) shows that between strengths (2.009) and weaknesses (0.606) is 1.403 This value indicates that the strength factor is more dominant than the weakness factor. On external factors (EFAS) shows that between opportunities (1.820) and threats (1.378) is 0.442. This value shows that the opportunity factor is more dominant than the threat factor. Based on the total score of the IFAS matrix (1.403) and EFAS (0.442), it can be mapped in the form of a SWOT analysis diagram (space matrix). The following results of mapping the strategic position based on space analysis are presented in the following figure.

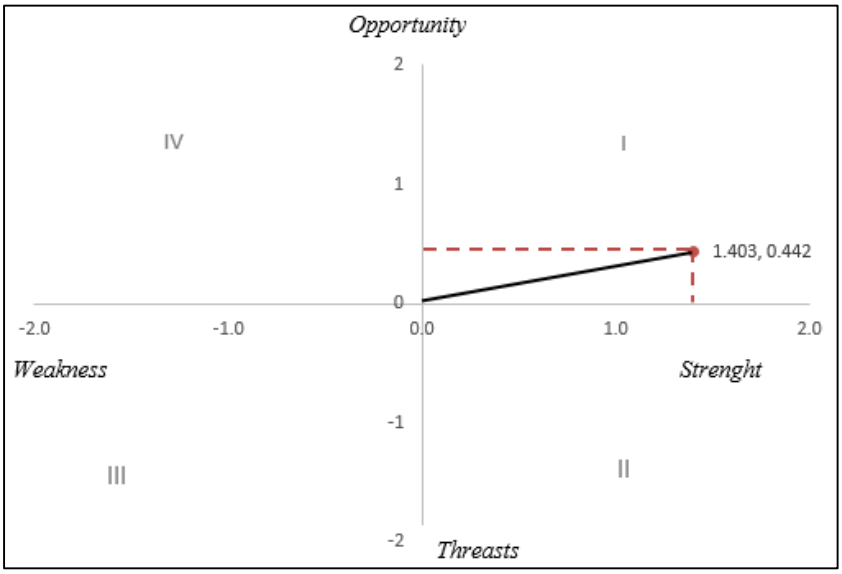


**Fig 1:** SWOT Analysis Diagram

The results of the SWOT analysis diagram show that a suitable strategy in the analysis of ecosystem-based commercial ship ballast water management at Soekarno Hatta Port Makassar is the S-O Strategy (Strenght-Opportunity). Based on SWOT analysis, alternative ballast water management strategies at Soekarno Hatta Port Makassar are (1) Carrying out training and training for crew / ship crew on the importance of ship ballast water management. (2) Conduct socialization of commercial ship ballast water management by stakeholders. (3) Affirmation of rules related to the management of commercial ship ballast water at Soekarno Hatta Port Makassar.

## Discussion

Based on the results of the SWOT analysis, the strength factor has a total score of 2.009. The strength of internal factors shows that the crew's knowledge of ship ballast water management regulations with a value of 0.246. The weakness factor has a total value of 0.606 with ballast water disposal still carried out at the dock when the ship is docked at the port being the biggest weakness with a value of 0.128. The value of external factors in the opportunity variable has a value of 1.820 with the highest opportunity score being the existence of regulations governing ballast water management with a value of 0.187. There are threats that need to be watched out for, namely uncertain changes in government policy.

In the SWOT matrix, four main strategies can be developed, namely S-O, W-O, S-T, and W-T. The internal factor matrix (IFAS) shows that between strengths (2.009) and weaknesses (0.606) is 1.403 This value indicates that the strength factor is more dominant than the weakness factor. On external factors (EFAS) shows that between opportunities (1.820) and threats (1.378) is 0.442. So that the results of the SWOT analysis diagram are shown to be in quadrant I position, namely an aggressive strategy (Strenght - Opportunity) maximizing all strengths to maximize all existing opportunities.

## Conclusion

Ecosystem-based commercial ship ballast water management at Soekarno Hatta Port Makassar obtained an alternative strategy, namely the S-O (Strenght-Opportunity) strategy. The position of internal and external factors in the ballast water management sub-sector in this quadrant shows that strengths and opportunities are more dominant than weaknesses and threats. Based on SWOT analysis, alternative S-O strategies include: (1) Carry out training and training for crew / ship crew on the importance of ship ballast water management. (2) Conduct socialization of commercial ship ballast water management by stakeholders. (3) Affirmation of rules related to the management of commercial ship ballast water at Soekarno Hatta Port Makassar.

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