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An Assessment of Waste Management Practices in Ship Operations and Their Implications for Port Environmental Protection (Case Study: Tanjung Perak Port)

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ABSTRACT

This study aims to analyze the waste management system of ship operational activities at Tanjung Perak Port, identify obstacles in ship waste management, and formulate strategies to improve the effectiveness of waste management to support port environmental protection. The research method used descriptive qualitative. Data collection techniques include observation, interviews, documentation, and literature studies. Data analysis was conducted using the fishbone analysis method to identify the main factors causing ship waste management problems. The results show that the ship waste management system at Tanjung Perak Port already has a regulatory basis and port reception facilities, but there is still room for improvement in implementation through facility capacity development, provision of sewage waste management services, the level of ship operator compliance with the use of port facilities that are still in the strengthening stage, and the ship waste monitoring system that is currently in the integration process. Therefore, it is necessary to increase the capacity of waste reception facilities, strengthen coordination between port stakeholders, and implement a more integrated waste management monitoring system to support port environmental protection.

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INTRODUCTION

A port is an area consisting of land and water used for maritime transportation activities and equipped with various facilities to support shipping operations. Ports play a crucial role in supporting logistics distribution and trade between regions and countries. High levels of ship operational activity at ports can have various environmental impacts, one of which is the generation of ship waste, which has the potential to pollute the marine environment if not

managed properly (Eryanto & Achmadi, 2012).

Waste generated from ship operations can include oil waste, hazardous and toxic waste (B3), domestic ship waste, and domestic liquid waste. B3 waste generated from port activities generally consists of flammable solids, flammable liquids, and toxic materials, requiring strict management to prevent environmental pollution (Daudsyah Imami et al., 2022). Therefore, ship waste management is a crucial aspect of maritime environmental protection. Every port needs to understand the characteristics and volume of waste generated from ship operations. This information can be used as a basis for planning hazardous waste storage capacity and the port's waste management system (Mayangsari et al., 2021). Furthermore, planning temporary waste storage facilities is also a crucial part of the port's waste management system to ensure waste can be safely managed before further processing (Ngudyana et al., 2022).

Internationally, ship waste management is regulated through the International Convention for the Prevention of Pollution from Ships (MARPOL), which requires every port to provide port reception facilities. These facilities serve as a place to collect, store, and manage ship waste before further processing or utilization (Pangow, 2017). The implementation of these facilities is a crucial indicator in efforts to prevent marine pollution from shipping activities. In Indonesia, the obligation to provide ship waste storage facilities is stipulated in various regulations, such as Law No. 17 of 2008 concerning Shipping and Minister of Transportation Regulation No. 29 of 2014 concerning the Prevention of Maritime Environmental Pollution. These regulations require every port to provide waste storage facilities to prevent pollution from ship operations at the port.

With increasing awareness of maritime environmental protection, the green port concept has begun to be implemented as an approach to sustainable port management. This concept emphasizes the importance of port environmental management through the implementation of environmentally friendly policies, increased operational efficiency, and effective waste management (Dirmansyah et al., 2024). Tanjung Perak Port is one of Indonesia's major ports with a high level of ship activity. This high level of operational activity has the potential to increase the volume of waste generated from ship operations at the port. Therefore, an effective ship waste management system is required to ensure that the waste generated is managed safely and does not cause environmental pollution.

Although various regulations related to ship waste management have been implemented in Indonesian ports, their implementation at some ports still requires strengthening in various aspects, such as developing facility capacity, improving ship operator compliance, and optimizing waste management monitoring systems. Several previous studies have focused more on the characteristics of port waste and the planning of hazardous and toxic waste storage facilities (Mayangsari et al., 2021; Ngudyana et al., 2022). However, studies specifically analyzing the effectiveness of operational ship waste management systems at ports and the factors influencing the optimal utilization of port reception facilities still require further development. Therefore, this study attempts to analyze the operational ship waste management system at Tanjung Perak Port and identify factors influencing the optimization of ship waste management through a fishbone analysis approach.

Based on these conditions, this study aims to analyze the operational waste management system of ships at Tanjung Perak Port, identify obstacles in the implementation of ship waste management, and formulate strategies to increase the effectiveness of ship waste management through a fishbone analysis approach to support port environmental protection.

METHODS

This study uses a qualitative descriptive approach to analyze the waste management system for ship operations at Tanjung Perak Port. Data were obtained through direct field observations and interviews. The research informants consisted of parties involved in ship waste management at Tanjung Perak Port, including port authorities, reception facility managers, and ship operators. Observations were conducted to obtain a concrete picture of the ship waste management system implemented at the port. According to Sugiyono (2020), observation is a data collection technique carried out by directly observing the research object to obtain relevant information. The data obtained were then analyzed using qualitative descriptive analysis through the stages of data reduction, data presentation, and conclusion drawing.

Other data was also obtained through literature studies, official documents, and regulations related to ship waste management at ports. The literature study was conducted to establish a theoretical basis to support the research and to compare the results with previous research (Snyder, 2020).

The data analysis in this study used the fishbone analysis method to identify the causal factors of problems in ship waste management at the port. A fishbone diagram is an analytical method used to systematically identify the root causes of a problem to help determine the appropriate solution (Septyanto et al., 2020). Data analysis was carried out through the stages of data reduction, data presentation, and conclusion drawing, as proposed by Miles and Huberman. Next, a fishbone analysis was conducted to identify the main causal factors in ship waste management problems at the port.

RESULTS AND DISCUSSION

Ship Waste Management System at Tanjung Perak Port

Operational waste management from ships at Tanjung Perak Port is carried out based on various national regulations governing the prevention of maritime environmental pollution, including Law Number 17 of 2008 concerning Shipping, Government Regulation Number 21 of 2010 concerning Maritime Environmental Protection, and Regulation of the Minister of Transportation Number 29 of 2014 concerning the Prevention of Maritime Environmental Pollution. These regulations require each port to provide ship waste storage facilities to prevent marine environmental pollution originating from ship activities in the port area.

In its implementation, ship waste management at Tanjung Perak Port is carried out through the provision of ship waste reception facilities or port reception facilities which function as temporary storage areas before the waste is processed or processed further. The existence of this facility is an important component in the ship waste management system at the port because it allows ships to hand over waste generated during their operational activities safely and in accordance with applicable regulations. According to Pangow (2017), port reception facilities are the main element in the ship waste management system because their existence can prevent the practice of dumping ship waste directly into the sea. Apart from that, ship waste management is also in line with the implementation of the green port concept, namely a port management approach that emphasizes efforts to reduce the environmental impact of port activities through the implementation of a sustainable environmental management system (Dirmansyah et al., 2024).

The port reception facilities at Tanjung Perak Port are managed by a business entity with a B3 waste management permit, namely PT Lamong Energi Indonesia, located on Jalan Nilam Barat Surabaya with a land area of approximately 1,350 m². The facility is equipped with several supporting facilities, including a B3 waste collection building with a maximum capacity of approximately 1.75 tons, a waste storage tank with a capacity of approximately 20 tons, and wastewater treatment equipment such as an oil water separator and a wastewater treatment plant (IPAL). This facility is designed to accommodate various types of B3 waste generated from ship operations, such as used lubricating oil, used batteries, electronic waste,

and used hazardous material packaging.

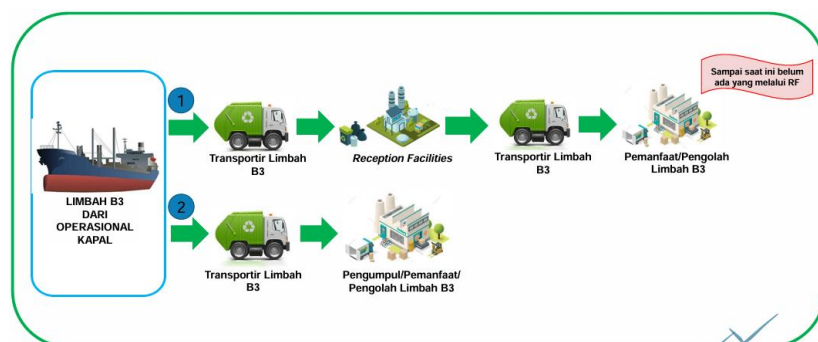


Figure 1. Existing Flow of B3 Waste Management

In addition to B3 waste management, domestic waste from ships is also managed through collaboration with several business entities tasked with collecting waste from ships. The domestic waste generated by ships is then transported to the Benowo Final Processing Site (TPA) as the final domestic waste processing location. This collaborative system demonstrates that ship waste management at the port involves not only the port authorities but also waste management businesses involved in the collection, transportation, and processing of waste.

Although the ship waste management system at Tanjung Perak Port has a regulatory framework and supporting facilities, research shows that ship waste management still faces several limitations. One major obstacle is the lack of a business entity that provides sewage collection services from ships. This situation indicates that not all types of ship waste generated from ship operations can be optimally managed through the current port waste management system.



Figure 2. FR Facility Documentation

These findings indicate a gap between regulatory provisions and the implementation of ship waste management in the field. From a port waste management theoretical perspective, the existence of port reception facilities is not only determined by the availability of physical facilities, but also by the adequacy of capacity, the completeness of the types of waste services that can be handled, and ease of access for ships to submit their waste. The limited capacity of reception facilities at Tanjung Perak Port indicates that the ship waste management system still does not fully meet the principle of facility adequacy as recommended in the MARPOL convention. Pangow (2017) stated that the existence of adequate port reception facilities is an important factor in encouraging ship compliance in submitting their operational waste at the port. Therefore, the limited availability of certain waste management services such as sewage indicates that the ship waste management system at Tanjung Perak Port still requires further development to meet the ship waste management standards recommended in the MARPOL convention and support the implementation of the green port concept more comprehensively.

Obstacles in Ship Waste Management

The main problem identified in this study is the need to improve the implementation of waste management during ship operations at Tanjung Perak Port. To identify the root causes of this problem, a fishbone analysis method was used, grouping causal factors into several main categories: man, machine, method, and measurement.

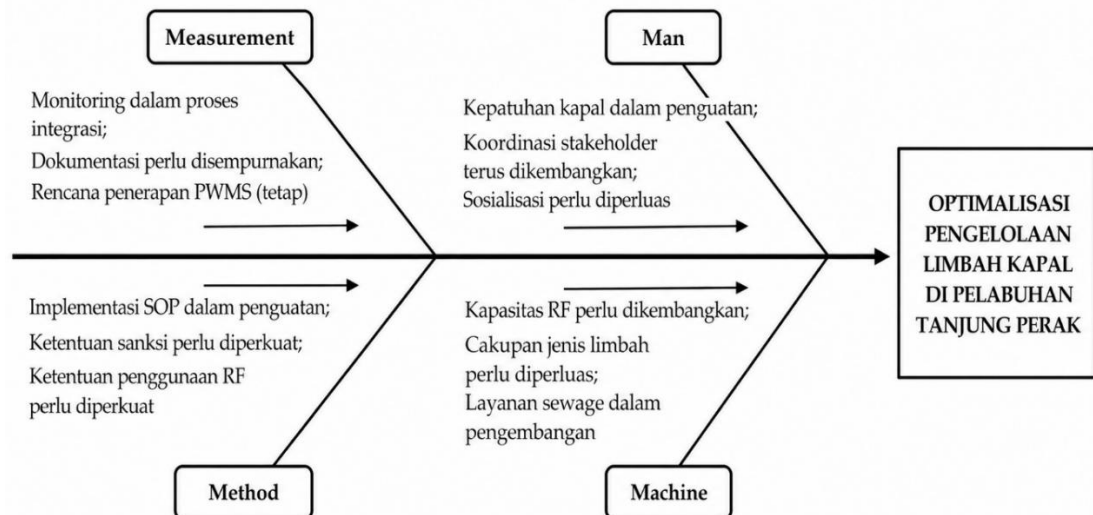


Figure 3. Fishbone Analysis

1. Man (Stakeholder and Ship Operator Compliance)

The human factor relates to the level of compliance, awareness, and coordination among stakeholders involved in ship waste management at ports. Some ship operators still choose to hand over waste directly to waste transporters without going through the port's reception facilities. This indicates an opportunity to further improve compliance with waste management systems. Furthermore, ship waste management involves various parties, such as the Port Authority (KSOP), port business entities, waste management, and ship operators, requiring strong coordination. However, in practice, coordination between port stakeholders continues to be developed to improve the effectiveness of integrated waste management. Dissemination of waste management policies and procedures is also limited, resulting in uneven understanding of the waste management system among the parties involved.

2. Machine (Waste Management Facilities and Infrastructure)

Facilities are a key factor influencing the effectiveness of ship waste management at the port. The reception facilities at Tanjung Perak Port have a waste collection capacity of approximately 1.75 tons, with a storage tank capacity of approximately 20 tons. This capacity requires further adjustments due to the high level of ship activity at the port. In addition to capacity limitations, the types of waste that reception facilities can manage are also limited, based on the environmental permits they hold. Research also indicates that the sewage collection service from ships at Tanjung Perak Port is still under development. This situation indicates that the capacity of port reception facilities is still being adjusted to meet the volume of ship activity at Tanjung Perak Port, necessitating facility development to optimally handle all types of ship waste.

3. Method (Procedure and Management System)

The method factor is the most dominant factor because it is directly related to the waste management systems and procedures implemented at the port. Regulatory, the ship waste management system is regulated by the 2020 Regulation of the Head of the Tanjung Perak Port Authority Office. Efforts are being made to strengthen the implementation of these SOPs in the field, including through expanded outreach to port stakeholders and changes to the management of

reception facilities, which have resulted in adjustments to the licensing and operational systems. Furthermore, the obligation for ships to use available reception facilities at the port has been strengthened. In practice, some ship waste is still collected directly by waste transporters without going through port facilities. This situation demonstrates the need to strengthen regulations that encourage ships to use port waste management facilities, making improving ship operators' compliance with the waste management system a priority.

4. Measurement (Monitoring and Supervision System)

The measurement factor relates to the monitoring and supervision system for ship waste management activities at the port. Research results indicate that ship waste management supervision is currently undergoing development towards digital integration. Therefore, the current manual monitoring process is expected to be improved. This situation necessitates strengthening the recording and supervision of ship waste handover activities, which are not yet optimal.

Furthermore, documentation of ship waste handover activities within the port reporting system is still being refined to provide more comprehensive data on the quantity and type of ship waste. To address this issue, the port authority plans to implement a digital-based ship waste reporting system through the Port Waste Management System (PWMS), which is expected to increase transparency and effectiveness of ship waste management oversight.

Strategies for Improving Ship Waste Management

Based on the results of the research analysis, improving the effectiveness of ship operational waste management at Tanjung Perak Port requires several strategic steps, including increasing facility capacity, strengthening coordination between stakeholders, and strengthening the monitoring and reporting system.

1. Assessment of the Adequacy of Port Reception Facilities (PRF)

An important step that needs to be taken is to conduct an assessment and inventory of the adequacy of port reception facilities (PRF) at the port. This assessment aims to determine whether the available facility capacity is sufficient to accommodate waste generated from ship activities at the port. This assessment should refer to Resolution MEPC.83 (44) concerning Guidelines for Ensuring the Adequacy of Port Reception Facilities, which emphasizes the importance of matching facility capacity to the type and volume of ship waste served.

2. Strengthening Stakeholder Coordination and Cooperation

Ship waste management involves various parties, such as port authorities, port business entities, waste management companies, and ship operators. Therefore, strengthening coordination and cooperation among stakeholders is necessary to ensure that the provision, operation, and supervision of port reception facilities comply with the provisions of Minister of Transportation Regulation Number 29 of 2014 concerning the Prevention of Maritime Environmental Pollution, as updated through Minister of Transportation Regulation Number 24 of 2022.

3. Strengthening the PRF Information and Reporting System

Optimizing ship waste management also requires the support of an integrated information system. Information regarding the availability of PRF facilities should be included in the Global Integrated Shipping Information System (GISIS) managed by the International Maritime Organization (IMO). Furthermore, documentation and evaluation of PRF provision and operation should be conducted periodically, referring to the MEPC.1/Circ.834/Rev.1 guidelines.

4. Strengthening the Implementation of Marine Pollution Prevention Regulations

Ship waste management must also be supported by the implementation of national and international regulations governing the prevention of marine pollution caused by ship activities.

These regulations include Government Regulation No. 21 of 2010 concerning Maritime Environmental Protection, Ministerial Regulation No. 5 of 2009 concerning Waste Management in Ports, and provisions in the MARPOL Convention governing the prevention of marine pollution from various types of ship waste.

5. Improving the Monitoring and Evaluation System

In addition to improving facilities and regulations, a more effective monitoring and evaluation system for ship waste management in ports is needed. Port authorities are required to periodically report on the results of PRF adequacy assessments, port waste management data, and ship waste management systems. These evaluations are expected to improve the transparency and effectiveness of ship waste management at the port.

This strategy is expected to support the implementation of the green port concept and increase environmental protection in the port area.

Synthesis of Ship Waste Management Analysis Results

Based on the research results, efforts to optimize operational waste management at Tanjung Perak Port are influenced by several key factors, including methods, facilities, human resources, and monitoring systems. Fishbone analysis indicates that the implementation of waste management SOPs is still being strengthened, the capacity and types of reception facilities are still being developed, the level of ship operator compliance with port facility use is still being strengthened, and the waste management monitoring system is undergoing more effective integration. Furthermore, the utilization of reception facilities at the port still requires improvement through capacity expansion, expansion of the types of waste that can be managed, and strengthening of regulations that encourage ships to utilize these facilities. This situation indicates variations in waste delivery practices by ship operators outside the port management system.

Therefore, efforts are needed to improve the ship waste management system through assessing the adequacy of port reception facilities, strengthening coordination among port stakeholders, enhancing the information and reporting system for ship waste, and strengthening the implementation of marine pollution prevention regulations in accordance with MARPOL and applicable national regulations. This research demonstrates that improving the effectiveness of ship waste management requires not only improvements to physical facilities but also strengthening regulations, coordination between stakeholders, and implementing an integrated monitoring system.

CONCLUSION

Based on the research conducted, it can be concluded that the ship waste management system at Tanjung Perak Port has a regulatory framework and ship waste reception facilities. However, in its implementation, several areas still require strengthening, such as developing the capacity of waste management facilities, improving operational oversight, and strengthening coordination among port stakeholders. The fishbone analysis indicates that problems in ship waste management are influenced by several key factors: human resources, management methods, waste management facilities, and the monitoring system. To improve the effectiveness of ship waste management at the port, it is necessary to increase the capacity of waste management facilities, strengthen monitoring and supervision systems, and increase environmental awareness among all parties involved in port operations.

REFERENCES

- Creswell, J. W., & Poth, C. N. (2020). *Qualitative inquiry and research design: Choosing among five approaches*. Sage Publications.
- Daudsyah Imami, A., Rahmah, P., et al. (2022). *Studi pengelolaan limbah bahan berbahaya dan*

beracun (B3) di kawasan pelabuhan batubara.

Dirmansyah, D., Setiono, B. A., & Nasihah, A. (2024). Implementation of the green port concept in PT Terminal Petikemas Surabaya. *Jurnal Aplikasi Pelayaran dan Kepelabuhanan*, 15(1).

Eryanto, E., & Achmadi, T. (2012). Analisis penanganan limbah minyak di kawasan pelabuhan.

Mayangsari, N. E., Ngudyana, I., Sophia, A. V., & Ramadani, T. A. (2021). Karakteristik dan timbulan limbah B3 di pelabuhan.

Ngudyana, I., Mayangsari, N. E., & Sophia, A. V. (2022). Perencanaan tempat penampungan sementara limbah B3 di Pelabuhan Tanjung Perak.

Pangow, Y. H. (2017). Kajian reception facility di Pelabuhan Tanjung Priok. *Geoplanart Journal*.

Septyanto, D., et al. (2020). Application of fishbone diagram for root cause analysis.

Sugiyono. (2020). *Metode penelitian kuantitatif, kualitatif dan R&D*. Bandung: Alfabeta.

Snyder, H. (2020). Literature review as a research methodology. *Journal of Business Research*.

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