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| **Analysis of the Effectiveness of the Implementation of thePort Waste Management System (PWMS) at Port of Tanjung Perak**  1Alam SyahRestu Husada, 2Intan Sianturi, 3Eka Nurmala Sari Agustina, 4Faris Nofandi  *1,2,3,4Politeknik Pelayaran Surabaya*  *Correspondence email of author:* [*alam7g03@gmail.com*](mailto:alam7g03@gmail.com) |
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***Abstract***

Ports are one of the important sectors in supporting a country's economy. Tanjung Perak Port is the second largest and busiest port in Indonesia. From busy port activities, it can have a negative impact on the environment, such as waste pollution from ship operations. Harbor Master and Port Authority of Tanjung Perak implements the PWMS to minimize waste pollution from ship operations in order to carry out its duties in protecting the maritime environment. This study aims to analyze the effectiveness of the implementation of the PWMS at Tanjung Perak Port. The results showed that the percentage of the number of ships filling in waste data in the PWMS was 8.48%, while the percentage of the number of ships filling in zero waste data in the PWMS was 91.52%. The percentage obtained shows that waste reporting in PWMS is not yet orderly. With these results, it is also a reference that the implementation of the PWMS at Tanjung Perak Port has not been effective. The ineffective implementation of the PWMS is caused by several factors, both internal and external factors. This research uses descriptive quantitative methods with data collection through documentation.

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| ***Keywords:*** *Effectiveness, Ship Waste, PWMS* |

# INTRODUCTION

According to Law on Indonesian Regulation Number 17 of 2008 concerning Shipping, a port is a place consisting of land and/or waters with certain boundaries as a place for government activities and business activities that are used as a place for ships to dock, board and unload goods, in the form of terminals and shipyards equipped with shipping safety and security facilities and port supporting activities as well as as a place of transfer intra- and intermodal transportation. Ports are a gateway to enter a region and as a connecting infrastructure between regions, between islands, between countries, and even between continents (Triatmojo, 2010).

Ports are one of the sectors that have an important role to support the economy of a country, especially in Indonesia as an archipelagic country. The port is a very busy center of logistics activities. As well as Tanjung Perak Port is the largest and second busiest port in Indonesia after Tanjung Priok Port Jakarta. This is because, in addition to being a connecting gateway for eastern Indonesia, it is also due to the increase in economic growth in the East Java Province area. This situation has an impact on the increasing flow of goods distribution from and to the East Java region both for domestic goods and international trade. From the existence of very busy port activities can have a negative impact on the environment, such as waste pollution resulting from ship operations. Ship's operational waste can pollute the environment if not managed properly. To avoid this, waste management is needed to maintain a sustainable maritime environment as a form of protection of the maritime environment. In accordance with Government Regulation on Indonesian Regulation Number 21 of 2010 concerning maritime environmental protection, maritime environmental protection is any effort to prevent and overcome pollution of the aquatic environment sourced from activities related to shipping (Fauzy et al., 2016).

It is also bound by international regulations issued by the IMO (International Maritime Organization)in the form of MARPOL or also known as Marine Pollutionis an international convention for pollution from ships. MARPOL is an international endorsement that contains provisions and procedures for preventing marine pollution from ships (Kuncowati, 2018). Existing international regulations and conventions have the same goal, which is to reduce the negative impact on the environment caused by shipping activities. With this, every ship that has a position is required to comply with every applicable provision in accordance with national and international regulations. One of its supervisory roles is delegated to government agencies, namely the Harbor Master and Port Authority as a Technical Implementation Unit under the auspices of the Ministry of Transportation. One of which is the Harbor Master and Port Authority of Tanjung Perak

The Harbor Master and Port Authority of Tanjung Perak has the main task as a supervisor of the technical aspects of shipping safety and security as well as maritime protection in terms of the fulfillment of procedures and requirements for prevention and countermeasures from ship operations and port activities in accordance with the provisions of articles 123, 232, and 236 of Indonesian Regulation Law Number 17 of 2008 concerning Shipping. Based on the provisions of Circular Letter Number: UM.003/86/18/DJPL-18 concerning Fillings for Shipborne Contaminated Goods, it is necessary to carry out maritime protection supervision from pollution and enforce the implementation of PWMSreporting on the inaportnet application. Then it was followed by the Decree of the Head of the Harbor Master and Port Authority of Tanjung Perak Number: KP-KSOPU. TPr 6 of 2024 concerning the Joint Secretariat for Waste Management at the Port of Tanjung Perak, the coordinator for supervision and enforcement implements the obligation of every ship that docks and departs to report ship waste data through PWMSsystem in the inaportnet application. Inaportnet is a system that is currently used in several major ports in Indonesia. Inaportnet is not only used in terms of port players, but also from importers, exporters, and shipping lines (Sianturi et al., 2021).

The implementation of good PWMS reporting is one of the supporting indicators in an effort to realize the Green Port conceptat the Port of Tanjung Perak. The Port of Tanjung Perak is increasingly aware of the importance of effective waste management to maintain environmental sustainability. With the green port conceptthat is being pursued, it also emphasizes the integration of environmentally friendly waste management from ship and port operations. In the implementation of the integration, it is implemented in the Inaportnet system in the form of PWMS.An integrated system is expected to support ship waste management, especially at the reporting stage in efforts to protect the maritime environment. The existence of waste reporting in the inaportnet system to realize waste management and simplify the monitoring process, pollution prevention as evaluation material. This report is submitted by the ship operator through the inaportnet system in accordance with applicable regulations.

Based on the results of the literature study and observations conducted by the author during the implementation of Land Practice at The Harbor Master and Port Authority of Tanjung Perak, in its implementation, several challenges were found in the implementation ofPWMS reporting, including, compliance and enforcement in its implementation considering the PWMSreporting. This is a new system at the Port of Tanjung Perak, resource capacity and system integration that cannot be implemented in all ports in Indonesia, as well as varying levels of digital literacy among ship operators.

This is clarified by the results of monthly reports from PWMSfor the period from August 2024 to March 2025. Therefore, from this it is necessary to conduct further studies and efforts to optimize the reporting of PWMSso that it can contribute to efforts to realize the concept of Green Port at the Port of Tanjung Perak. In detail the reporting is presented in the following figure:

Fig 1. PWMSReport Graph

# METHOD

The type of research used in this study is a descriptive quantitative method. Research methods are scientific ways to obtain data with specific purposes and uses. Quantitative research methods are research methods based on the philosophy of positivism, used to research on specific populations and samples (Sugiyono, 2018). Descriptive quantitative research is research that provides a factual description of variables supported by data in the form of numbers taken from actual circumstances (Mulyani, 2024).

Descriptive quantitative is statistical analysis used to describe, summarize, analyze quantitative data (Sudirman et al., 2023). The descriptive method is used to provide a description and description systematically (Mulyani, 2024).

Population is a general area consisting of objects or subjects that have certain characteristics and qualities that are determined by the researcher to be studied so that the researcher can draw a conclusion (Sugiyono, 2018). The population used in this study is all ships that reported to the PWMS in the period August 2024 to March 2025.

A sample is a part of a population that is selected in a certain way to be the subject of research and research (Sugiyono, 2018). In this study, the sample used is the number of reporting ships, both those that fill in waste data and those that fill in zero waste data in PWMS in the period of August 2024 to March 2025. The sample data processed is overall data, so the author takes samples from the entire population.

Data analysis is the process of finding and compiling data obtained from the results of field records, and documentation systematically, by organizing data into categories, describing it into units, synthesizing, organizing it into patterns, choosing which ones are important and what will be studied and making conclusions so that they can be easily understood by themselves and others (Sugiyono, 2018). The analysis techniques used in this study are descriptive statistical methods, including percentage calculations, data presentation in tables, graphical diagrams.

To find out the level of effectiveness of the PWMS, the percentage results that have been obtained are then translated based on the following table:

Table 1. Effectiveness Category

|  |  |
| --- | --- |
| Percentage (%) | Effectiveness Category |
| 0 – 25% | Not Yet Effective |
| 26 – 50% | Less Effective |
| 51 – 75% | Quite Effective |
| 76 – 100% | Effective |

# RESULTS AND DISCUSSION

**Results**

**Presentation Ship Waste Reporting Data in the PWMS at Tanjung Perak Port for the Period of August 2024 to March 2025**

Table 2. Ship Waste Reporting Data in PWMS

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| No. | Month | Number of Ships Reported | Number of Ships Filling Waste Data in PWMS | Number of Ships Filling Zero Waste Data in PWMS |
| 1 | August 2024 | 2274 | 563 | 1711 |
| 2 | September 2024 | 2183 | 357 | 1826 |
| 3 | October 2024 | 2526 | 42 | 2484 |
| 4 | November 2024 | 1816 | 28 | 1788 |
| 5 | December 2024 | 2201 | 139 | 2062 |
| 6 | March 2025 | 2320 | 0 | 2320 |
| Total | | 13320 | 1129 | 12191 |

The data used by the author in the Table 2 is secondary data in the form of data that has been recapped from waste reporting on ships on the PWMS every month in the period from August 2024 to March 2025. However, there have been system maintenance in January and February 2025 which has caused reporting data to not be recorded on the system. So that the data in January and February 2025 are incomplete and it can be said that the data is corrupted which makes the author not enter the data into the table. The number of reported ships is obtained from the number of incoming ships and the number of departing ships. From the number of reported ships, there is also a classification in the form of the number of ships that fill in waste data in PWMS and the number of ships that fill in zero waste data in PWMS.

The Table 2 shows the data on waste reporting on ships at PWMS from August 2024 to March 2025. October 2024 will be the month with the highest number of reported ships, with a total of 2526 reported ships. August 2024 will be the month with the highest number of ships filling waste data at PWMS, with a total of 563 ships. Meanwhile, the highest number of ships filling in zero waste data at PWMS occurred in October 2024, with a total of 2484 ships.

November 2024 will be the month with the fewest number of reported ships, with a total of 1816 ships. The least number of ships filling waste data at PWMS will occur in March 2025, with a total of 0 ships. Meanwhile, the number of ships filling in zero waste data at PWMS will be the smallest in August 2024, with a total of 1711 ships.

**Analysis of the Effectiveness of the Implementation of the PWMS on Waste Reporting on Ships at Tanjung Perak Port for the Period of August 2024 to March 2025**

Table 3. Percentage of Ship Waste Reporting Data in PWMS

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| No. | Month | Percentage of Number of Ships Reported | Percentage of Ships Filling Waste Data in PWMS | Percentage of Ships Filling Zero Waste Data in PWMS |
| 1 | August 2024 | 100% | 24,76% | 75,24% |
| 2 | September 2024 | 100% | 16,35% | 83,65% |
| 3 | October 2024 | 100% | 1,66% | 98,34% |
| 4 | November 2024 | 100% | 1,54% | 98,46% |
| 5 | December 2024 | 100% | 6,32% | 93,68% |
| 6 | March 2025 | 100% | 0,00% | 100,00% |
| Average | | | 8,48% | 91,52% |

The Table 3 is the result of a recap of waste reporting on board the ship at PWMS*,* which the author then processed into percentage data. If the percentage of ships filling in waste data at PWMS is getting higher, the more orderly ship waste reporting will be. However, if the percentage of the number of ships filling in zero waste data in PWMS is getting higher, then ship waste reporting is not orderly, on the other hand, if the percentage of the number of ships filling in zero waste data in PWMS is getting lower, then waste reporting is more orderly.

From this percentage Table 3, the highest percentage of ships filling waste data at PWMS occurred in August 2024 at 24.76%, and the lowest percentage of ships filling waste data at PWMS occurred in March 2025 at 0.00%. Meanwhile, the highest percentage of ships filling in zero waste data at PWMS occurred in March 2025 at 100.00%, and the lowest percentage of ships filling in zero waste data at PWMS occurred in August 2024 at 75.24%.

Fig 2. Graph of Ship Waste Reporting Data in PWMS

From August to September there was a percentage decrease of 8.40%, then from September to October there was a decrease in the highest percentage of 14.69%. From October to November, there was a decrease of 0.12%. However, there was also a percentage increase in November to December of 4.77%. Then, there was a decline again in December to March of 6.32%.

From August to September there was a percentage increase of 8.40%, then from September to October there was the highest percentage increase of 14.69%. From October to November, there was an increase of 0.12%. However, there was also a percentage decrease in November to December of 4.77%. Then there was an increase again in December to March of 6.32%.

Based on the graph that has been presented, it can be seen that there is more often a decrease than an increase in the percentage of the number of ships filling waste data in PWMS. With the highest percentage of 24.76% from 100.00% that occurred in August. The average number of ships filling waste data at PWMS was 8.48% and the average number of ships filling in zero waste data at PWMS was 91.52%. The percentage of ships that fill waste data in PWMS is smaller than the number of ships that fill in zero waste data in PWMS, which means that ship waste reporting is still not fully orderly.

**Factors Affecting the Percentage Decrease in the Number of Ships Filling Waste Data in the PWMS**

The implementation of PWMS is expected to run well in supporting waste reporting on board ships at Tanjung Perak Port. Thus, it can help in the tracing process related to waste at the port to minimize waste pollution in the maritime environment.

Based on data on waste reporting on ships at Tanjung Perak Port for the period from August 2024 to March 2025 that has been processed, it can be seen that there is more often a decrease in trend than an increase in trend. The downward trend shows that ship waste reporting is still not orderly. This is due to several factors that will be classified based on internal factors and external factors that the author has obtained from the results of questions and answers to the staff of the Harbor Master and Port Authority of Tanjung Perak.

**Internal Factors**

First thing is policies and regulations. Policies and regulations are important factors in waste reporting activities on board. Unclear regulations cause inconsistencies on the part of system users in reporting waste on board. In addition, the existence of unclear regulations causes the application of non-optimal sanctions to system users in waste reporting activities on board ships that are not in accordance with the provisions.

The second is reporting system. The reporting system in the form of aPWMS is one of the vital factors in supporting waste reporting activities on board, where this system will be used as a forum to accommodate, process, and recap data which is then used to make further decisions or policies. The system is also still in the process of development, in its use there is still a possibility of system maintenance, so the system cannot be used for a while. This certainly interferes with the process of waste reporting activities on board.

The third is human resources of regulators. Of course, in the operation of a system, competent human resources are needed with a sufficient number. Moreover, the PWMS itself is a new thing implemented at the Port of Tanjung Perak, so it takes time to get used to operating this system. With a limited number of Human Resources, of course, it will make the process of processing and resuming data quite time-consuming. In addition, it causes loopholes for invalid data verification because of the limited number of human resources required to handle a large amount of waste reporting data on ships.

**External Factors**

The first thing is facility availability. The facility in question is Reception Facilities(RF). In contrast to Tanjung Priok Port which has carried out a pilot projectrelated to PWMS due to adequate facilities in the form of sea RF and land RF, while at Tanjung Perak Port there is only a land RF available, which has not yet functioned optimally. Of course, facilities such as RF that have not functioned optimally are also a factor in the decrease in the percentage of ships filling waste data in PWMS.

The second is collaboration between regulators, shipping parties, and port business entities Collaboration between regulators, shipping parties, and Port Business Entities has not been optimal. From collaboration that is not optimal, it can cause incompatibility in flows or procedures in waste reporting activities. So that it can make it difficult for seafarers to report waste on board.

The third is human resources of seafarers. Similar to human resources as a regulator, PWMS is also a new thing for seafarers, especially for domestic shipping. Therefore, it also takes time to get used to using this system. Understanding of the international convention on Marine Pollution(MARPOL) and awareness of the importance of reporting waste on board for seafarers is also something that needs to be considered. Seafarers play the role of primary users of this system in the hope of reporting waste according to its original state.

**Discussion**

The results of this study know that the PWMSat the Port of Tanjung Perak has been implemented in accordance with the Decree of the Head of The Harbor Master and Port Authority of Tanjung Perak Number: KP-KSOPU. TPr 6 of 2024. However, in its implementation, waste reporting is still not orderly. Based from the results of the data processed by the author regarding waste reporting on ships at PWMS, the period from August 2024 to March 2025 shows that there is more often a decrease in trend than an increase in trend. The average percentage obtained from the number of ships that fill waste in PWMS is 8.48% where the value if matched to the category table of the percentage level of effectiveness that has been determined before, is included in the category with a value range of 0 – 25%. Therefore, it can be said that the implementation of PWMS at Tanjung Perak Port has not been effective.

From the results that show that the implementation of PWMS at Tanjung Perak Port has not been effective, of course, due to several factors, both from internal and external factors. From internal factors such as policies and regulations, reporting systems, and human resources from regulators. Meanwhile, from external factors such as the availability of facilities, collaboration between regulators, shipping parties, and Port Business Entities as well as human resources from seafarers.

The implementation of good PWMS reporting is one of the supporting indicators in an effort to realize the Green Port concept at the Port of Tanjung Perak. With this stated, the PWMShas a role in realizing Green Portat Tanjung Perak Port.

In the implementation of PWMS at Tanjung Perak Port, synergy from internal and external factors is needed to support the success of the implementation of PWMS itself. With the successful implementation of PWMS in Tanjung Perak, it will certainly have a positive impact in helping to minimize waste pollution in the Tanjung Perak Port environment and help in realizing the concept of Green Portat Tanjung Perak Port.

# CONCLUSION

Based on the results of the research from the processing of ship waste report data inthePWMS at Tanjung Perak Port for the period of August 2024 to March 2025 recorded a total of 13320 ships that have submitted reports during the process of arrival and departure. With a note for the data in January and February 2025 it was not included in the data because there was system maintenance in that period which caused the data to be corrupted. According to the number of reported ships, only 1129 ships (8.48%) filled in ship waste data at PWMS, while as many as 12191 ships (91.52%) filled in zero ship waste data at PWMS. This shows that waste reporting on board the ship has not been orderly.

Based on percentage analysis, the average effectiveness level obtained from the number of ships filling waste data in PWMS is 8.48%, which then if included in the percentage category table, the effectiveness level is included in the not yet effective category. With the lowest point occurring in March 2025 at 0% and the highest point occurring in August 2024 at 24.76%.

There are factors that cause the implementation of PWMS at Tanjung Perak Port to be ineffective, include internal factors such as policies and regulations, reporting system, and human resources of regulators. The external factors such as facility availability, collaboration between regulators, shipping parties, and port business entities, also human resources of seafarers.

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