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A Quantitative Study on the Effect of Waste Management and Handling Plans on Marine Pollution in MV. Zaleha Fitrat

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Abtsrak

Pencemaran laut akibat aktivitas pelayaran merupakan isu lingkungan yang mendesak, terutama terkait dengan pengelolaan sampah di atas kapal. Penelitian ini bertujuan untuk menganalisis pengaruh Garbage Management Plan (GMP) dan penanganan sampah terhadap tingkat pencemaran laut pada kapal MV. Zaleha Fitrat. Dengan menggunakan pendekatan kuantitatif deskriptif, data diperoleh melalui survei terhadap 23 awak kapal menggunakan kuesioner yang mencakup pelaksanaan GMP, penanganan sampah, dan persepsi terhadap pencemaran laut. Hasil penelitian menunjukkan bahwa implementasi GMP dan penanganan sampah sebagian besar berada pada kategori tinggi, yaitu masing-masing sebesar 56,52% dan 52,17%. Sementara itu, tingkat pencemaran laut yang dirasakan oleh awak kapal sebagian besar berada dalam kategori rendah (60,87%). Temuan ini mengindikasikan bahwa pelaksanaan GMP yang baik dan penanganan sampah yang sesuai prosedur dapat menurunkan tingkat pencemaran laut. Oleh karena itu, peningkatan pemahaman awak kapal dan pengawasan implementasi prosedur pengelolaan sampah menjadi kunci dalam mitigasi pencemaran laut di sektor pelayaran.

Kata kunci: *garbage management plan, penanganan sampah, pencemaran laut, pelayaran, MARPOL Annex V*

Abtsract

Marine pollution due to shipping activities is a pressing environmental issue, particularly related to waste management on board ships. This study aims to analyze the influence of the Garbage Management Plan (GMP) and waste handling on the level of marine pollution on the MV Zaleha Fitrat. Using a descriptive quantitative approach, data were obtained through a survey of 23 crew members using a questionnaire covering GMP implementation, waste handling, and perceptions of marine pollution. The results showed that the implementation of GMP and waste handling were mainly in the high category, at 56.52% and 52.17%, respectively. Meanwhile, the level of marine pollution perceived by the crew was mainly in the low category (60.87%). These findings indicate that proper implementation of GMP and proper waste handling procedures can reduce the level of marine pollution. Therefore, improving crew understanding and monitoring the implementation of waste management procedures are key to mitigating marine pollution in the shipping sector.

Keywords: *garbage management plan, waste handling, marine pollution, shipping, MARPOL Annex V*

INTRODUCTION

Pollution is the contamination of the environment with substances that harm human health, quality of life, or ecosystem function. While some pollution is natural, such as from volcanic eruptions, most is caused by human activities (Zakir Laghari, 2007). Moreover, marine pollution continues to be a significant global environmental concern, particularly in regions with high shipping traffic. One of the essential sources of marine pollution is waste generated by ships, ranging from domestic refuse to operational waste, much of which is still discharged into the sea, either due to negligence or non-compliance. This occurs despite the existence of international conventions such as MARPOL Annex V, which strictly prohibit the disposal of

most waste types into the marine environment. The International Maritime Organization (IMO), through documents such as the "Guidelines for the Implementation of MARPOL Annex V" (IMO, 2017), emphasizes the need for structured onboard waste handling procedures, waste record documentation, and training for all ship personnel. Studies have shown that improper waste management at sea contributes significantly to marine debris, impacting biodiversity and coastal economies (Andrady, 2011; Vegter et al., 2014). Research published in Marine Pollution Bulletin and Ocean & Coastal Management further confirms that the effectiveness of waste management depends not only on regulatory frameworks but also on the onboard practices and behavioral adherence of seafarers (Hinojosa & Thiel, 2009; Dinmore et al., 2021). Moreover, institutional enforcement and crew competence are consistently identified as critical factors influencing environmental outcomes in the maritime sector (Yliskylä-Peuralahti & Gritsenko, 2022; WMU Journal of Maritime Affairs).

Existing literature has examined various aspects of shipboard waste regulation. Several studies, such as those by Novi (2022) and Widodo & Wahyuni (2020), emphasize the Garbage Management Plan (GMP) as a core compliance mechanism. However, empirical investigations into the actual implementation of GMP and its direct correlation with pollution levels remain limited. The effectiveness of waste management policies ultimately depends on the awareness, understanding, and discipline of the ship crew. In this study, crew awareness is measured through their understanding of the contents and procedures outlined in the GMP, such as knowledge of waste categories, discharge restrictions, and logbook entries. In contrast, technical practices are assessed through real behaviors such as proper waste segregation, use of designated containers, and adherence to disposal procedures. Therefore, this research adopts a quantitative, data-driven approach to evaluate how GMP implementation and waste handling practices among crew members influence perceived levels of marine pollution aboard the MV Zaleha Fitrat. The study aims to contribute a practical perspective to maritime environmental management by offering empirical evidence from an operational merchant vessel, bridging the gap between policy and practice.

The persistent gap between maritime waste regulations and their practical implementation on board ships suggests that regulatory compliance alone is insufficient to reduce marine pollution. The effectiveness of waste management policies depends heavily on the awareness, understanding, and behavioral discipline of crew members. Therefore, it is crucial to go beyond normative or policy-based evaluations and adopt a research approach that empirically examines the actual level of GMP implementation and technical waste-handling practices on ships. This study hypothesizes that a higher level of understanding and adherence to the Garbage Management Plan (GMP) by the crew is significantly associated with lower levels of marine pollution. The core thesis is that individual behavior and technical execution of waste management procedures are the key determinants of environmental outcomes at sea. The novelty of this research lies in its quantitative, data-driven assessment of how the simultaneous implementation of GMP policies and onboard practices directly influences pollution levels. Unlike previous studies that mainly focus on regulatory frameworks, this study provides empirical evidence from an operational merchant vessel, offering a more holistic and realistic understanding of marine pollution management in the shipping sector. In this study, crew awareness is measured through respondents' understanding of the contents and procedures outlined in the GMP document, such as knowledge of waste categories, prohibition clauses under MARPOL Annex V, and internal waste handling protocols. Meanwhile, technical practices refer to the crew's actual waste management behaviors on board, including proper segregation of waste, the use of designated garbage containers based on waste types, operation of food waste comminutors, and adherence to scheduled waste discharge procedures.

By capturing data directly from ship personnel and operational settings, this research intends to bridge the gap between formal policy and everyday practice. The findings are expected to contribute both theoretically and practically, offering empirical insight into how regulatory frameworks are internalized and acted upon by ship crews, and guiding future improvements in maritime environmental policy and onboard waste management systems. Therefore, this study aims to quantitatively assess the relationship between the crew's understanding and implementation of the Garbage Management Plan (GMP) and the level of marine pollution observed aboard the MV Zaleha Fitrat. Specifically, it seeks to evaluate two key independent variables-crew awareness and technical waste management practices-and analysed how these variables influence the dependent variable: perceived pollution levels on board.

METHOD

The research approach used in this study is quantitative research. Thus, quantitative research emphasizes measurable measurements and results that can be explained through numbers that are processed systematically and structured. According to Ali et al. (2022), quantitative research is a type of research that is conducted systematically, organized, and structured. The data collection method for both primary and secondary categories was carried out during sailing practices undertaken by one of the research teams on the MV. Zaliha Fitrat sailed for one year, namely from June 10, 2023, to June 18, 2024. The primary data were obtained from the provided questionnaire, while the secondary data included shipboard waste logs, GMP documents, and relevant MARPOL compliance records, where available. The population was the crew of the MV. Zaleha Fitrat, and the sample used was purposive sampling, where the researchers selected 23 people as respondents and considered them all appropriate people to be asked for information regarding data related to the problem being studied. Those respondents were purposively selected from all departments on board, including deck officers, engineering officers, ratings, and cadets.

The questionnaire consisted of 15 items using a 5-point Likert scale, covering GMP awareness, waste-handling practices, and perceived marine pollution. The instrument was validated through expert judgment and tested for internal consistency using Cronbach’s alpha.

The data analysis used is descriptive analysis, which aims to present a clear and precise picture of a condition or phenomenon based on existing data, without conducting further analysis or drawing general conclusions. According to Riyanto and Arini (2021), descriptive analysis is the process of collecting and presenting data that aims to describe existing conditions, without drawing further conclusions or predictions.

RESULT AND DISCUSSION

This research study presents the results of analyzing the garbage management plan and waste handling for marine pollution on the MV. Zaleha Fitrat can be described as follows:

The Analysis of Garbage Management Plan on MV. Zaleha Fitrat

The inconsistency in the implementation of the Garbage Management Plan aboard MV Zaleha Fitrat can be attributed to three main factors. First, the crew's limited understanding of MARPOL Annex V procedures reflects a lack of adequate training and awareness, which hinders consistent compliance. Second, the ship is constrained by insufficient waste handling facilities, such as limited storage space and a lack of proper segregation equipment, making it difficult to follow standard procedures. Third, weak management oversight results in minimal monitoring and enforcement, allowing improper practices to persist without correction. These factors collectively contribute to the ineffective execution of environmental regulations on board. Moreover, the descriptive Analysis of the Garbage Management Plan on board the MV.

Zaleha Fitrat can be seen from the results of information related to the implementation of the garbage management plan in the following table: (Each variable is grouped into very low, low, high, and very high categories, which are determined based on the mean value and standard deviation):

Table 1. Frequency distribution for garbage management plan:

Class interval	Category	F	%
36,36<X	Very high	2	8,70%
31,695<X≤36,36	High	13	56,52%
27,03<X≤31,695	Low	8	34,78%
X≤27,03	Very Low	0	0%
	Total	23	100%

(Source : Data processed in 2024)

The form of the graphic version can be seen as follows:

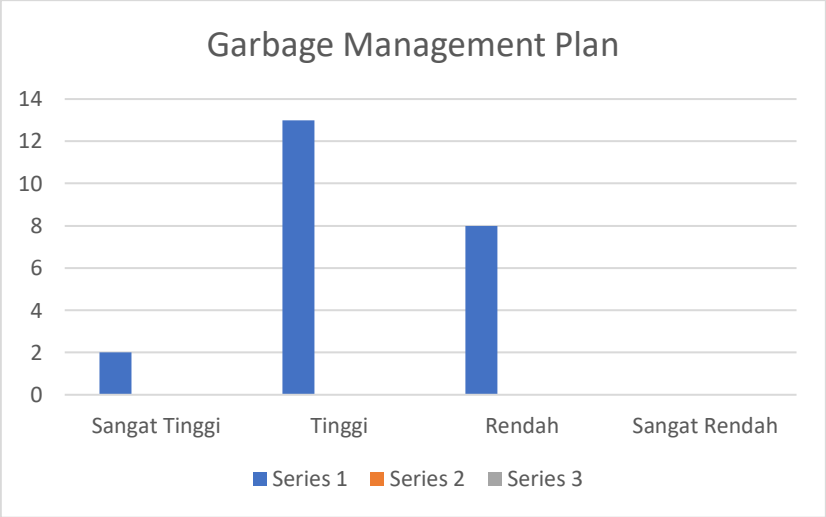

Figure 1. Garbage Management Plan

As shown in table 1 and figure 1, the majority of respondents, fifty-six point five two percent (56.52%), rated the implementation of the Garbage Management Plan (GMP) as high. In contrast, eight point seven zero percent (8.70%) rated it as very high. No respondents rated the implementation as very low; however, thirty-four point seven eight percent (34.78%) perceived it as low, indicating some gaps in procedural understanding and limited supporting facilities (Rijulvita, Thamrin, Suprayogi, & Edyanus, 2023). Overall, these findings suggest that GMP implementation is in place on board the MV. Zaleha Fitrat is generally effective and positively perceived by most crew members, though a notable proportion still considers it suboptimal, reflecting varied adherence levels.

The results of this analysis show that there is a significant relationship between the implementation of the garbage management plan and the level of marine pollution that occurs on the MV Zaleha Fitrat ship.

The Analysis of Waste Management on the MV. Zaleha Fitrat

Common non-compliances under MARPOL Annex V include improper disposal of plastics beyond permitted zones, incomplete garbage record-keeping, misuse or poor maintenance of food comminutors, and inadequate use of port reception facilities. These issues

often arise from insufficient crew training and a lack of onboard resources. For compliance, the Garbage Management Plan (GMP) must clearly outline waste handling procedures aligned with IMO standards. At the same time, the food comminutor must grind food waste to particles no larger than 25 mm and discharge it beyond 12 nautical miles from shore. Proper maintenance and crew training are crucial to ensure adherence to these guidelines.

Therefore, the descriptive analysis of waste management on the MV. Zaleha Fitrat can be seen from the table of results of the calculation of the frequency distribution of waste management, as follows: (Each variable is grouped into very low, low, high, and very high categories, which are determined based on the mean value and standard deviation).

Table 2. Distribution of Waste Handling Frequency

Class Interval	Category	F	%
36,599<X	Very High	1	4,35%
29,173<X≤36,599	High	12	52,17%
21,746<X≤29,173	Low	8	34.78%
X<21,746	Very Low	2	8,70%
	Total	23	100%

(Source : Data processed in 2024)

The form of the graphic version can be seen as follows:

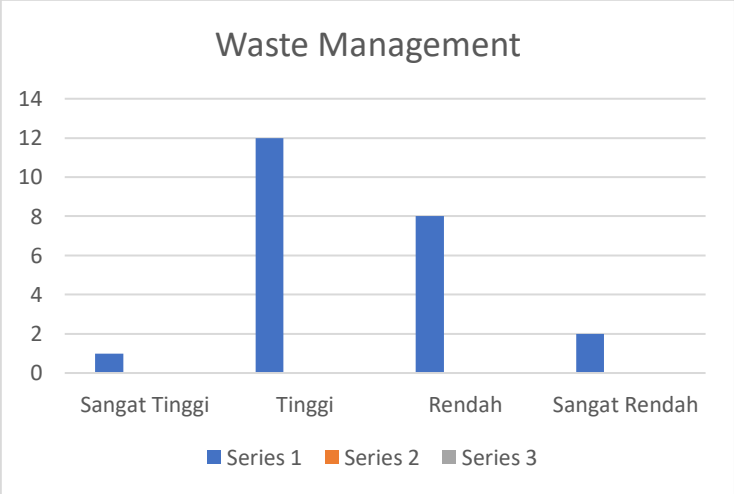

Figure 2. Waste Management

As shown in table 2 and figure 2, and based on the data obtained, one crew member (4.35%) assessed that the level of waste management was in the very high category. Twelve respondents (52.17%) placed waste management in the high category, while eight respondents (34.78%) assessed it in the low category, and two respondents (8.70%) categorized it as very low. This finding indicates that the majority of the crew members of the MV. Zaleha Fitrat assessed that waste management practices had been implemented well, as reflected in the dominant assessment in the high category (52.17%).

However, the proportion of respondents who rated waste management as low to very low (34.78% and 8.70%, respectively) indicates that there is still inconsistency in technical implementation in the field. This indicates that not all crew members are implementing waste

management procedures optimally, particularly in terms of separating waste types and utilizing food comminutors for food waste processing, as recommended by MARPOL Annex V (Novi, 2022).

Moreover, marine pollution serves as the dependent variable (Y) in this study. To measure this variable, a marine pollution scale instrument consisting of eight statements was used. This instrument was distributed to 23 ship crew members via Google Form. After data collection, analysis was conducted, and the results obtained are as presented below: (Each variable is grouped into very low, low, high, and very high categories, determined based on the mean and standard deviation values.)

Table 3. Distribution of Marine Pollution Frequency

Class Interval	Category	F	%
37,086<X	Very High	2	8,70%
32,217<X37,086	High	6	26,08%
27,348<X≤32,217	Low	14	60,87%
X≤27,348	Very Low	1	4,35%
	Total	23	100%

(Source : Data processed in 2024)

The form of the graphic version can be seen as follows:

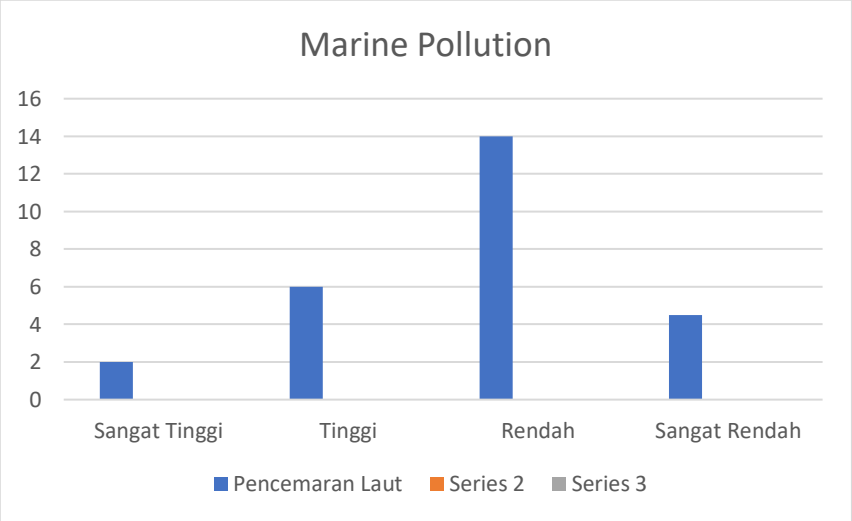

Figure 3. Marine Pollution

As shown in table 3 and figure 3, and based on the data obtained, as many as two crew members (8.70%) assessed that the level of marine pollution was in the very high category. As many as six respondents (26.08%) assessed marine pollution as being in the high category, while the majority of respondents, namely 14 people (60.87%), categorized it as low. Only one respondent (4.35%) assessed marine pollution as very low. From these findings, it can be concluded that the level of marine pollution on board the MV. Zaleha Fitrat is generally in the low category, as indicated by the majority of crew members' perceptions.

The dominance of perceptions in the low category (60.87%) reinforces the assumption that the implementation of the Garbage Management Plan (GMP) and waste handling practices has had a positive impact on marine pollution control efforts (Widodo & Wahyuni, 2020). However, the persistence of perceptions of marine pollution in the high (26.08%) to very high (8.70%) categories indicates that the implementation of procedures is not yet entirely uniform or consistent across all parts of the ship.

These findings align with previous studies confirming that marine pollution is generally caused by human activities, particularly in the shipping sector (Prawitasari, 2022; Idrus, Husen, Qamar 2023). In this regard, GMP serves not only as an administrative document but also as a technical guideline that must be understood and internalized by all crew members to ensure its effectiveness.

Furthermore, the success of GMP implementation also depends heavily on the availability of supporting facilities and infrastructure, both on board ships and at ports. Improving waste management facilities and implementing monitoring procedures are crucial to support this goal (Rijulvita, Thamrin, Suprayogi, & Edyanus, 2023).

Therefore, effective ship waste management requires a synergy between technical understanding by crew members, compliance with international regulations, and adequate infrastructure support. These steps are crucial for maintaining the sustainability of marine ecosystems and comprehensively and sustainably complying with MARPOL Annex V requirements.

CONCLUSION

From the above study, it can be concluded that: 1) The garbage management plan has indicated potential influence on the level of marine pollution on the MV. Zaleha Fitrat. Thus, the implementation of an effective and well-managed garbage management plan can reduce the negative impact on marine pollution caused by the MV. Zaleha Fitrat, 2). Effective waste management has a significant positive effect on reducing the level of marine pollution on the MV. Zaleha Fitrat. This means that the better and more appropriate the waste handling procedures applied, the greater the possibility of reducing the level of marine pollution caused by the MV. Zaleha Fitrat, 3). When the garbage management plan and waste management are carried out correctly and work simultaneously, they can have a significant positive impact on reducing marine pollution on the MV. Zaleha Fitrat.

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