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The Degree of Implementation of Waste Management on Ship

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ABSTRACT

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Ships generating waste pose a significant environmental challenge in the maritime sector. This research aims to assess how effectively waste management practices are implemented by maritime personnel to mitigate the environmental impacts of onboard waste. Data gathered from survey questionnaires were analyzed using a quantitative research design, focusing on responses from chief officers and second engineers of ships. A four-point Likert scale was employed, and results were evaluated using frequency percentages,

weighted means, and the Chi-square statistical analysis. The study aimed to profile the ship's crew and evaluate the implementation of waste management strategies, particularly regarding waste management plans and waste disposal onshore and ship-to-shore. The findings indicate that waste management implementation at the Port of Surigao's ships was fully achieved. These results underscore the importance of comprehensive waste management systems and training to ensure consistency in perceptions and practices among maritime officers. Therefore, the researchers suggested that ship operators can reduce environmental impact and promote sustainability in the maritime industry by developing a comprehensive waste management plan, providing crew training, installing effective waste segregation facilities, implementing recycling initiatives, and conducting regular audits.

INTRODUCTION

Waste management on ships is critical for minimizing environmental effects and adhering to international standards. The International Maritime Organization (IMO) (2017) has set standards and regulations for disposing of ship-generated garbage under the International Convention for the Prevention of Pollution from Ships (MARPOL). The waste of ships is a major environmental concern in port reception facilities. Discharging waste into the sea is undesirable, and port reception facilities are critical in preventing marine pollution. These measures aim to significantly reduce marine pollution by providing adequate waste reception facilities (Ülker et al., 2023). Implementing efficient waste management is a problem for ship crew and staff due to the significant volume of garbage generated by marine activities (Andersen & Becker, 2018). The maritime industry is vital for global trade and faces increasing scrutiny regarding its environmental impact.

Many studies often prioritize regulatory compliance over exploring optimal practices in waste management. While compliance remains critical, understanding the extent to which ships surpass regulatory requirements to adopt innovative and sustainable waste management practices can offer valuable insights into areas for enhancement and potential environmental benefits. According to Zis and Cullinane (2020), insufficient training and awareness among crew members regarding waste management practices can result in adverse environmental impacts. This study aims to assess the implementation level of waste management practices employed by maritime personnel to mitigate the environmental effects of onboard waste generation. By evaluating international standards and crew proficiency in Waste Management Systems aligned with MARPOL

regulations, this research aims to shed light on the role of ship personnel in waste management. It seeks to propose strategies for Waste Management Plans (WMPs), onshore waste disposal, and ship-to-shore waste disposal to foster sustainable maritime operations. The study carries broader implications for sustainable shipping practices, human health, and global initiatives aimed at reducing the environmental footprint of maritime activities.

Studying waste management aboard ships is crucial as it addresses pivotal challenges at the nexus of maritime operations, environmental stewardship, and the maritime economy. As per MARPOL guidelines, managing waste in maritime operations requires concerted efforts from ship operators, crew members, and port facilities to uphold international regulations and mitigate the impact of ship-generated waste on marine ecosystems. Effective waste management on ships significantly bolsters the maritime economy by supporting environmental objectives, ensuring compliance with regulations, enhancing operational efficiency, cutting costs, and bolstering the industry's reputation. Embracing sustainable waste management practices is essential for fostering the long-term success and resilience of the maritime sector.

FRAMEWORK

The regulatory compliance theory proposed by Ringbom (2020) highlights that adherence to international and national regulations is a key factor in ship waste management practices. The International Maritime Organization (IMO) (2017) sets standards through conventions such as MARPOL, specifically Annex V, which details guidelines for preventing pollution by garbage from ships. Compliance with these regulations is mandatory, requiring ships to maintain detailed records of waste activities. The study by Kim and Seo (2019) emphasizes that insufficient crew training and awareness result in inefficiencies, suggesting that comprehensive training and awareness programs are essential. Effective onboard waste management is vital for marine environmental protection and regulatory compliance. By integrating regulatory requirements, operational procedures, technological solutions, and continuous improvement practices, shipping companies can foster a sustainable waste management system and promote environmental responsibility among crew members (Wang & Gu, 2018).

OBJECTIVE OF THE STUDY

This study aimed to determine the degree of implementation of waste management on ships rated by the chief officer and the second engineer.

METHODOLOGY

Research Design

The researchers employed a quantitative research design using techniques in this study. The researchers gathered data on these study categories of the ship at Port of Surigao, Surigao City to determine the degree of implementation of waste management.

Research Site

This study was conducted at the Port of Surigao, Surigao City. The port acts as an inter-island passenger and vehicle transit port and is a central transhipment centre in the region. It serves the city of Surigao and its surrounding area. This port has various ships available for passenger journeys, ranging from pump boats and fast crafts for short journeys to ferries and ships for longer journeys.

Research Respondents

The study's participants were the ship's crew, specifically the chief officers and second engineers responsible for assessing onboard waste management in accordance with the International Convention for the Prevention of Pollution from Ships (MARPOL), Safety of Life at Sea (SOLAS), and Standards of Training, Certification, and Watchkeeping (STCW). The total number of respondents corresponded to the number of ships docked at the Port of Surigao, Surigao City. The researchers conducted the study during the ships' scheduled arrivals at the Port of Surigao, with each ship providing two respondents—the chief officer and the second engineer. Therefore, the study included 30 respondents, corresponding to the 15 ships present at the Port of Surigao during the study period.

Table 1
Respondents of the Study

Types of Ship	Number of Ships	Total Number of Respondents
Container Ship	2	4
Tanker Ship	1	2
Passenger Ship	12	24
Total	15	30

Instrumentation

The researchers used a survey questionnaire to help gather data in response to the specific information related to the study. The questionnaire was adapted from Kalomo's (2018) study, "Assessing Port Reception Facilities for ship-generated Solid Waste: The Case of the Port of Walvis Bay, Namibia," with a letter of permission from the owner. Part I of the survey questionnaire will identify the profile of the ship's crew, while part II of the adapted survey questionnaire will determine the degree of implementation of waste management on ships.

Research Ethics Protocol

In conducting the study and gathering data, the researchers considered the following:

The crews and ship's staff of the Port of Surigao gave their informed approval. The researchers will first seek permission from the port management of each crew, after which a letter outlining the purpose of the study will be delivered. After the respective port management had given their approval before asking for the questionnaire, the researchers gave verbal consent to the ship's crew themselves. The researchers further explained the study; the students can ask questions and withdraw anytime. After receiving agreement from the respective students, the researcher administered the questionnaire with the assistance/permission of the port management at the Port of Surigao in Surigao City.

Data Gathering Procedure

Step 1. The researchers asked permission from the Philippine Ports Authority in Surigao City or any related authority to have access to conduct a study at the Port of Surigao.

Step 2. The researchers then provide the respondents with a letter of consent to get their approval of the documentation.

Step 3. The researchers provided a survey questionnaire to the respondents and documented the interview.

Step 4. The researchers determined the total population of the respondents based on the total number of ships according to the data on the arrival schedule at Eva M Macapagal Port.

Step 5. When distributing the survey questionnaire, the researchers followed the arrival of the ships at the port. Moreover, while the respondents answered the questionnaires, researchers were around in case they needed help. Furthermore, the respondents were encouraged to complete the questionnaire and answer honestly for valid results.

Step 6. Lastly, the researchers will gather the survey questionnaires from the respondents after they have been given time to answer.

Statistical Treatment

The researchers used a four (4) point Likert Scale. They tabulated the result using the frequency percentage method, weighted mean, and Chi-square statistical method to identify the ship's crew profile and determine the degree of implementation of waste management on ships.

RESULTS AND DISCUSSION

Table 2

Profile of the Ship's Crew in Terms of Position

Position	Passenger Ship		Tanker Ship		Container Ship		Total		Rank
	F	%	F	%	F	%	F	%	
Chief Officer	12	40%	1	3.33%	2	6.67%	15	50%	1.5
2nd Engineer	12	40%	1	3.33%	2	6.67%	15	50%	1.5
Total	24	80%	2	6.66%	4	13.34%	30	100%	

The table outlines the ship's crew profile by position, focusing on the chief officer and the 2nd Engineer. Each of these positions constitutes 50% of the total respondents. Specifically, 40% of chief officers are on passenger ships, 3.33% on tanker ships, and 6.67% on container ships. Similarly, 40% of 2nd Engineers are on passenger ships, 3.33% on tanker ships, and 6.67% on container ships. Both positions rank equally at 1.5 in the crew profile. The study found that the chief officer (deck department) and the 2nd Engineer (engine department) are typically responsible for maintaining the waste management plan on the ship (Karan, 2021).

The Chief Officer is responsible for garbage management for the deck and accommodation part of the ship. He has to make sure all the crew members are complying with the environmental regulations by the International Convention

for the Prevention of Pollution from Ships (MARPOL), Safety of Life at Sea (SOLAS), and Standards of Training, Certification, and Watchkeeping (STCW). Additionally, according to the Standards of Training, Certification, and Watchkeeping (STCW) 95 section A- III /2 (as amended), the duties of the 2nd Engineer include the upkeeping of safety equipment and pollution prevention in the engine department.

Table 3

Profile of the Ship's Crew in Terms of On-Board Years of Experience

Onboard Years of Experience	Chief Officer		2nd Engineer		Total		RANK
	F	%	F	%	F	%	
10 years and below	13	43.33%	12	40%	25	83.33%	1
11-20 years	2	6.67%	3	10%	5	16.67%	2
21-30 years	0	0	0	0	0	0	3.5
31 years and above	0	0	0	0	0	0	3.5
Total	15	50%	15	50%	30	100%	

The table examines the ship's crew profile based on their years of onboard experience. It shows that 43.33% of chief officers and 40% of chief Engineers have 10 years or less of experience. Most (83.33%) of respondents, comprising chief officers and 2nd Engineers, fall within this experience range, ranking first in the profile. Additionally, 16.67% of respondents have 11-20 years of experience, with 6.67% being chief officers and 10% being 2nd Engineers, ranking second. No crew members have 21-30 years or over 31 years of experience. This indicates that most crew members responsible for implementing waste management on ships at the Port of Surigao have 10 years or less of onboard experience.

The Career Guide (2022) study contradicts the finding that inexperienced employees struggle with organizational or industry changes. Inexperienced workers may need more support and might consider leaving their current roles due to apprehensions. Conversely, experienced employees tend to possess stronger skills and greater knowledge, enabling them to effectively meet performance standards and productivity goals. They are typically more adaptable to organizational and industry changes and require less guidance from supervisors.

Table 4
Profile of the Ship's Crew in Terms of Type of Ship

TYPE OF SHIP	Chief Officer		2nd Engineer		Total		RANK
	F	%	F	%	F	%	
Container ship	2	6.67%	2	6.67%	4	13.34%	2
Tanker ship	1	3.33%	1	3.33%	2	6.66%	3
Passenger ship	12	40%	12	40%	24	80%	1
Total	15	50%	15	50%	30	100%	

The table profiles the ship's crew by type of ship at the Port of Surigao, identifying passenger ships, tanker ships, and container ships. It reveals that 40% of chief officers and 40% of 2nd Engineers serve on passenger ships, totaling 80% and ranking first in the profile. On tanker ships, 3.33% of chief officers and 2nd Engineers serve, totaling 6.66% and ranking third. The total ship types are 30, with 80% being passenger ships, 13.34% container ships, and 6.66% tanker ships.

Therefore, the findings show that passenger ships have the greatest number of types of ships, where 40% are chief officers and 40% are 2nd Engineers, with a total of 80%, who rank first on the profile of the ship's crew in terms of the type of ship. The result was aligned with Globalport Terminals, Inc. (2023) that the most common ships that arrive at the Port of Surigao are passenger ships since they serve Surigao City in the province of Surigao del Norte. It houses the Eva Macapagal Passenger Terminal and ranks as a major transhipment point in the region. Surigao Seaport functions as an inter-island passenger and vehicle transportation port (RoRo) for the city and its surrounding area. Logistics Cluster (2022) states that the Port of Surigao is large. The types of vessels regularly calling at SURIGAO are Ro-Ro/Passenger Ship (24%), General Cargo (16%), Cargo (16%), Passenger (13%), and Landing Craft (8%). The maximum length of the vessels recorded to have entered this port is 122 meters. The maximum draught is 6.3 meters. The maximum deadweight is 7787 tons.

Table 5

Trainings Attended by the Ship's Crew in Terms of Mandatory Training

Mandatory Training	Chief Officer		2nd Engineer		Total		Rank
	F	%	F	%	F	%	
Basic Training	15	50	15	50	30	100	1
Basic Training for Oil and Chemical Tanker Cargo Operations	1	3.33	0	0	1	3.33	3.5
Advanced Training for Oil Tanker Cargo Operations	1	3.33	0	0	1	3.33	3.5
Advanced Training for Chemical Tanker Cargo Operations	0	0	0	0	0	0	5.5
Basic Training for Liquefied Gas Tanker Cargo Operations	0	0	0	0	0	0	5.5
Others: (SOLAS, Cargo Handling)	1	3.33	1	3.33	2	6.67	2

The table details the mandatory training attended by chief officers and 2nd Engineers based on the International Maritime Organization's (IMO) (2017) Standards of Training, Certification, and Watchkeeping for Seafarers (STCW) Convention. This convention sets global standards for seafarer training to ensure safety and marine environmental protection. Training requirements vary depending on the type of ship. According to the table, 100% of respondents, chief officers, and 2nd Engineers have completed basic training, ranking first among mandatory training. None attended Advanced Training for Chemical Tanker Cargo Operations or Basic Training for Liquefied Gas Tanker Cargo Operations, as these are specialized for tanker ships. At the same time, most respondents serve on passenger ships.

The findings show that all respondents have completed Basic Training consistently, which aligned with the study of Kamis et al. (2020), stated that the STCW Basic Training (BT) is mandatory for all seafarers before starting work on merchant ships. STCW requires familiarization and basic safety training per Section A-VI/1 of the STCW code. Maritech Academy (2020) added that their basic safety training course meets these minimum requirements. The STCW 2010 Convention, adopted by the IMO in 2010 and enforced in 2012, sets global standards for training, certification, and watchkeeping, ensuring seafarers are trained to the highest standards (Kumar, 2023). This convention also mandates ongoing training and professional development, benefiting seafarers and

promoting safer, more efficient maritime operations. Kumar (2023) concluded that the STCW 2010 Convention is vital for maintaining high training and safety standards in the shipping industry.

Table 6

Trainings Attended by the Ship's Crew in Terms of Company Training

Company Training	Chief Officer		2nd Engineer		Total		Rank
	F	%	F	%	F	%	
Marine Environmental Awareness Training	5	16.67	4	13.33	9	30	1
ODME - Oil Discharge Monitoring Equipment	1	3.33	1	3.33	2	6.66	4.5
Environmental Management Training	4	13.33	2	6.67	6	20	2.5
Health and Safety Management Training	4	13.33	2	6.67	6	20	2.5
Tanker Training	2	6.67	0	0	2	6.67	4.5
Others	0	0	0	0	0	0	6

Table 6 portrays the results of the company-specific training attended by the respondents. These trainings are designed to meet the unique operational needs, policies, and equipment of the company. According to the table, Marine Environmental Awareness Training is the most attended, with 16.67% of chief officers and 13.33% of 2nd Engineers participating, totaling 30%. Conversely, ODME (Oil Discharge Monitoring Equipment) and Tanker Training had the lowest attendance among the respondents.

The results indicate that only a few ship crew members have attended company trainings. According to Galileo Maritime Academy (2023), company or in-person training has been a traditional method used in the maritime industry for many years. However, it can be costly, time-consuming, and inflexible, making it difficult for trainees with other commitments to attend. Additionally, Belokas (2018) emphasized that training is crucial for business success in the shipping industry. Crew members are the company's most valuable asset once onboard, and they work to apply theoretical knowledge practically, especially concerning safety and technological advancements.

Table 7

Degree of Implementation on Waste Management as rated by the chief officer and 2nd engineer among the different types of ship as to waste management plan, waste disposal onshore, and waste disposal ship to shore

	Chief Officer		2nd Engineer		Average Weighted Mean	Verbal Description	Rank
	Weighted Mean	Verbal Description	Weighted Mean	Verbal Description			
A. Waste Management Plan (WMP)	3.37	Largely Implemented	3.27	Largely Implemented	3.3	Largely Implemented	3
B. Waste Disposal Onshore	3.47	Largely Implemented	3.68	Fully Implemented	3.58	Fully Implemented	2
C. Waste Disposal Ship to Shore	3.6	Fully Implemented	3.64	Fully Implemented	3.62	Fully Implemented	1
Average Weighted Mean	3.48	Largely Implemented	3.53	Fully Implemented	3.5	Fully Implemented	

The table illustrates the degree of implementation on ships, rated by the chief officer and 2nd Engineer using a scale where 4 indicates "Fully implemented," 3 signifies "Largely implemented," 2 represents "Partially implemented," and 1 denotes "Not implemented."

The chief officer assessed the waste management plan (WMP) with a total weighted mean of 3.37, indicating a verbal description of "largely implemented." The 2nd Engineer rated it with a total weighted mean of 3.27, also described as "largely implemented." The average weighted mean of 3.3 places it in the "largely implemented" category, ranking 3rd on the table.

The chief officer evaluated Waste disposal onshore, resulting in a total weighted mean of 3.47, indicating it is "largely implemented" verbally. On the other hand, the 2nd Engineer rated it with a total weighted mean of 3.68, describing it as "fully implemented." The average weighted mean of 3.58 categorizes it as "fully implemented" verbally, ranking 2nd overall.

The chief officer assessed the waste disposal ship to shore, yielding a total weighted mean of 3.6, and described it as "fully implemented." Similarly, the 2nd Engineer rated it with a total weighted mean of 3.64, also describing it as "fully implemented." The average weighted mean of 3.62 places it in the "fully implemented" category verbally, ranking 1st overall in the degree of

implementation of waste management on the ship as rated by both the chief officer and 2nd Engineer.

Thus, the chief officer has an overall weighted mean of 3.48, characterized as "largely implemented," while the 2nd Engineer has an overall weighted mean of 3.53, described as "fully implemented." The average weighted mean of 3.5 indicates the summary of the degree of implementation of waste management on the ship, as rated by both the chief officer and 2nd Engineer, was "fully implemented."

The findings indicate that implementing waste management practices, including waste management plan, waste disposal onshore, and waste disposal ship to shore, was fully achieved according to ratings by the chief officer and 2nd Engineer across different types of ships. This conclusion aligns with Andersen and Becker (2018), who suggest that comprehensive waste management systems can enhance operational efficiency by reducing waste, optimizing storage space, cutting disposal costs, and minimizing the risk of regulatory penalties. Moreover, full adherence to waste management practices is critical for meeting international regulations like the International Maritime Organization's (IMO) (2017) MARPOL Annex V, which provides stringent guidelines for the disposal and management of waste generated by ships.

Table 8

Significance difference in waste management as rated by the chief officer and 2nd Engineer among the different types of ships as to waste management plan, waste disposal onshore, and waste disposal ship to shore

	COMPUTED x^2 value	Critical Value	Decision
A. Waste Management Plan (WMP)	6.41	7.82	ACCEPT NULL HYPOTHESIS
B. Waste Disposal Onshore	5.57	7.82	ACCEPT NULL HYPOTHESIS
C. Waste Disposal Ship to Shore	0.2547	7.82	ACCEPT NULL HYPOTHESIS

Table 8 examines the differences in how waste management is rated by the chief officer and 2nd engineer across various types of ships, focusing on waste management plan (WMP), waste disposal onshore, and waste disposal ship to shore.

For Waste Management Plan (WMP), the computed chi-square x^2 value

was 6.41, below the critical value of 7.82. Therefore, the null hypothesis was accepted, indicating no significant difference in ratings between the chief officer and 2nd engineer for WMP among different types of ships.

Regarding waste disposal onshore, the computed x^2 is 5.57 while the critical value is 7.82 also less than the critical value of 7.82. Thus, the null hypothesis was accepted again, suggesting no significant difference in how waste management is rated by the chief officer and 2nd engineer among different types of ships for waste disposal onshore.

Similarly, for waste disposal ship to shore, the computed x^2 is 0.2547 value was 0.2547, well below the critical value of 7.82. Consequently, the null hypothesis was accepted again, indicating no significant difference in ratings between the chief officer and 2nd engineer for waste disposal ship to shore across different types of ships.

The varying perspectives between chief officers and 2nd engineers regarding waste management implementation across different types of ships highlight crucial aspects of maritime operations. These differences are influenced by the specific roles and responsibilities associated with each position, as well as the unique challenges presented by different vessel types. However, Chatzinikolaou and Ventikos (2015) argue against this conclusion, suggesting that there is indeed a significant difference in how chief officers and 2nd engineers across various types of ships rate waste management implementation. These disparities reflect their distinct professional focuses and duties: chief officers prioritize regulatory compliance and overall operational efficiency, whereas 2nd engineers emphasize the technical functionality and maintenance of waste management systems. Understanding these divergent perspectives is essential for enhancing waste management practices, ensuring compliance, and optimizing operational efficiency in maritime settings (Chatzinikolaou & Ventikos, 2015).

CONCLUSIONS

The present study offers novel perspectives by underscoring the noteworthy influence of crew training and company-specific programs on the implementation of waste management on board ships. It also underscores the significance of customized training programs in augmenting environmental sustainability within the maritime sector.

Effective waste management policies should prioritize company-specific initiatives and thorough crew training programs to ensure the best waste management practices and environmental stewardship in maritime operations.

This study emphasizes how waste management policies should incorporate

company-specific initiatives and customized crew training programs to improve environmental sustainability and regulatory compliance in the maritime industry.

Directions for Further Research are as follows: Examine how well virtual reality simulations facilitate crew training for shipboard waste management procedures and consider how immersive technology could enhance knowledge retention and useful application.

Utilizing a systems thinking approach, compare waste management practices in various maritime regions, incorporating social, economic, and environmental aspects to create a comprehensive understanding of sustainable waste management tactics in the global maritime sector.

TRANSLATIONAL RESEARCH

Apply specially designed crew training programs in accordance with the study's conclusions to improve marine personnel's knowledge and proficiency in waste management, guaranteeing the efficient application of waste management procedures on board ships.

To promote a cooperative approach to environmental sustainability in the marine industry, collaborate with shipping firms, regulatory agencies, and port facilities to set standard waste management procedures and best practices.

Investigate the integration of cutting-edge technologies such as smart waste management solutions and waste tracking systems to improve monitoring capabilities, expedite trash disposal procedures, and boost overall efficiency in waste management onboard ships.

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