

EVALUATION OF SHIPBORNE BLACKWATER DISCHARGE PRACTICES AND MARPOL ANNEX IV COMPLIANCE IN RIVERS STATE.

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Abstract

This study evaluates shipborne blackwater discharge practices and compliance with MARPOL Annex IV regulations in Rivers State, Nigeria. Using survey data from 121 maritime professionals, including ship crew, port officials, and regulatory officers, the research reveals significant non-compliance and operational challenges. Findings show that 76.9% of vessels lack onboard sewage treatment plants, 43% discharge untreated blackwater directly into the sea, and 81% do not conduct regular maintenance of treatment systems. Moreover, 83.5% of respondents lack training on proper discharge procedures, and 73.5% are unaware of penalties for non-compliance. Port reception facilities are widely perceived as inadequate, inaccessible, and expensive, contributing to illegal discharges. Enforcement of MARPOL Annex IV is viewed as weak or absent by over 70% of participants. The study concludes that improving compliance requires stricter enforcement, enhanced training, public awareness, and investment in affordable port waste reception infrastructure to protect marine environments and promote sustainable maritime operations in the region.

Keywords: Shipborne blackwater, Marine pollution, Ship waste regulations, Environmental protection, Shipping industry.

1. Introduction

The maritime sector plays a pivotal role in the global and national economy, facilitating the movement of goods and services across continents. However, this sector also contributes significantly to marine pollution, particularly through the discharge of ship-generated waste such as blackwater. Blackwater refers to wastewater from toilets, medical facilities, and other sources on vessels that contains fecal matter and pathogens

(United States Environmental Protection Agency [USEPA], 2010). If inadequately treated or improperly discharged into the marine environment, blackwater can have serious environmental and public health consequences, particularly in coastal regions like Rivers State, Nigeria (Ogboeli, et al., 2025).

Rivers State, located in the Niger Delta region of Nigeria, hosts several active seaports, including the Port Harcourt Port Complex, Onne Port, and Bonny Port. These ports handle a high volume of maritime traffic comprising commercial vessels, offshore supply boats, and oil tankers (Nigerian Ports Authority [NPA], 2023). The cumulative effect of blackwater discharges from these vessels contributes to the degradation of coastal water quality, threatens aquatic ecosystems, and poses health risks to local populations who rely on these waters for fishing, recreation, and domestic use (Aroh et al., 2010).

Globally, efforts to regulate the discharge of ship-generated sewage are governed under Annex IV of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78). This Annex, adopted in 2003, prohibits the discharge of untreated sewage into the sea and mandates that ships must be equipped with approved sewage treatment plants, sewage holding tanks, or discharge connections to port reception facilities (International Maritime Organization [IMO], 2021). Annex IV is binding for all ships over 400 gross tonnage and for all passenger vessels, regardless of size, on international voyages. Compliance is monitored through a system of inspections, certification, and enforcement by flag and port states.

Despite Nigeria's status as a signatory to MARPOL and its incorporation of international conventions into national maritime law through the Nigerian Maritime Administration and Safety Agency (NIMASA), there are concerns about weak enforcement mechanisms and limited monitoring capacity (Okonkwo & Agu, 2018). Specifically, in the maritime jurisdiction of Rivers State, anecdotal evidence suggests that many vessels continue to discharge untreated or partially treated blackwater directly into the sea or creeks due to the unavailability of functional port reception facilities, lack of operational sewage treatment systems on vessels, and inadequate regulatory oversight (Chukwu, 2016; Udoh et al., 2021; Ogboeli, et al., 2025)

The environmental consequences of such practices are well documented. Untreated sewage introduces high levels of nutrients, bacteria, viruses, and parasites into marine environments. This results in eutrophication, depletion of dissolved oxygen, and contamination of marine organisms, thereby threatening biodiversity and affecting the livelihoods of fishing communities (Ogamba et al., 2020; Ogboeli, et al., 2025). Furthermore, human exposure to polluted coastal waters, either directly or through the consumption of contaminated seafood, is linked to gastrointestinal diseases, skin

infections, and other public health challenges (World Health Organization [WHO], 2018).

Rivers State, as a major industrial and maritime hub, faces the dual challenge of promoting port development while ensuring sustainable environmental practices. While the Nigerian government has made efforts to implement port waste reception facilities in selected ports, the coverage, functionality, and accessibility of these facilities remain questionable. For example, NIMASA and NPA have reported operational gaps and infrastructural inadequacies in enforcing MARPOL compliance at smaller or privately managed terminals (NIMASA, 2022). Moreover, there is a dearth of local empirical data on the current shipborne blackwater discharge practices, the level of compliance with MARPOL Annex IV among shipping operators, and the capacity of port authorities to monitor and regulate such discharges effectively.

Several studies have examined marine pollution in the Niger Delta, focusing on oil spills, ballast water, and solid waste (Ekpo et al., 2013; Obunwo et al., 2022; Ogboeli, et al., 2025). However, the specific issue of blackwater discharge and its regulation under international maritime law remains under-researched. Understanding the status of compliance and the challenges facing enforcement agencies in Rivers State is essential for developing targeted interventions, improving regulatory frameworks, and safeguarding the coastal marine environment.

Additionally, ship operators' level of awareness, the technical capabilities of sewage treatment plants onboard vessels, and the economic or logistical disincentives to using port reception facilities also merit investigation. Non-compliance may be driven not only by regulatory lapses but also by operational cost considerations, lack of training, or insufficient collaboration between port operators and environmental agencies (Oluwatosin & Adeyemi, 2019). Without accurate data and a comprehensive evaluation, policy responses will continue to be fragmented and ineffective.

In this context, evaluating shipborne blackwater discharge practices and the level of MARPOL Annex IV compliance within Rivers State is both timely and crucial. Such an evaluation will provide empirical evidence to guide environmental policy, improve maritime waste management systems, and strengthen institutional capacities for monitoring and enforcement. Moreover, the findings can serve as a baseline for future studies and contribute to regional efforts toward sustainable marine governance in West Africa.

The study is therefore guided by the need to answer the following critical questions:

- What are the current practices of shipborne blackwater discharge in Rivers

State?

- To what extent are vessels calling at the state's ports compliant with MARPOL Annex IV regulations?
- What challenges do regulatory authorities and shipping companies face in achieving full compliance?

Addressing these questions will help identify the policy, infrastructural, and technical gaps that need to be bridged to ensure environmentally responsible maritime operations. In the long run, this will enhance Nigeria's credibility in global maritime governance, promote the health and wellbeing of coastal communities, and support the achievement of the United Nations Sustainable Development Goal 14 on the conservation and sustainable use of oceans and marine resources (UN, 2015).

2. Materials And Methods

The Onne seaport is situated in the town of Onne, which is part of Port Harcourt. It is positioned at a geographical longitude of 4°43'10.11"N and a latitude of 7°9'10.11"E. As an urban area within Port Harcourt, it encompasses an estimated land area of approximately 186 square kilometers, contributing to the overall metropolitan expanse of 462km². According to the 2006 census, the population was recorded at 1,230,114, within a total metropolitan population of the same year (NPC, 2006). Applying a growth rate of 2.54%, the population is projected to be around 1,580,806 by 2016. The Onne Port Complex was established as a 'Free Port Zone' (FPZ) to act as a central hub for the oil and gas sector in West Africa. This complex, which originated in 1982 as the Federal Lighter Terminal (FLT), has developed significantly over the years, primarily due to Public/Private Partnerships. The Onne Port Complex is located along the Bonny Estuary on Ogu Creek, approximately 25 kilometers south of Port Harcourt, in Rivers State, Nigeria. The geographical scope of the Port extends from NAFCON (now known as NOTORE) Jetty to Bonny Island. It traverses three Local Government Areas in Rivers State, namely Eleme, Ogu-Bolo, and Bonny. The land area, which covers around 2,500 hectares, is located within the Eleme Local Government Area, while the access channel to the Port runs along the Bonny River and Ogu Creek, within the jurisdictions of Bonny and Ogu-Bolo Local Government Areas. These ports serve as key points for offshore support vessels, crude oil tankers, fishing trawlers, and international cargo ships. The state's extensive waterways, proximity to industrial operations, and population centers make it particularly vulnerable to the environmental impacts of shipborne waste discharges (Nigerian Ports Authority [NPA], 2023).

This study employed a mixed-methods research design, combining quantitative data collection through structured questionnaires with qualitative insights from key informant interviews and field observations. The rationale for adopting a mixed-methods approach was to comprehensively evaluate both the practices surrounding

shipborne blackwater discharge and the level of compliance with MARPOL Annex IV regulations in Rivers State, Nigeria. This methodological triangulation allowed for a more nuanced understanding of compliance behavior, infrastructural limitations, and institutional enforcement dynamics in the maritime sector.

The target population for this study included:

- Ship crew members (chief engineers, captains, environmental officers),
- Port and terminal operators,
- Officials from the Nigerian Maritime Administration and Safety Agency (NIMASA) and
- Environmental regulators (Federal Ministry of Environment, Nigerian Ports Authority),
- Private waste reception facility operators.

To ensure representative coverage across different vessel types and regulatory bodies, a stratified purposive sampling technique was adopted. The population was stratified by stakeholder group (vessel type, agency, and terminal location). Within each stratum, participants were selected based on availability, willingness to participate, and relevance to the research objectives.

A total of 150 participants were targeted, consisting of:

- 60 ship crew members (from 20 vessels),
- 40 port officials,
- 30 regulatory officers, and
- 20 private reception facility staff.

This sample size was considered sufficient based on saturation principles commonly used in qualitative-dominant mixed methods research (Creswell & Plano Clark, 2018).

A structured questionnaire was administered to ship crew members and port operators.

The questionnaire was divided into three sections:

- Section A collected demographic and professional background information (e.g., years of experience, type of vessel).
- Section B addressed blackwater discharge practices, including the presence of sewage treatment systems, use of holding tanks, and port reception facilities.
- Section C examined compliance with MARPOL Annex IV, including awareness levels, certification, inspection history, and perceived challenges.

The questionnaire was validated by three maritime environmental experts, and a pre-test was conducted with 10 respondents at the Port Harcourt Port to refine clarity and content relevance.

Semi-structured interviews were conducted with:

- NIMASA enforcement officers,

- Port health officers,
- Environmental protection officers,
- Terminal managers, and
- Reception facility operators.

A total of 20 key informants participated. The interviews explored institutional perspectives on MARPOL enforcement, infrastructure readiness, inter-agency collaboration, and policy challenges. Each interview lasted 30–45 minutes and was audio-recorded with informed consent.

Direct observational checklists were used to assess:

- Presence and functionality of sewage treatment plants onboard selected vessels,
- Availability and accessibility of port reception facilities,
- Visual evidence of blackwater discharge points near jetties and port channels.

Field observations were conducted at Onne, Port Harcourt, and Bonny ports over a six-week period. Photographs were taken to document infrastructural conditions, and notes were recorded systematically using a standardized logbook.

The quantitative data from questionnaires were coded and analyzed using Statistical Package for Social Sciences (SPSS) version 25.0. Descriptive statistics such as frequencies, percentages, and means were used to summarize demographic characteristics and blackwater discharge practices.

To test the relationship between vessel characteristics (e.g., vessel size, age) and MARPOL compliance, chi-square tests and binary logistic regression were conducted. The level of significance was set at $p < 0.05$.

Ethical Considerations: Ethical approval for the study was obtained from the Ethics Committee of the Faculty of Environmental Sciences, University of Port Harcourt. Participation was voluntary, and all participants were assured of confidentiality and anonymity. Verbal and written informed consent was obtained from each respondent. No personal identifiers were used in data reporting.

Additionally, access to ships and port facilities was granted through formal permissions obtained from NIMASA, the Nigerian Ports Authority, and private terminal managers. All observations and interviews were conducted by safety protocols and under port security supervision.

3. Result

Demographic data

The data revealed in Table 1 shows that 71.9% of respondents are male, and only 28.1%

are female. This is consistent with global maritime employment patterns, where seafaring and port-related professions are overwhelmingly male-dominated. According to the International Maritime Organization (IMO, 2021), women account for only 2% of the world's 1.89 million seafarers, most of whom work in service-related roles. The gender disparity may influence environmental compliance behaviors and attitudes due to differences in training, exposure, and risk perception. Addressing gender inclusion may also broaden the talent pool in environmental stewardship roles.

Most respondents fall between 35–54 years (66.1%), indicating a workforce with considerable life and work experience. Only 1.7% are below 25 years. The age structure implies that many of the professionals involved in blackwater management are mature and potentially well-versed in environmental protocols. Research shows that older maritime personnel often demonstrate higher regulatory compliance due to greater experience and awareness (Nguyen et al., 2019).

The sample includes a variety of roles: Ship crew (39.7%), Port officials (30.6%), Regulatory officers (20.7%), and Reception facility staff (9.1%). This cross-section of the maritime sector offers a holistic view of blackwater discharge practices across operational and oversight domains. Studies have shown that collaboration between ship operators and regulatory authorities significantly improves MARPOL compliance (Rahman, Lee, & Ghazali, 2021). However, the relatively low representation of reception facility staff could indicate underdeveloped infrastructure or limited stakeholder engagement in waste reception systems. The limited involvement of reception facility staff (9.1%) may highlight gaps in waste reception infrastructure, a known barrier to effective MARPOL Annex IV implementation (Jiang et al., 2022).

A significant proportion of respondents (79.3%) have over 7 years of experience, with 44.6% having more than 10 years. This high experience level suggests respondents are likely familiar with MARPOL Annex IV requirements. However, the effectiveness of this experience in influencing actual practice depends on continued professional development and enforcement mechanisms (Chatzinikolaou & Ventikos, 2015).

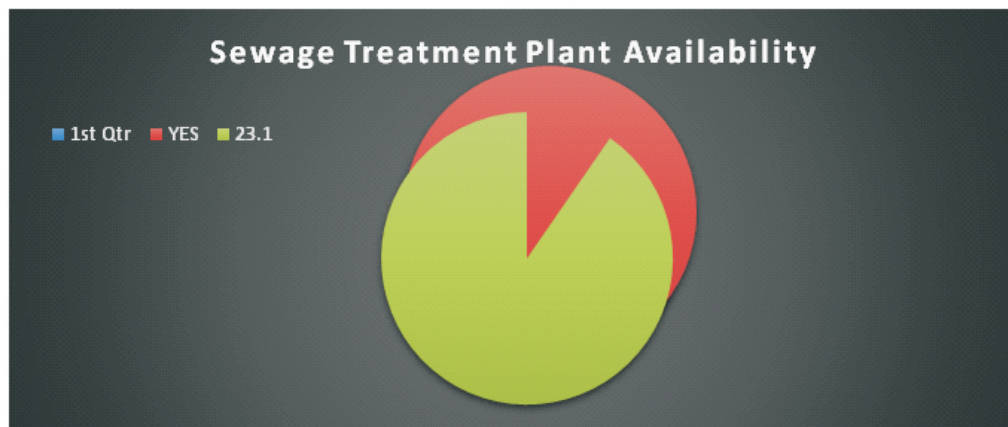
The most frequently operated or monitored vessel types are: Cargo (71.9%), followed by Tankers (18.2%), and Passenger vessels (3.3%). Cargo and tanker vessels produce large volumes of blackwater, especially during long voyages. According to Kim and Dinwoodie (2020), cargo vessels contribute significantly to marine pollution when not equipped with effective sewage treatment systems or when port reception facilities are inadequate. The low percentage of passenger and naval vessel respondents suggests either limited access or under-reporting in these segments, despite their known contributions to sewage discharges (IMO, 2020). With the cargo fleet dominating

maritime operations in Rivers State, tailored strategies are needed to target their compliance, such as onboard treatment technology adoption and stricter port inspection routines.

Variables		Frequency	Percentage
Sex	Male	87	71.9
	Female	34	28.1
Age	< 25	2	1.7
	25-30	17	14.0
	35-44	43	35.5
	45-54	37	30.6
	55+	22	18.2
Position	Ship Crew	48	39.7
	Port Official	37	30.6
	Regulatory Officer	25	20.7
	Reception Facility staff	11	9.1
Year of Experience	< 1	0	0
	1-3	5	4.1
	4-6	28	23.1
	7-10	42	34.7
	10+	54	44.6
Type of vessel most frequently operated/monitored	Cargo	87	71.9
	Tanker	22	18.2
	Passenger	4	3.3
	Fishing	2	1.7
	Naval	6	5.0

Blackwater Management Practices

Is there a sewage treatment plant (STP) onboard your vessel?



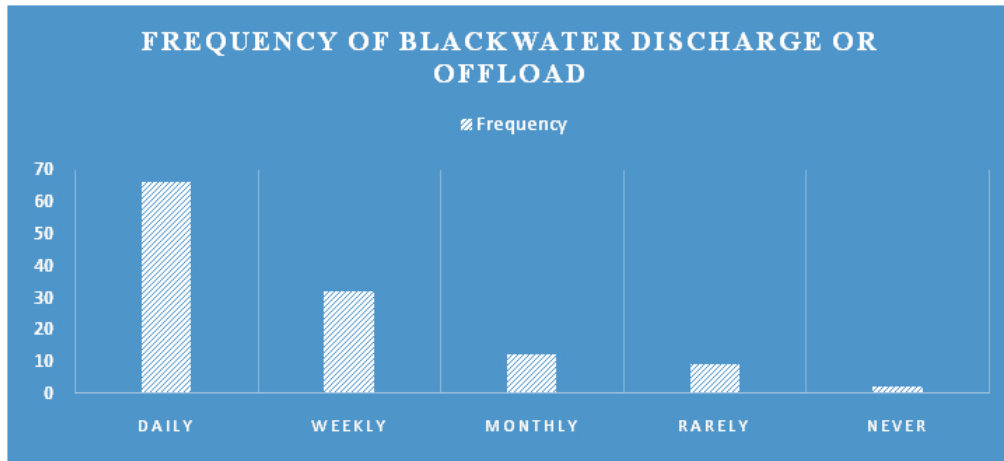
The data reveals that only 23.1% of vessels surveyed are equipped with an onboard sewage treatment plant (STP), while a significant 76.9% lack this essential facility. This finding raises serious environmental and regulatory concerns, particularly in light of MARPOL Annex IV, which mandates that ships of 400 gross tonnage and above, or those certified to carry more than 15 persons, must be equipped with an approved STP, a sewage holding tank, or a connection to port reception facilities (IMO, 2020). The high proportion of non-compliant vessels suggests inadequate enforcement of international regulations and possible gaps in awareness or infrastructure. This scenario contributes to the risk of untreated blackwater discharges into coastal waters, endangering marine ecosystems and public health (Jiang, Zhao, & Wu, 2022). Addressing this issue requires stricter port-state control, investment in onboard sanitation systems, and the development of adequate shore-based reception facilities.

What method is primarily used for blackwater disposal?

Primary blackwater disposal method	Frequency	Percentage
Discharged directly into the sea	52	43.0
Held in holding tanks	43	35.5
Treated and then discharged	8	6.6
Offloaded to port reception facility	18	14.9
Total	121	100

The findings indicate that 43.0% of vessels discharge blackwater directly into the sea, while only 6.6% treat sewage before discharge and 14.9% offload it to port reception facilities. Meanwhile, 35.5% utilize holding tanks for temporary containment. These statistics underscore widespread non-compliance with MARPOL Annex IV, which prohibits direct discharge of untreated sewage within 12 nautical miles of the nearest land unless an approved treatment system is used (IMO, 2020). The high rate of direct discharge suggests poor enforcement and insufficient onboard treatment systems or port infrastructure. Limited use of reception facilities further reflects the challenges facing ports in Rivers State, including inadequate capacity or accessibility. Similar trends in developing regions have been attributed to cost-saving measures, lack of training, and weak regulatory oversight (Jiang et al., 2022). To improve compliance, investments are needed in onboard STPs, port facilities, and personnel training.

How frequently is blackwater discharged or offloaded?



The study reveals that 54.5% of vessels discharge or offload blackwater daily, while 26.4% do so weekly. Only 9.9% discharge monthly, 7.4% rarely, and 1.7% never. The high frequency of daily discharge raises environmental concerns, particularly given the earlier finding that 43% of vessels release untreated blackwater directly into the sea. Such frequent disposal, if not properly treated, contributes to marine pollution, eutrophication, and public health risks in coastal areas (Jiang, Zhao, & Wu, 2022). Frequent discharges may result from limited holding tank capacity, lack of onboard treatment systems, or inadequate reception facilities at ports. According to MARPOL Annex IV (IMO, 2020), regulated discharge practices are required to protect marine ecosystems, especially near coastlines. The data suggests a need for improved enforcement, larger containment systems, and operational reforms, including scheduled offloading and treatment infrastructure both onboard and ashore, to mitigate environmental impacts.

Is the blackwater treatment system regularly maintained?

Regular maintenance of the blackwater treatment plant	Frequency	Percentage
Yes	23	19.0
No	98	81.0
Total	121	100

The data shows that only 19.0% of vessels conduct regular maintenance on their blackwater treatment plants, while a concerning 81.0% do not. This neglect poses serious implications for the effectiveness of sewage management and environmental compliance. Poorly maintained systems often lead to equipment failure or untreated discharges, contributing to marine pollution and public health hazards (Chatzinikolaou & Ventikos, 2015). According to MARPOL Annex IV, onboard sewage treatment

systems must be properly maintained and operated to meet discharge standards (IMO, 2020). The lack of regular maintenance suggests limited technical capacity, budget constraints, or inadequate regulatory enforcement within the maritime sector in Rivers State. This finding underscores the need for mandatory maintenance protocols, regular inspections, and capacity-building for ship operators and port authorities. Ensuring the functionality of treatment systems is critical to protecting coastal water quality and achieving sustainable maritime operations.

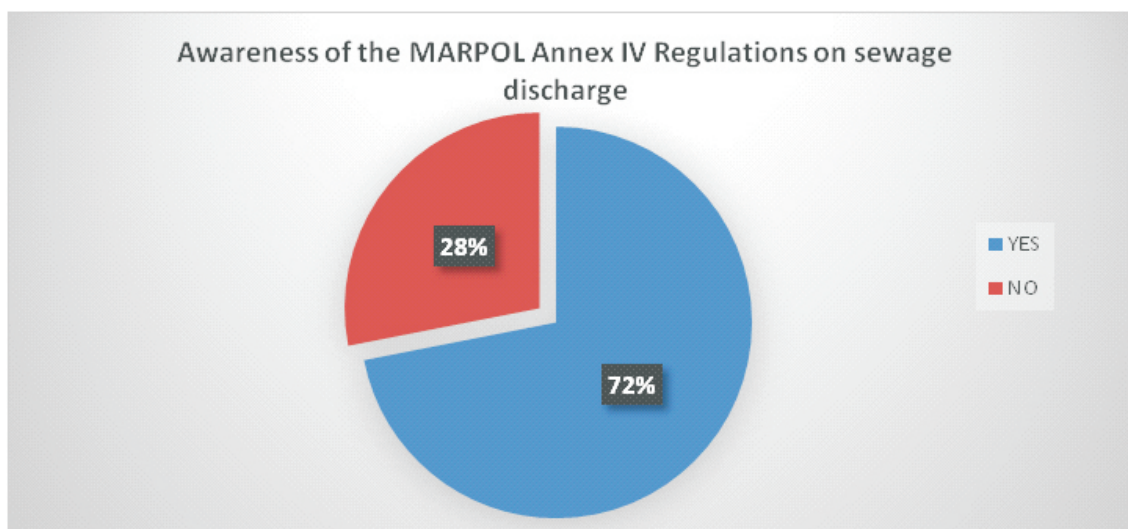
Are the ship's crew trained in proper blackwater discharge procedures?

Training on proper blackwater discharge procedure	Frequency	Percentage
Yes	20	16.5
No	101	83.5
Total	121	100

The findings indicate that only 16.5% of respondents have received training on proper blackwater discharge procedures, while a significant 83.5% have not. This lack of training is a major barrier to MARPOL Annex IV compliance, as proper sewage handling requires technical knowledge and awareness of environmental regulations. Studies show that crew training is essential for reducing illegal discharges and ensuring safe operation of treatment systems (Rahman, Lee, & Ghazali, 2021). The absence of training suggests a critical gap in maritime environmental management in Rivers State and highlights the urgent need for targeted capacity-building programs.

Compliance with MARPOL Annex IV

Are you aware of MARPOL Annex IV regulations on sewage discharge?



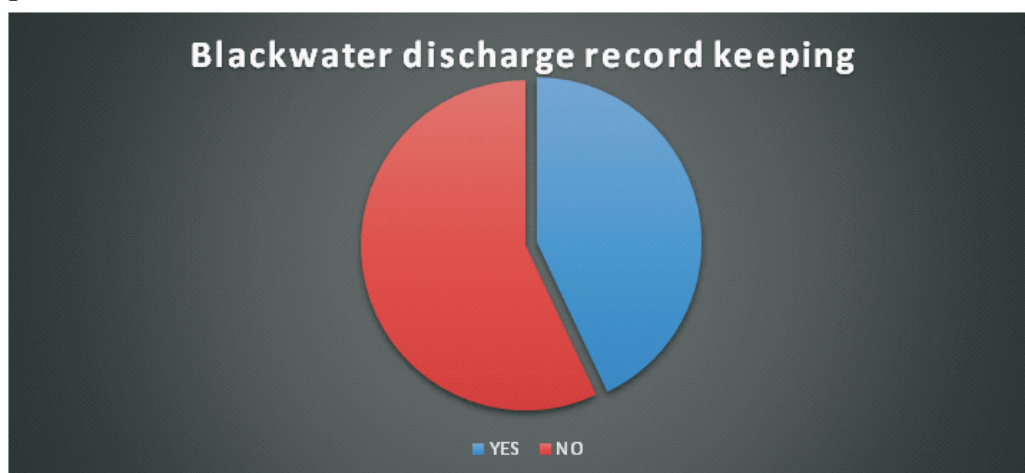
The data shows that 55.4% of respondents are aware of MARPOL Annex IV regulations on sewage discharge, while 44.6% lack such awareness. Although a slight majority demonstrate regulatory knowledge, the high percentage of unaware personnel raises concerns about enforcement and compliance effectiveness. According to the IMO (2020), awareness of environmental conventions is foundational for proper implementation. Lack of knowledge often leads to improper discharge practices and environmental violations. This finding emphasizes the need for improved regulatory outreach, mandatory awareness campaigns, and training programs to ensure all maritime personnel understand and comply with international sewage discharge standards.

Has your vessel been inspected for Annex IV compliance in the last 2 years?

Inspection for Annex Iv compliance in the last two years	Frequency	Percentage
Yes	43	35.5
No	78	64.5
Total	121	100

The results indicate that only 35.5% of vessels were inspected for MARPOL Annex IV compliance in the past two years, while 64.5% were not. This low inspection rate suggests a serious gap in enforcement mechanisms within Rivers State's maritime sector. Regular inspections are critical for verifying proper sewage management and deterring non-compliance (Chatzinikolaou & Ventikos, 2015). The absence of consistent oversight increases the likelihood of illegal discharges and environmental degradation. To enhance compliance, port state control authorities must prioritize routine inspections, align with international best practices, and ensure adequate resources and personnel for effective monitoring.

Do you keep records of blackwater discharge or treatment as per MARPOL requirements?



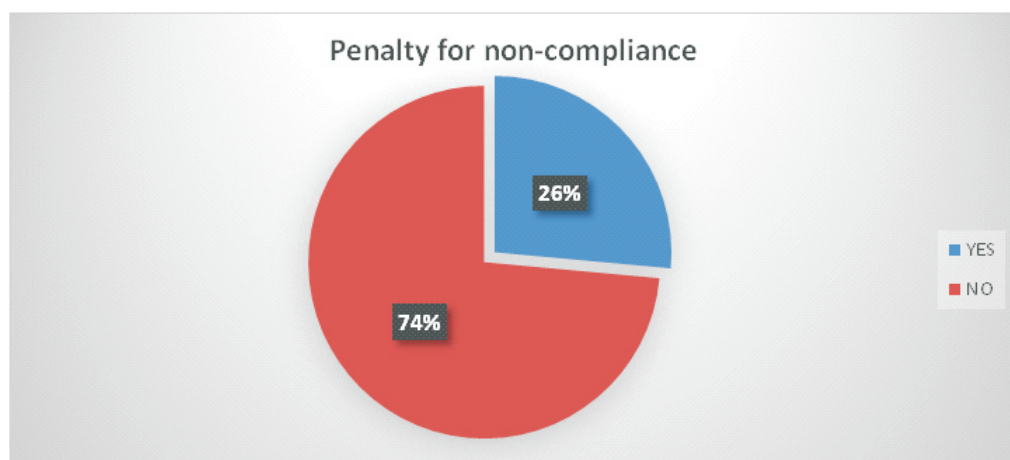
The data shows that only 43.0% of respondents maintain records of blackwater discharge, while 57.0% do not. This lack of proper documentation undermines efforts to ensure MARPOL Annex IV compliance, which requires accurate record-keeping to monitor sewage management practices and support enforcement actions (IMO, 2020). Poor record maintenance often reflects weak operational discipline and may conceal non-compliant discharge activities. According to Chatzinikolaou and Ventikos (2015), record keeping is essential for transparency, accountability, and auditing by port state control. Strengthening regulations and training on logbook use is necessary to improve compliance and environmental protection.

Are you familiar with the areas (ports or zones) in Rivers State where blackwater discharge is prohibited?

Familiarity with the restricted zone	Frequency	Percentage
Yes	39	32.2
No	82	67.8
Total	121	100

The data reveals that only 32.2% of respondents are familiar with restricted zones for sewage discharge, while a significant 67.8% are not. Restricted zones are areas, such as within 12 nautical miles of shore or designated sensitive regions, where untreated blackwater discharge is prohibited under MARPOL Annex IV (IMO, 2020). This low level of awareness increases the risk of illegal discharges and environmental contamination, particularly in ecologically vulnerable coastal waters. According to Jiang et al. (2022), understanding spatial discharge restrictions is essential for compliance and effective environmental protection. Strengthening training and navigational guidance is crucial to address this knowledge gap.

Have you or your organization ever been penalized for non-compliance with Annex IV?



The findings show that only 26.5% of respondents are aware of penalties for non-compliance with MARPOL Annex IV, while a striking 73.5% are unaware. This lack of awareness undermines the deterrent effect of enforcement measures and encourages continued non-compliance with sewage discharge regulations. According to the IMO (2020), awareness of legal consequences is critical for effective environmental governance in maritime operations. When penalties are unknown or not enforced, ship operators may prioritize convenience or cost-saving over regulatory adherence (Rahman et al., 2021). Strengthening legal education, publicizing penalties, and enforcing sanctions are essential steps toward improving compliance in Rivers State.

In your opinion, how strict is the enforcement of MARPOL Annex IV in Rivers State?

Strictness to the enforcement of MARPOL Annex IV in Rivers State	Frequency	Percentage
Very strict	2	1.7
Moderate	34	28.1
Weak	67	55.4
Not enforced at all	18	14.9
	121	

The data indicates that enforcement of MARPOL Annex IV in Rivers State is perceived as weak by 55.4% of respondents, while 14.9% believe it is not enforced at all. Only 1.7% view enforcement as very strict, and 28.1% rate it as moderate. This highlights a serious gap in regulatory implementation and oversight. Effective enforcement is essential to ensuring compliance with international environmental standards (IMO, 2020). Weak enforcement not only encourages illegal discharges but also undermines the credibility of maritime governance. As noted by Jiang et al. (2022), strengthening institutional capacity, inspections, and punitive measures is key to improving environmental performance in port regions.

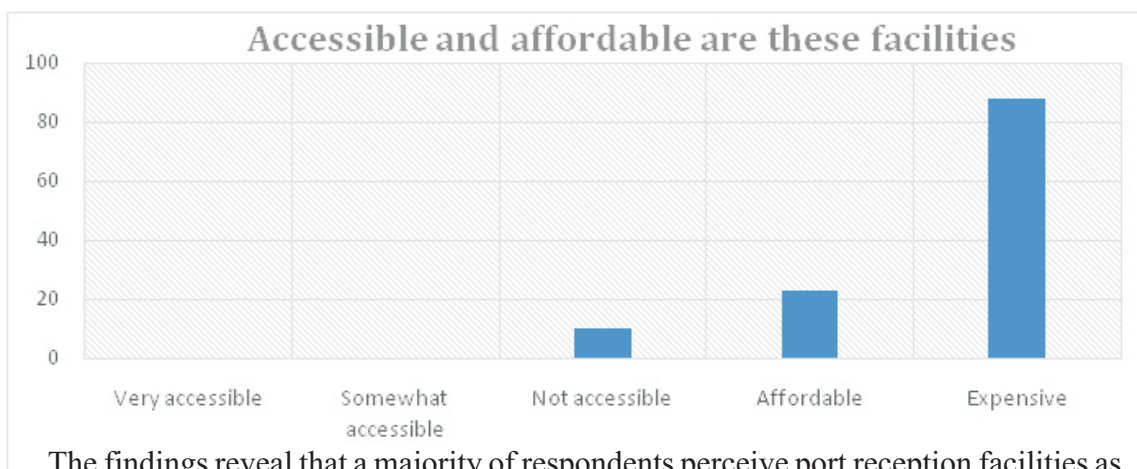
Port Reception Facilities and Environmental Impact

Are there adequate port reception facilities for blackwater in Rivers State ports?

Adequacy of port reception facilities	Frequency	Percentage
Yes	15	12.4
No	106	87.6
Total	121	

The data shows that only 12.4% of respondents consider port reception facilities in Rivers State adequate, while a substantial 87.6% do not. This overwhelming perception of inadequacy suggests that most ports lack the infrastructure required to properly receive and manage shipborne sewage (blackwater). According to MARPOL Annex IV, adequate port reception facilities are essential to prevent illegal at-sea discharges (IMO, 2020). Inadequate facilities force vessels to discharge directly into the sea, undermining environmental protection efforts. As highlighted by Kim and Dinwoodie (2020), investment in modern, accessible port reception systems is critical for improving compliance and protecting coastal ecosystems.

How accessible and affordable are these facilities for ship operators?



The findings reveal that a majority of respondents perceive port reception facilities as expensive (88 responses) and not accessible (10 responses), while only 23 consider them affordable. This highlights significant economic and logistical barriers to proper blackwater offloading in Rivers State. According to IMO (2020), port reception facilities must be both adequate and accessible without causing undue delay or cost to ship operators. When facilities are costly or hard to access, vessels may resort to illegal sea discharges, undermining MARPOL Annex IV objectives. As emphasized by Jiang et al. (2022), improving affordability and access is essential to drive compliance and reduce marine pollution risks.

Have you ever experienced difficulty in disposing of blackwater at port facilities?

Difficulty in waste disposal	Frequency	Percentage
Yes	56	46.3
No	65	53.7
Total	121	

The findings show that 46.3% of respondents experience difficulty in waste (blackwater) disposal, while 53.7% do not. Although a slight majority report no difficulty, the high percentage facing challenges is concerning. Difficulties in disposal often stem from inadequate, inaccessible, or expensive port reception facilities, as previously highlighted. According to MARPOL Annex IV, ships must have access to efficient disposal options to prevent marine pollution (IMO, 2020). Persistent disposal challenges may compel vessels to discharge untreated sewage into the sea. Chatzinikolaou and Ventikos (2015) argue that operational and infrastructural barriers must be addressed to ensure regulatory compliance and environmental protection.

Conclusion

The study reveals significant gaps in the management of shipborne blackwater and compliance with MARPOL Annex IV in Rivers State. Findings show that most vessels lack sewage treatment plants, discharge untreated blackwater directly into the sea, and fail to maintain proper discharge records or conduct regular maintenance. Awareness of the regulations, restricted zones, and penalties remains low, while enforcement is generally perceived as weak. Furthermore, port reception facilities are considered inadequate, inaccessible, and unaffordable by the majority of respondents, leading to widespread non-compliance and environmental risks. These findings highlight the urgent need for strengthened regulatory enforcement, improved training and awareness among maritime personnel, and substantial investment in port infrastructure. Addressing these challenges is critical to ensuring compliance with international maritime environmental standards, protecting marine ecosystems, and promoting sustainable shipping practices in Rivers State and beyond.

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