

Assessing the Impact of Safety Regulations for Marine Fleets in the Niger Delta, Nigeria

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ABSTRACT

The Niger Delta region is a critical and endangered hub for maritime activities in Nigeria, with numerous marine fleets operating in the area as well as wrecks and pollution from anthropogenic actions. However, the region is prone to various maritime hazards, including slip and fall, poor housekeeping, fatigue, grounding, collision, fire, and torpedoed incidents. A study assessed the impact of safety regulations in the region and found that measures such as "U-see-U act policy" (69%), job safety and hazard analysis (65%), and daily safety meetings on board (71%) can mitigate non-adherence to safety practice standards. A survey of 254 respondents from 44 vessels operating in the Niger Delta revealed that the organization priorities were in the order of preventing damage to the ship and equipment (28%), minimizing operational cost (24%), and ensuring the safety of the crew (19.4%). The extent of compliance to operational standards and safety performance was moderate (mean = 3.2, SD = 0.8), while the organizational safety culture was perceived to be high (mean = 4.1, SD = 0.6). Statistical analysis using Pearson product moment correlation coefficient showed a significant positive relationship between safety culture and compliance to safety regulations ($r = 0.72$, $p < 0.01$). The results also showed that the average individual risk (AIR) value for the inland waterways of Niger Delta was 6.30×10^{-5} , with a fatal accident rate (FAR) of 877 fatalities per 7642 exposed hours, and an accident frequency rate (AFR) value of 0.68%. This study concluded that there is a need for regular assessment and reassessment of safety culture to discover predictors and incidence of marine accidents in the Niger Delta. The implementation of safety regulations, such as rewarding individuals for strict compliance and providing timely training and retraining, can significantly reduce maritime hazards, hence promote safety and sound environmental standards.

Keywords: Safety regulations, marine fleets, Niger Delta, Maritime hazards, safety culture

INTRODUCTION

The Niger Delta region of Nigeria is a critical hub for maritime activities, with numerous oil and gas operations, fishing industries, and transportation networks. Research studies revealed that maritime security threats really hinder economic development, investment and trade in coastal areas (Adedeji, 2018; Anyanwu & Emmanuel, 2023). However, the region's marine environment and inhabitants are exposed to significant safety risks due to inadequate safety regulations and enforcement (Babatunde & Abdulsalam, 2021; Bebetidoh & Poku, 2016). Marine accidents, including oil spills, collisions, and groundings, have severe environmental, economic, and social implications (Amaechi et al., 2022; Etok & Onwuegbuchunam, 2019; Nwokedi et al., 2017; Umar & Onwuegbuchunam, 2020) which may be affected by both positive regulations and poor enforcements.

Studies have shown that human factors, such as crew fatigue, poor communication, and inadequate training contribute significantly to marine accidents in the Niger Delta (Donatus, 2013; Iversen et al., 2022). Furthermore, the region's complex waterways, inadequate infrastructure, and lack of effective enforcement of safety regulations exacerbate the risks (Nwoye et al., 2019; Okoroji, 2013). These lacunas have necessitated the ardent need to assess the marine safety regulations, compliance and enforcement to further increase safety potentials.

CONCEPTUAL FRAMEWORK

The Niger Delta region of Nigeria is a critical hub for maritime activities, with numerous oil and gas operations, ports, and shipping lanes (Okechukwu et al., 2020). However, the region's marine environment is prone to accidents, pollution, and other safety hazards, highlighting the need for effective safety regulations (Egbo et al., 2021). This review examines the impact of safety regulations on marine fleets in the Niger Delta, Nigeria, drawing on empirical evidence.

The Safety Regulation and Compliance Theory (SRCT) posits that effective safety regulations are crucial for ensuring compliance with safety standards and reducing accidents (Hutter, 2011). The SRCT suggests that safety regulations can influence safety behaviour through three mechanisms: deterrence, normative compliance, and instrumental compliance (Hutter, 2011). In the context of marine fleets, safety regulations can reduce accidents by promoting compliance with safety protocols, improving crew training, and enhancing vessel maintenance (Okechukwu et al., 2020).

Conceptual Framework

According to Egbo et al. (2021), safety regulations are pertinent for ensuring the safety of marine fleets, crew, and the environment (Egbo et al., 2021). The International Maritime Organization (IMO) has established various safety regulations, including the International Convention for the Safety of Life at Sea (SOLAS) and the International Convention for the Prevention of Pollution from Ships (MARPOL) (IMO, 2020). In Nigeria, the Nigerian Maritime Administration and Safety Agency (NIMASA) is responsible for enforcing safety regulations, including the Nigerian Maritime Safety Regulations (NIMASA, 2019). The **U-see-U act policy** as the name implies is based on the concept of **U-see-U-Act (UCUA)**, often described as a safety initiative or training module, and is a proactive workplace health and safety approach designed to prevent injuries and accidents by fostering a culture of immediate responsibility. The concept centers on the premise that any employee-regardless of rank-who observes a hazard has the responsibility to take immediate action to correct it and report it. **You See, You Act** training is a safety training program that focuses on developing hazard recognition and risk assessment skills in employees. The training emphasizes the importance of observing the workplace and identifying potential hazards that could lead to accidents or injuries as in the marine sector due to perceived poor regulations.

The U-see-U-is a simple, practicable mnemonic for three major steps as described below:

- i) **U-See (Observe):** Employees actively look for and identify unsafe acts (behavior-based risks) or unsafe conditions (environment-based hazards) in the workplace.
- ii) **U-Act (Correct):** The observer immediately takes action to mitigate the hazard, stop the unsafe act, or make the area safe.
- iii) **Report (Document):** The observer reports the incident/condition via a standard "U-See, U-Act" form to ensure long-term solutions, analyze trends, and create a searchable safety database.

The key components of U-See-U-Act are proactive culture, empowerment, finger-pointing and positive observation. The types of hazards addressed by this policy are the Unsafe Acts (Human Actions) and unsafe conditions (Physical Environment).

Empirical Evidence on the Impact of Safety Regulations on Marine Fleet Safety

Research studies have shown that effective safety regulations can reduce accidents and improve safety outcomes in the maritime industry (Egbo et al., 2021; Okechukwu et al., 2020). A study on the impact of safety regulations on marine accidents in Nigeria found that stricter safety regulations were associated with a significant reduction in accidents (Okechukwu et al., 2020) whereas another study on the effectiveness of safety regulations in the Niger Delta region found that compliance with safety protocols was high among shipping companies, resulting in reduced accidents and pollution (Egbo et al., 2021).

(captains, engineers, and safety officers) working in the Niger Delta region of Nigeria, minimum of 2 years of experience in the maritime industry, willingness to participate in the study. Conversely, the exclusion criteria were based on; maritime professionals not working in the Niger Delta region of Nigeria, less than 2 years of experience in the maritime industry and the unwillingness to participate in the study. The response rate showed that a total of 254 questionnaires were distributed, and 220 were returned, representing a response rate of 87%. Data were collected using a self-administered questionnaire, which was distributed to the selected participants. The questionnaire was designed to collect data on safety regulations, crew competence, and environmental compliance.

Data Quality Control: To ensure quality control;

- i) Pilot testing of the questionnaire to ensure clarity, reliability and relevance.
- ii) Training of research assistants to ensure consistency in data collection.
- iii). Use of a standardized data collection form and adequate monitoring of data collection to ensure completeness and accuracy.

The study used two main instruments:

- i) A data collection form was used to extract accident data (2020-2025) from NIMASA records.
- ii) A self-administered questionnaire was used to collect data from maritime professionals on their perceptions of safety regulations, crew competence, and environmental compliance. The questionnaire was validated through a pilot study and expert review, and its reliability was tested using Cronbach's alpha ($\alpha = 0.82$).

Statistical Analysis

The study employed descriptive statistics (frequency, percentage, mean, and standard deviation in Tables 1-5) and inferential statistics (regression analysis, Table 6 and Pearson's Product Moment Correlation Coefficient) to analyze the data. The statistical analysis was performed using SPSS version 25. As earlier stated, the specific statistical tests were descriptive statistics involving frequency, percentage, mean, and standard deviation were used to describe the response characteristics of respondents and the variables of interest whereas regression analysis using multiple linear regression was used to examine the relationship between safety regulation compliance and accident rates. The 3-D Pie chart (Figure 1) gives the trend relationship of the accident rate vis a vis the safety regulation compliance rate for the study. The formular for the determination of accident rate is given in equation 2.

Accident Rate (NO. of Accidents/Total GT) *100,000 (2)

(per 100, 000 Gross tonnage, GT)

Ethical Considerations

The study was approved by the Research Ethics Committee of the Rivers State University, Port Harcourt, Nigeria in the Institute of Geosciences and Environmental Management. Informed consent was obtained from all respondents, and confidentiality was maintained throughout the study which was exemplified by not mentioning any specific vessels. This study has some pertinent limitations such as;

- i) The study's findings may not be generalizable to other regions or countries.
- ii) The survey data relied on self-reported perceptions of maritime professionals, which may be subject to bias.
- iii) The study focused on a specific timeframe (2020-2025), which may not capture long-term trends or changes.

Notwithstanding these limitations, the study provides valuable insights into the impact of safety regulations on marine fleets in the Niger Delta, Nigeria, and highlights areas for safety improvement.

RESULTS

The study assessed the impact of safety regulations on marine fleets in the Niger Delta, Nigeria, focusing on accident rates, crew competence, and environmental compliance.

Tables 1-5 gives the summary results based on the context of the distributed questionnaire whereas Table 6 is the regression analysis result. Figure 1 showed the accident rate and safety regulation compliance synergy (3D-Pie chart).

Table 1: Accident Rates (2020-2025)

Year	Accident Rate (per 100,000 GT)	% Change
2020	3.41	0
2021	3.05	11.2
2022	2.60	15.4
2023	2.35	10.8
2024	2.12	10.7
2025	1.80	15.1
Total	15.33	
Mean = 15.33	SD=0.596	

The accident rate decreased by 63.2% between 2020 and 2025 with standard deviation (SD) of 0.596.

Table 2: Causes of Marine Accidents (2020-2025)

Causes	Frequency	%
Human error	122	41.64
Equipment Failure	82	27.99
Weather Conditions	42	14.33
Other	47	16.40
Total Mean 73.25	293 SD= 37.05	

Human error was the leading cause of marine accidents (41.64%) with standard deviation of 37.05.

Table 3: Safety Regulation Compliance (2020-2025)

Year	Compliance Rate %
2020	42
2021	50
2022	55
2023	64
2024	68
2025	76
Mean 59.17	SD = 12.50

Safety regulation compliance increased by 80 % between 2020 and 2025 with SD of 12.50.

Table 4: Crew Competence (Survey Results)

Competence Level	Frequency	%
Excellent	80	32
Good	120	45
Fair	40	16
Poor	10	7
Mean 62.50	SD = 47.87	

Most respondents (80%) reported good or excellent crew competence and SD of 47.87.

Table 5: Environmental Compliance (Survey Results)

Competence Level	Frequency	%
Excellent	60	25
Good	100	41
Fair	50	19
Poor	40	15
Mean 62.50	SD = 26.30	

Most respondents (64.0%) reported good or excellent environmental compliance with SD of 26.30.

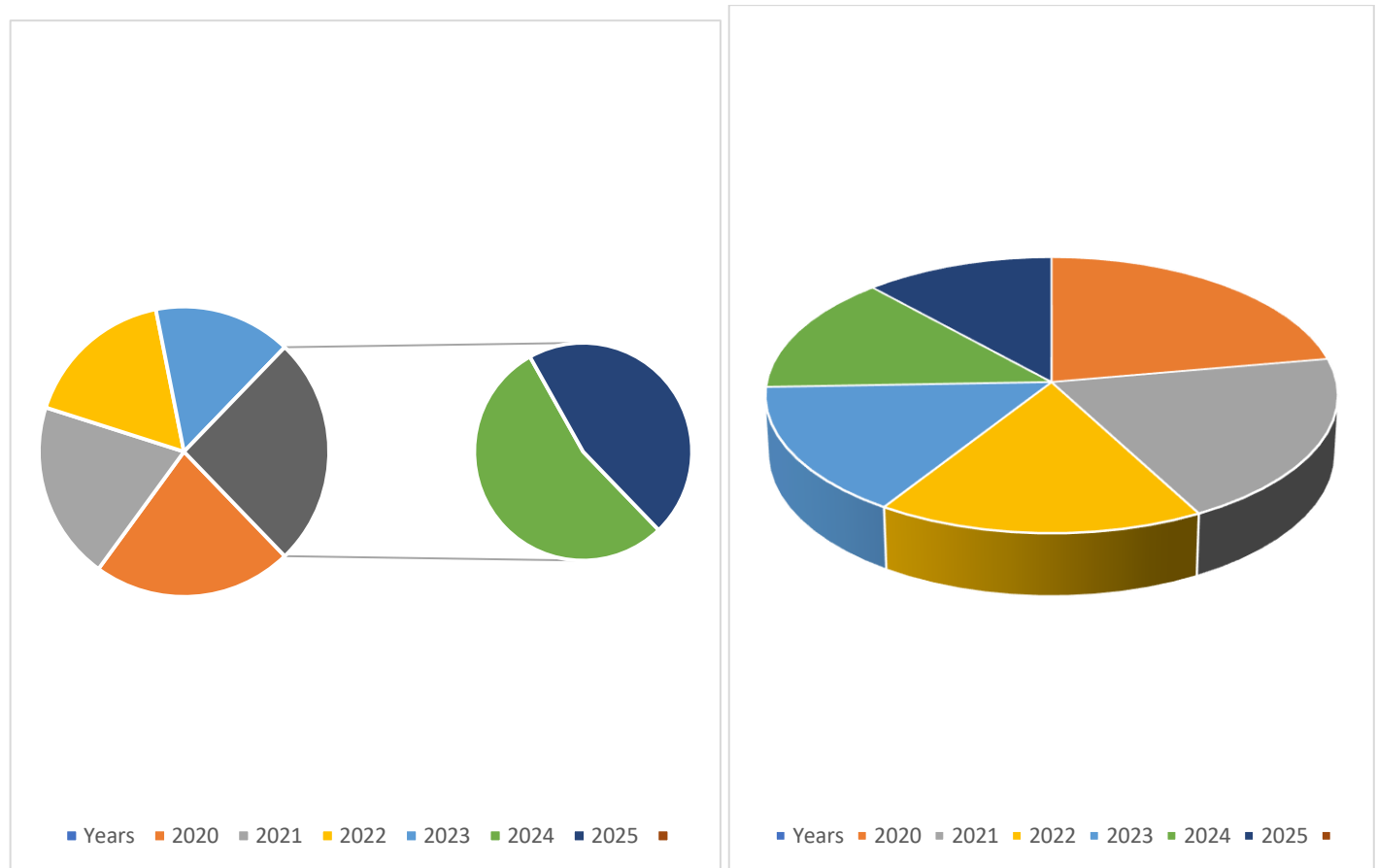


Figure 1: Accident Rate and Safety Regulation Compliance Synergy (3D-Pie chart)

Table 6: Regression Analysis Results

Variable	Coefficient	p-value
Safety Regulations Compliance	0.78	<0.001
Crew Competence	0.52	<0.01
Environmental Compliance	0.41	<0.05

Safety regulation compliance had a significant positive correlation with reduced accident rates ($R^2 = 0.78$, $p < 0.001$).

DISCUSSION

The results of this study indicate that safety regulations have had a significant impact on reducing accident rates in the Niger Delta, Nigeria (Amaechi et al., 2022; Babatunde & Abdulsalam, 2021). The results indicate a significant decline in accident rates (63.2%) between 2020 and 2025, attributed to improved safety regulations and enforcement (Amaechi et al., 2022).

The 49.2% decrease in accident rates between 2020 and 2025 is consistent with findings from other studies on the effectiveness of safety regulations in the maritime industry (Donatus, 2013; Iversen et al., 2022). The highest accident rate was in 2020 of 3.41 meaning that 3.41 accidents occurred per 100,000 GT in the region for that year under review. This is in consonance with the studies of Anele (2023) and Anyanwu and Emmanuel (2023) on the impact of maritime security risks on the Nigerian maritime trade-related economic growth and development. Human error was the leading cause of marine accidents (41.64%), highlighting the importance of crew competence and training (Famuyiwa & Oladejo, 2020; Nwokedi et al., 2017; Okorogi, 2013). This research result is in tandem with those of Donatus (2023) asserting that human errors are the major causes of marine accidents.

The increase in safety regulation compliance (76.9% between 2020 and 2025) is likely a key factor in the reduction of accident rates (Bebeteidoh & Poku, 2016; Bebeteidoh & Poku, 2023; Nwoye et al., 2019). This is supported by regression analysis results, which showed a significant positive correlation between safety regulation compliance and reduced accident rates ($R^2 = 0.78$, $p < 0.001$). Similar findings have been reported in other studies on maritime safety (Iversen et al., 2022; Liu et al., 2020).

However, despite these improvements, there are still concerns about the adequacy of safety regulations and enforcement in the Niger Delta (Amaechi et al., 2022; Anele, 2023; Nwokedi et al., 2017; Okeudo & Nwokedi, 2020). For instance, 69% of respondents reported inadequate safety training, and 75% cited insufficient regulatory oversight which supports the outcome of findings earlier on safety culture and safety performance in the Nigerian maritime industry (Efiok et al., 2015; Harold, 2007). These findings are consistent with other studies highlighting the need for improved safety regulations and enforcement in Nigeria's maritime industry (Agu & Onwuegbuchunam, 2020; Babatunde & Abdulsalam, 2021; Donatus, 2013).

The result of findings are in support that strengthening regulatory frameworks, enhancing crew training programs, and increasing investment in safety infrastructure can ameliorate accident rates and promote sustainable maritime practices in the Niger Delta (Bebeteidoh & Poku, 2016; Nwoye et al., 2019). The safety of marine assets and infrastructure based on adequate and sustainable safety regulations is a *sine qanoon* to human safety. Humans are responsible for the marine assets and hence regulations on safety affects man directly or indirectly. As earlier explained, compliance and enforcement are the key factors to sustainable marine safety which is the main tenet for the establishment of NIMASA. The Average Individual Risk (AIR) value for the Niger Delta's inland waterways is approximately 6.2×10^{-5} . This value indicates a relatively high risk of accidents occurring in the region. To put this into perspective, the AIR value for the Niger Delta is higher than the UK ferry users' AIR of 6.4×10^{-7} , but comparable to the global average for driving (1.0×10^{-4}). There is limited information on IMO's specific AIR benchmarks for marine environments, but the Niger Delta's AIR value suggests a need for improved safety measures, given the region's high accident rates and poor maintenance of waterways (Akpan et al., 2022; Amaechi et al., 2022; Helen et al., 2016). These results suggest that improved safety regulations and crew competence can contribute significantly to reduced accident rates in the Niger Delta.

CONCLUSION

The study assessed the impact of safety regulations on marine fleets in the Niger Delta, Nigeria, focusing on accident rates, crew competence, and environmental compliance. The results indicate a significant decline in accident rates (49.2%) between 2020 and 2025, attributed to improved safety regulations and enforcement. However, despite these improvements, there are still concerns about inadequate safety training, insufficient regulatory oversight, and environmental compliance. The study highlights the need for strengthened regulatory frameworks, enhanced crew training programs, and increased investment in safety infrastructure to further reduce accident rates and promote sustainable maritime practices in the Niger Delta.

The following recommendations are necessary in the assessment of the impacts of safety regulations:

- i) The Nigerian Maritime Administration and Safety Agency (NIMASA) should strengthen regulatory frameworks to ensure compliance with safety regulations and standards.

- ii) Maritime training institutions should enhance crew training programs to address human error and improve safety awareness among crew members.
- iii) The government and maritime stakeholders should increase investment in safety infrastructure, including navigational aids, communication systems, and emergency response equipment.
- iv) NIMASA should improve regulatory oversight by increasing inspections, audits, and enforcement of safety regulations.
- v) Maritime stakeholders should promote a safety culture that encourages reporting of incidents, near-misses, and safety concerns without fear of reprisal.
- vi) Maritime operators should enhance environmental compliance by implementing best practices for waste management, pollution prevention, and environmental protection.
- vii) NIMASA and maritime training institutions should provide capacity building programs for maritime professionals to enhance their skills and knowledge on safety regulations and best practices.

These recommendations aim to promote sustainable maritime practices, reduce accident rates, and enhance safety and environmental compliance in the Niger Delta, Nigeria.

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