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ASSESSMENT OF HAZARDS ASSOCIATED WITH MARITIME ACTIVITIES IN THE NIGER DELTA REGION OF NIGERIA

BY

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Abstract

Maritime hazards potentially affect the human, the marine environment, properties, and activities aboard ships and ashore in various forms and degree of extent. The study examined various hazards associated with maritime activities in the Niger Delta region of Nigeria. The cross-sectional survey research design was employed and with the aid of Taro Yamane, 350 respondents in form of onshore and offshore staff, captains, chief mates, crew members, administrative and safety officers were selected for the study. The result revealed that hazards commonly associated with maritime activities include slip and fall, poor housekeeping, fatigue, grounding, collision, fire and torpedoed. Over-reliance on the vessels technology (60.3%), attributes beyond human capacity such as bad weather and sudden storm (57.3%), technological malfunction due to ecological attributes (61.5%), inadequate function of vessel crew (55.5%), unsatisfactory organization value affecting staff mode of operation (54.6%) are the causes of maritime hazards of merchant ships/vessels. Finding indicated that the organization priorities was in the order of preventing damage to the ship and equipment (24.3%), minimizing operational cost (21.3%), and ensuring the safety of the crew (17.4%). The extent of compliance to the operational standard and safety performance was moderate while the organizational safety culture was perceived to be high in their organization. There is need for regular assessment and reassessment of safety culture as the tool to discover the organization actual level of safety culture to learn and improve.

Keywords: *Maritime, Hazards, Safety, Niger Delta*

Introduction

Maritime hazards potentially affect the human, the marine environment, properties, and activities aboard ships and ashore in various forms and degree of extent. The effects of the resulting accidents vary from minor injuries to fatalities and from insignificant damage to very severe damage to the environment and property. The cost of accidents, including fatalities and injuries, damage to property and the environment, prevention and mitigating measures, and insurance accounts for a considerable share of transport costs (Mullai & Paulsson, 2011, Ceyhun, 2014). While it is generally accepted that the overall level of maritime safety has improved in recent years, further and ongoing improvements are still desirable (Pallis, 2017). The safety culture of anticipating hazards rather than waiting for accidents to reveal them has been widely used in many industries. The international shipping industry has begun to move from a reactive to a proactive approach to safety through what is known as Formal Safety Assessment (FSA) (Pallis, 2017).

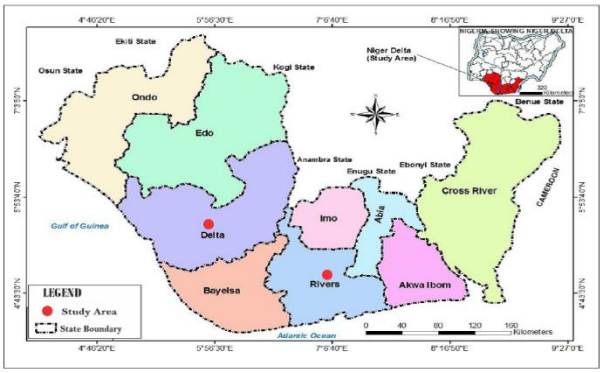
Risk has been considered as the chance that someone or something that is valuated will be adversely affected by the hazard (Woodruff, 2005; Pallis, 2017), while "hazard" is any unsafe condition or potential source of an undesirable event with potential for harm or damage (Reniers, Ale, Dullaert & Soudan, 2005; Pallis, 2017). Moreover, risk has been defined as a measure under uncertainty of the severity of a hazard (Høj and Kröger, 2002; Pallis, 2017), or a measure of the probability and severity of adverse effects (Haimes, 2009; Pallis, 2017). In general, "danger" should be defined as an attribute of substances or processes, which may potentially cause harm (Høj and Kröger, 2002; Pallis, 2017). Marine accidents are caused by exposure to risks, perils, and hazards of the marine environment, provided that the accidental objects are at sea or being harnessed for sea movement, in port or in a dockyards, and can be protected by a policy of marine insurance. It is immaterial whether the vessel or object involved in accident is sailing or stationary at the point and time of accident (Nwokedi *et al*., 2017).

Nwokoro & Nwokedi (2015) asserted that the prevalence of hazards and perils of the sea, exposes maritime prosperities and investment in ships to risk of accident and loss of various nature, this necessitates the application of formal safety assessment (FSA) and other forms of risk assessment methods as well as proper implementation of other International Maritime Organization (IMO) convention instruments to limit the occurrence of maritime accidents and consequent economic losses occasioned by it (Nwokedi *et al*., 2017). Considering this perspective, the study examined various hazards associated with maritime activities in the Niger Delta region of Nigeria.

Materials and Method

Study Area

The study area is Niger Delta region of Nigeria which extends from Aboh (5°33′49″ N and 6°31′38″ E) in the North to palm point (4°16′22″ N and 6°05′27″ E) in the South. The East-West limit is between Benin River estuary (5°44′11″ N and 5°3′49″ E) in the West and Imo River estuary (4°27′16″ N and 7°35′27″ E) (Figure 1) protruding towards the Gulf of Guinea on the Atlantic coast of West Africa (Shittu, 2014). The Niger Delta region is a densely-populated area in Nigeria. Its population is about 31 million people. The land mass extends over about 70,000 km2, and make up 7.5 percent of Nigeria's landmass. The region consists of the present-day Abia, Akwa-Ibom, Bayelsa, Cross-River, Delta, Edo, Imo, Ondo, and Rivers states.



Research Design

A cross-sectional survey research design was employed in this study. This method was adopted because it is a suitable and efficient way of studying large population. It allows only a sample population to be used to represent the entire population. The population of the study comprised of carefully and randomly selected onshore and offshore staff, captains, chief mates, crew members, administrative and safety officers of marine vessels that operate within Niger Delta water.

Sample Size

The Ports of study comprises of Rivers Port, Onne Port, Delta Ports, and jetties within the states. A list of registered marine operators was sourced from Nigerian Maritime Administration and Safety Agency (NIMASA) and employment list of the licensed maritime firm handling the selected jetties. The selected ports handle liquid, dry and bulk cargoes, oil and gas-free zone, general cargoes, and other logistic/multipurpose services (Table 1).

Table 1: Sample Selection from the Population

States	Port/Jetties	No of Terminal	Primary Purpose
Rivers	Rivers Port	2	Liquid, dry and bulk cargoes,
	Onne Port	4	Container oil and gas, dry or wet bulk, general cargoes, and other logistic services.
	Jetty	5	Multipurpose services
	Warri Port	8	Multipurpose cargoes
Delta	Jetty	3	Multipurpose services

To get a true representative sample of the target population, the Taro Yamane (1964) formula for sample size determination was used:

$$n = \frac{N}{1 + N(e)^2} \quad \text{..... (3.1)}$$

Where: e= Level of precision (0.05)
N= Population
n= Sample size
1= Constant

$$n = \frac{1074}{1 + 1074(0.05)^2}$$

$$n = \frac{1074}{1 + 1074 * 0.0025}$$

$$n = \frac{1074}{1 + 2.685}$$

$$n = \frac{1074}{3.685}$$

$$n = 291.452 \approx 292$$

$$n = 292$$

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*For non-response increase by 20% (from the n=292)
= 292 + 58
=350

Date Collection

The method of data collection that was adopted for this study was well-structured questionnaire. Using proportionate sampling techniques, the distribution of the sample size was based on the percentage of each of the staff force from each ports/terminals which also determines the amount of questionnaire that was distributed among the ports/terminals (Table 2).

Table 2: Distribution of the Questionnaire

States	Port	Registered Marine Operators	Taro Yamane Sample size	Sample Population (%)	Questionnaire Distribution
Rivers	Rivers Port	245	350*	23	81
	Onne Port	379		35	122
	Jetties	125		12	42
Delta	Warri Port	238		22	77
	Jetties	87		8	28
Grand Total		**1,074**			**350**

Data Analysis

The retrieved questionnaires were coded using MS Excel (office 2016) before being transferred to the Data entry of Statistical Package for the Social Sciences (SPSS v. 22) for proper analysis. The descriptive statistics tool such as frequency counts, percentages of response, and chats was adopted for the analysis. The use of such statistics allows the researcher to present the evidence of the study in a way that can be understandable and makes conclusion concerning the variables of study.

Result

From the 350 questionnaires administered to those involved in the study, 333 of the questionnaire returned filled and useful for further analysis. Approximately, the retrieved questionnaire represents 95% of the aggregated amount administered.

Socio-Demographic Details of the Respondents

The Table 3 showcased the socio-demographic details of respondents involved in the study. The outcome revealed that 61.6% of those engaged are male while 38.4% were female. The age range of the participants deduced that 21.6% are within age 18-29years, 39.0% are within age 30-40years, 24.9% are within age 41-50years while 8.4% and 6.0% of the respondents are within the age of 51-60years and 61years and more respectively. This is an indication that most of the engaged are within the age 30-40years. Approximately, more than half of the sampled population are married (59.8%) while 21.0% are single, 15.6% are divorced and 3.6% of the sampled population claimed widowed. The religion of those involved in the study indicated that more than half are Christianity which represent 52.0%, 25.5% practice Islam while 17.7% and 4.8% of those involved in the study are traditionalist and other form of religion. The educational qualification deduced that 15.9% holds OND/HND qualification, 34.8% holds Bachelor degree education while 18.0% and 21.9% of the respondents holds Master degree education and professional certificate respectively. The outcome indicated that everyone captured in the study are one way or the other educated and understood the content of the study. The position held by the respondents captured in the study indicated 6.3% were captains, 7.5% are chief mate, 34.8% were crew members, 27.3% are safety officers, while 16.2% and 7.8% of the respondents were administrative officers and other positions such as chief engineer. The outcome deduced that 28.2% of the respondents have less than 5years, 46.2% claimed to have 5-10years experience, 12.3% possesses 11-15years experience while 7.2% and 6.0% possesses 16-20years and 21years above experience in maritime operations.

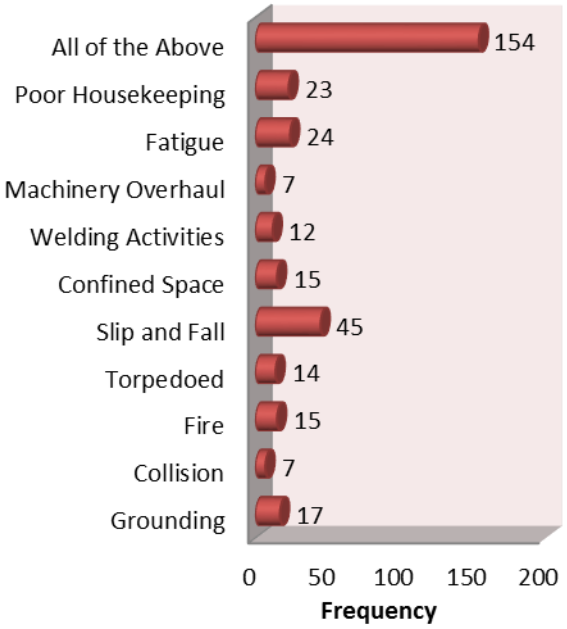
Hazards Associated with Maritime Activities

Figure 1-4 depict the hazard associated with maritime activities. The outcome on the common hazard in maritime activities deduced that 12.9% indicated grounding is the common hazard, 12.3% indicated collision is most common hazard, 21.0% indicated fire to be common hazard, 19.5% indicated torpedoed is more common while 33.0% of the respondents indicated all of the mentioned forms of hazards are commonly associated with maritime activities. The outcome indicated that 18.9% of the respondents noted sea swell as hazard associated with vessels at sea, 25.5% indicated storm, 13.5% indicated heavy rain, 8.1% indicated low lake, 13.5% indicated sagging and rolling while 9.6% and 10.8% of the respondents indicated pounding and painting, and geographical location are hazard associated with vessels at sea. 4.8% of the individuals captured in the study affirmed that cold is the foreseeable hazard associated with vessel at sea, 7.2% indicated high winds, 18.3% indicated spills, 8.7% indicated fishing nets, 10.8% indicated pressurised lines, 6.3% claimed reg, 5.7% indicated loose objects, 13.2% claimed tidal current while 24.9% of the individuals captured in the

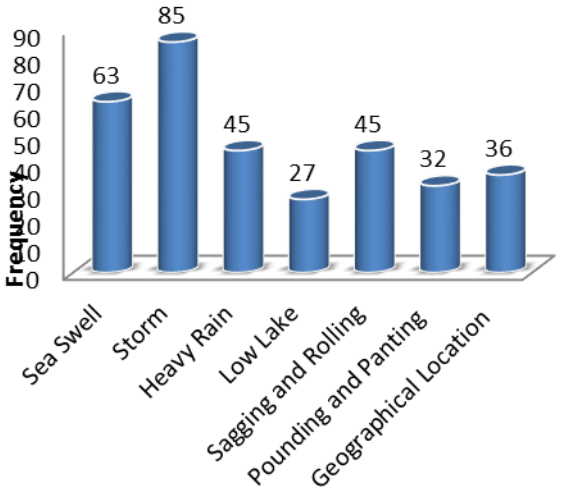
study noted that all the aforementioned attributes are foreseeable hazard associated with vessel at sea. The finding indicated that 30.9% of the respondents claimed the hazard occurrence is very frequent, 46.8% indicated that the occurrence is less frequent while 12.6% and 9.6% of the respondents claimed the hazard occurrence is rare and very rare.

Table 3: Socio-Demographic Details of the Respondents

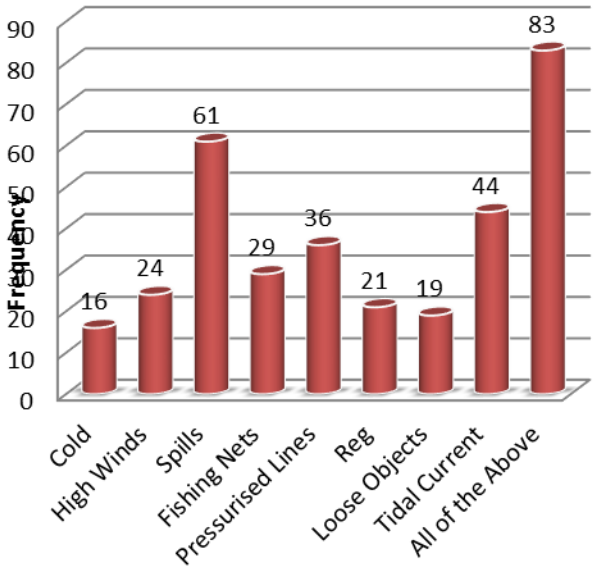
Variable	Frequency (n=333)	Percentage (%)
Sex of Respondents		
Male	205	61.6
Female	128	38.4
Age (years)		
18-29 years	72	21.6
30-40 years	130	39.0
41-50 years	83	24.9
51-60 years	28	8.4
61 and above	20	6.0
Marital Status		
Single	70	21.0
Married	199	59.8
Divorced	52	15.6
Widowed	12	3.6
Religion		
Christianity	173	52.0
Islam	85	25.5
Traditionalist	59	17.7
Other	16	4.8
Educational Qualification		
OND/HND	53	15.9
B.Sc	116	34.8
M.Sc	60	18.0
Ph.D.	31	9.3
Professional Certificate	73	21.9
Position held on the vessel/Organization		
Captains	21	6.3
Chief Mate	25	7.5
Crew Member	116	34.8
Safety Officer	91	27.3
Administrative Officer	54	16.2
Others	26	7.8
Maritime operational years of experience		
Below 5years	94	28.2
5-10years	154	46.2
11-15years	41	12.3
16-20years	24	7.2
21years and above	20	6.0



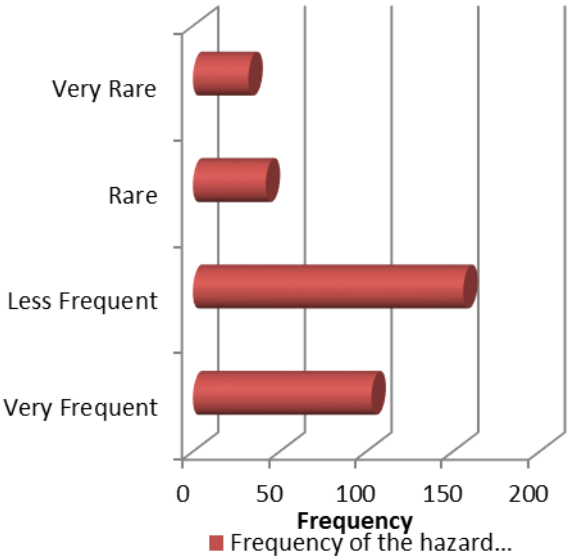
A



B



C



D

A: Hazard commonly associated with maritime activities, **B**: Hazard Associated with Vessel at Sea, **C:** Foreseeable Hazards Associated with Vessel at Sea, **D:** Frequency of the Hazard Occurrence

Causes of Maritime Hazards in Merchant Ships

Table 4 showed the causes of maritime hazards of merchant ships/vessels among respondents. The finding indicated that the 39% of respondents agreed that poor equipment design to suit crew member activities is the cause of maritime hazard while 57.6% disagreed and 3.3% were undecided. The variable showed mean of 3.23 and standard deviation of 1.03. 39.9% agreed that inadequate knowledge of own ship system causes maritime hazard while 57.0% disagreed and 3.0% undecided with variable mean and standard deviation was 3.27 and 0.98 respectively. 60.3% of the respondents agreed that over-reliance on the vessels technology causes the hazard, 35.4% disagreed and 4.2% were undecided while the variable mean and standard deviation was 3.50 and 1.12 respectively. 55.5% agreed inadequate function of vessel crew causes maritime hazard, 39.2% disagreed, and 5.4% were undecided with mean 3.48 and standard deviation of 1.15. Unsatisfactory organization value affect staff mode of operation as causal agent of maritime hazard was agreed by 54.6%, disagreed by 38.7%, and undecided by 6.6% while the mean and standard deviation was 3.48 and 1.13 respectively. 61.5% agreed that technological malfunction due to ecological attributes causes' maritime hazard, 28.5% disagreed while 9.9% were undecided. The variable mean and standard deviation was 3.48 and 1.19 respectively. 55.2% of individual involved in the study agreed that man-related attributes is a main cause of hazard, 41.4% of the individual disagreed while 3.3% were

undecided. The variable mean and standard deviation was 3.48 and 1.13 respectively. 52.2% of the participants agreed that inadequate understanding and practice of operator causes the maritime hazard, 36.9% disagreed while 10.8% were undecided. The mean and standard deviation of the causal agent was 3.30 and 1.21 respectively. 34.2% of the participants agreed that insufficient rules of engagement and mode of operation causes maritime hazards, 52.2% of the participants disagreed while 13.5% were undecided. The mean and standard deviation of the causal agent was 2.99 and 1.19 respectively. 57.3% of individuals engaged in the study agreed that attributes beyond human capacity such as bad weather, sudden storm are responsible for maritime hazard, 34.8% of the individuals disagreed while 7.8% were undecided. The mean and standard deviation of the causal agent was 3.50 and 1.19 respectively30.0% agreed that technological factor such as unavailability of advance equipment causes the maritime hazard, 64.2% disagreed while 5.7% were undecided concerning the causal agent. The mean and standard deviation of the causal agent was 3.04 and 1.15 respectively. 52.8% of individuals engaged in the study agreed that poor visibility and loud noise causes maritime hazard is responsible for maritime hazard, 39.9% of the individuals disagreed while 7.2% were undecided. The mean and standard deviation of the causal agent was 3.40 and 1.16 respectively.

Compliance with International Maritime Organization (IMO) Standards

The compliance with IMO standard was presented in Table 5. The outcome deduced that 21.3% of the respondents affirmed that the perceived organization priorities was about minimising the operation cost, 17.1% indicated that it is ensuring on-time performance, 11.4% indicated that the priorities was about preventing damage to good and/or cargo, 24.3% indicated that it is preventing damage to the ship and equipment while 17.4% and 8.4% of the respondent affirmed that the perceived organization priorities was ensuring the safety of the crew and welfare respectively. The extent of compliance of the operational standard deduced that 29.1% claimed the compliance was very high, 6.3% indicated that compliance was high, 37.5% indicated that compliance was moderate while 20.7% and 6.3% of those captured in the study indicated that compliance was very low and low respectively. 20.7% of the captured individuals in the study indicated that organizational safety culture was very high in their organization, 37.8% indicated that the safety culture was high, 30.6% indicated that safety culture was moderate while 8.1% and 2.7% indicated that the organizational safety culture was very low and low respectively. The finding indicated that 25.8% of the respondents affirmed that the extent of operational safety performance was very high, 12.3% indicated that the safety performance was high, 35.7% indicated that it was moderate while 21.0% and 5.1% indicated that the operational safety performance of their organization was very low and low respectively.

Discussion

From the outcome of the analysis, the respondents indicated that slip and fall, poor housekeeping, fatigue, grounding, collision, fire, and torpedoed are among the hazards commonly associated with maritime activities. The outcome showed similar outcome with the study by Corovic and Djurovic (2013), Berg (2013), and Chauvin et al. (2013). Corovic and Djurovic (2013) pointed that the event of the listed hazards causes damage to vessels, facilities or personnel. Berg (2013) opined that assessing the marine related accidents is significant in discovering the challenges in respect to human attributes to such accidents and developing means to forestall and enhance maritime safety. Chauvin *et al*., (2013) asserted that most of collision at sea is as a result of poor decision-making couple with poor visibility and inappropriate use of facilities. Considering the hazard associated with vessels at sea, the outcome deduced that storm was the leading hazard as indicated by the respondents followed by sea swell, heavy rain, sagging and rolling, low lake, geographical location, and pounding and painting. Also, the outcome indicated that cold, high winds, spills, fishing nets, pressurised lines, reg, loose objects, and tidal current are foreseeable hazards associated with vessel at sea. Corovic and Djurovic (2013) noted hazard associated with vessels at sea could be unintended, series of events based on the operation of the vessel leading to unwanted outcome or jeopardizing the safety of a ship. Che Ishak *et al*., (2019) pointed that workers are susceptible to accidents in maritime activities due various factors including physical requirement of job specification, environments, and hours of engagement. The finding indicated that the hazard occurrence in maritime activities is less frequent. This corroborated with the finding of European Maritime Safety Agency (2010) which noted that hazards such as sinking, collisions, and groundings is become less frequent; although, fire/explosion and other hazards are still frequent.

Considering the causes of maritime hazards of merchant ships/vessels, the respondents agreed that (based on the extent of weighted mean) over-reliance on the vessels technology, attributes beyond human capacity such as bad weather and sudden storm, technological malfunction due to ecological attributes, inadequate function of vessel crew, unsatisfactory organization value affecting staff mode of operation, man-related attributes, poor visibility, and loud noise and inadequate understanding and practice of operator are the causes of maritime hazards of merchant ships/vessels. The finding showed similarity with of Bielić, Hasanspahić, and Čulin (2017) where the finding indicated that the mind-set of technology of been highly dependable lead to insufficient performance from vessels' crew. Mousavi and Jafari (2017) opined that in spite the technological advancement, human error is account for 80% of the accidents related to maritime activities. the finding corroborated with the study of Dogarawa (2012) and Donatus (2013) where the causes of maritime hazards was based on series of inadequate safety culture, human and technological factors. The respondents disagreed that that inadequate knowledge of own ship system,

poor equipment design to suit crew member activities, technological factor such as unavailability of advance equipment, insufficient rules of engagement, and mode of operation. However, the finding of Anyanwu (2014) indicated that poor knowledge, insufficient rules of engagement, and lack of advanced technology such as Global Maritime Distress and Safety System (GMDSS) are the causes of maritime hazards. Bielić *et al*., (2017) where the finding indicated that 31% of the maritime accidents are connected to technology.

In understanding the organization compliance with IMO standard, the respondents deduced that the organization priorities was in the order of preventing damage to the ship and equipment, minimizing operational cost, ensuring the safety of the crew, ensure on-time performance, preventing damage to good and/or cargo and ensure the welfare of the crew. The extent of compliance to the operational standard was deduced to be moderate while the organizational safety culture was perceived to be high in their organization. Also, the extent of operational safety performance was deduced to be moderate. The finding shared similar view and measure with the study conducted by Andrei, et al. (2015) where the deduced organization priorities included safety, crew wellbeing, low cost of operation, and maximum operational outcome. The outcome supported by Formela *et al*., (2019) which asserted the importance of IMO in the regulations and standard set for organizations and workers in the maritime industries. Chauvin (2011) opined that organization must focus on their safety culture which is vital in impacting the staff decision-making and attitude. The outcome is in line with the opinion of Oluseye and Ogunseye (2016) which asserted that fostering safety culture is significant in preventing deliberate indiscipline act at sea. Efiok, Oluseye, Uduak, and Olalekan (2015) noted that possessing adequate and effective safety culture is capable of dealing with various human-related maritime hazards.

Table 4: Causes of Maritime Hazards of Merchant Ships

S/N	Causes of Maritime Hazards of Merchant Ships	SA (%)	A (%)	D (%)	SD (%)	UN (%)	Total (%)	Mean	SD
1	Poor equipment design to fit on board actual needs of crew member	41 (12.3)	89 (26.7)	120 (36.0)	72 (21.6)	11 (3.3)	333 (100)	3.23	1.03
2	Inadequate knowledge of own ship system	37 (11.1)	96 (28.8)	131 (39.3)	59 (17.7)	10 (3.0)	333 (100)	3.27	0.98
3	Over-reliance due to highly automated system of modern vessels	59 (17.7)	142 (42.6)	52 (15.6)	66 (19.8)	14 (4.2)	333 (100)	3.50	1.12
4	Inadequate function of vessel crew	68 (20.4)	117 (35.1)	74 (22.4)	56 (16.8)	18 (5.4)	333 (100)	3.48	1.15
5	Unsatisfactory organization value affect staff mode of operation	62 (18.6)	120 (36.0)	87 (26.1)	42 (12.6)	22 (6.6)	333 (100)	3.48	1.13
6	Technological malfunction due to ecological attributes	58 (17.4)	147 (44.1)	56 (16.8)	39 (11.7)	33 (9.9)	333 (100)	3.48	1.19
7	Man-related attributes is a main cause of hazards	68 (20.4)	116 (34.8)	66 (19.8)	72 (21.6)	11 (3.3)	333 (100)	3.48	1.13
8	Inadequate understanding and practice of operator	49 (14.7)	125 (37.5)	71 (21.3)	52 (15.6)	36 (10.8)	333 (100)	3.30	1.21
9	Insufficient rules of engagement and mode of operation	38 (11.4)	76 (22.8)	109 (32.7)	65 (19.5)	45 (13.5)	333 (100)	2.99	1.19
10	Attributes beyond human capacity such as bad weather, sudden storm.	72 (21.6)	119 (35.7)	71 (21.3)	45 (13.5)	26 (7.8)	333 (100)	3.50	1.19
11	Technical factors like unavailability of advanced equipment	55 (16.5)	45 (13.5)	110 (33.0)	104 (31.2)	19 (5.7)	333 (100)	3.04	1.15
12	Poor visibility and loud noise causes maritime hazard	58 (17.4)	118 (35.4)	81 (24.3)	52 (15.6)	24 (7.2)	333 (100)	3.40	1.16

NB: SA-Strongly Agreed, A- Agreed, D- Disagreed, SD- Strongly Disagreed, UD-Undecided, and SD-Standard Deviation

Table 5: Compliance with IMO Standards

Variable	Frequency (n=333)	Percentage (%)
Perceived Organization (Company's) Priorities		
Minimising operational cost	71	21.3
Ensuring on-time performance	57	17.1
Preventing damage to good and/or cargo	38	11.4
Preventing damage to the ship and equipment	81	24.3
Ensuring the safety of the Crew	58	17.4
Ensuring the welfare of the crew	28	8.4
Level of Compliance to Operational Standard		
Very High	97	29.1
High	21	6.3
Moderate	125	37.5
Very Low	69	20.7
Low	21	6.3
Level of the Organizational Safety Culture		
Very High	69	20.7
High	126	37.8
Moderate	102	30.6
Very Low	27	8.1
Low	9	2.7
Level of the Operational Safety Performance		
Very High	86	25.8
High	41	12.3
Moderate	119	35.7
Very Low	70	21.0
Low	17	5.1

Conclusion

Many of the activities of maritime are highly associated with hazards which if not handle properly could lead to morbidities, loss of lives and facilities, and negative reputation about the organization involved. Over-reliance on the vessels technology and attributes beyond human capacity such as bad weather and sudden storm are the causes of maritime hazards of merchant ships in the study area. Therefore, organizations should encourage and sustain an effective feedback system in respect to safety error and support for efficient follow-through of safety procedures to encourage better safety culture. Also, there is need for regular assessment and reassessment of safety culture as the tool to discover the organization actual level of safety culture to learn and improve.

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