Quest Journals
Journal of Research in Humanities and Social Science
Volume 10 ~ Issue 11 (2022) pp: 305-311
ISSN(Online):2321-9467
www.questjournals.org

Research Paper

Maritime Hazards and Mitigation Measures of Marine Vessels in the Niger Delta Region of Nigeria

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Abstract
The study examined the maritime hazards and mitigation measures of vessels/ships 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 descriptive statistics tool such as frequency counts, percentages of response and chats was adopted for the analysis. The result revealed that hazards commonly associated with maritime activities include slip and fall, poor housekeeping, fatigue, grounding, collision, fire, torpedoed confined space, machinery overhaul and poor housekeeping. Finding revealed that measures such as "U-see-u act policy" (66.6%), job safety and hazard analysis (62.4%), daily safety meetings on board (68.7%), promoting feedback and two way communication (49.5%), non-restriction to communication (50.4%), organizational learning (50.1%) and timely report of unsafe act (50.7%) can mitigate against the non-adherence of safety practice standard. The study concluded that various mitigation measures should be incorporated into the organizational safety culture to improve adherence to safety practices.

Keywords: ***Maritime Hazards, Mitigation, Marine Safety, Vessels, Niger Delta***

Received 10 Nov., 2022; Revised 22 Nov., 2022; Accepted 24 Nov., 2022 © The author(s) 2022.
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I. Introduction

Nigeria being a maritime nation is one of the One Hundred and Sixty-Nine (169), and three (3) associate member countries of the International Maritime Organization (IMO) which is an agency of the United Nations (UN), with the mission of regulating safety operations and instrumentation in the global maritime industry (Nnadi, 2014; Nwokedi et al., 2017). Nwokedi *et al*., (2017) explains hazards and perils of the sea as unforeseen occurrences making vessels, underwater installation, seaborne cargo, oil and gas drilling rigs and platforms, and on board-personnel vulnerable to risks of marine accident with the attendant economic loss. Marine vessel seafarers work in a dangerous environment which comprises the physical, ergonomic, chemical, biological, psychological and social elements which could lead to occupational accidents, injuries and diseases (ILO, 2014; Cakir & Paker, 2017). As a result of this dangerous environment, seafarers are exposure to extreme weather conditions, hazardous enclosed spaces, noisy mechanical equipment and toxic cargoes (Cakir & Paker, 2017). Exploring the root causes of marine vessels hazard/accidents is the focus upon which the on-going research aimed towards and provide mitigate measures to enhance maritime safety.

Maritime hazard adversely affects the human, the marine environment, properties and activities aboard ships and ashore in various forms and degree of extent. The effects of 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). Several reasons such as human errors, technical failures, natural conditions, shipping factors, route conditions and cargo related factors play role in these accidents. Unfortunately, such accidents are inevitable cases of maritime field, in contravention of creative and innovative technologies in shipping sector and execution of precautionary safety rules and regulations.

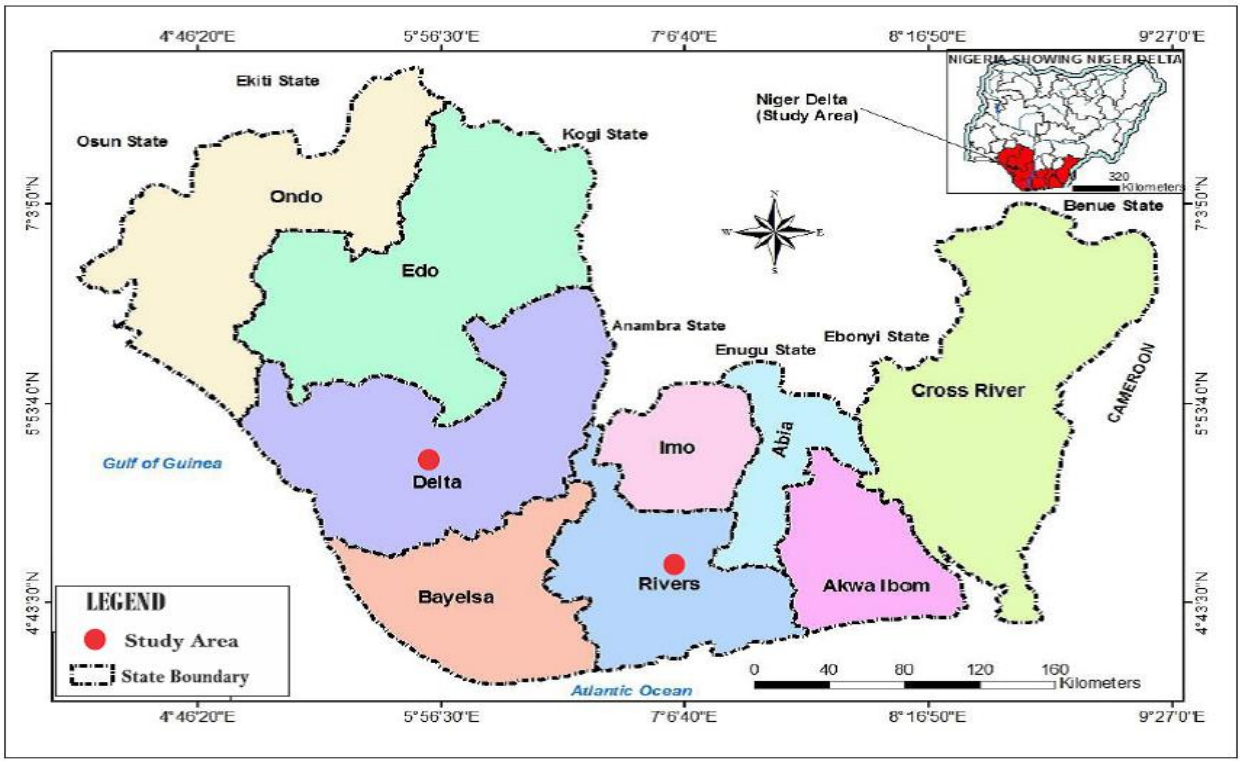
As a result of increased oil and, gas and other maritime related activities in the Niger Delta region of Nigeria, there has been a tremendous increase in merchant accidents, leading to personal injuries, loss of lives

and tremendous damage to facilities (Donatus, 2013; Bebeteidoh & Poku, 2016). According to Dogarawa (2012) marine accidents is on the increase not minding the measures put in place to regulate such from happening. The yearly increase in maritime accidents all over the world, with particular reference to Nigeria has led to this study. On yearly basis, the Nigerian waterways have been bedevilled with accidents leading to fatality (Dogarawa, 2012; Bebeteidoh & Poku, 2016). The study examined the maritime hazards and mitigation measures of vessels/ships in the Niger Delta region of Nigeria.

II. 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

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

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

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

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

$$n = 291.452 \approx 292$$

$$n = 292$$

*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.

III. 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.

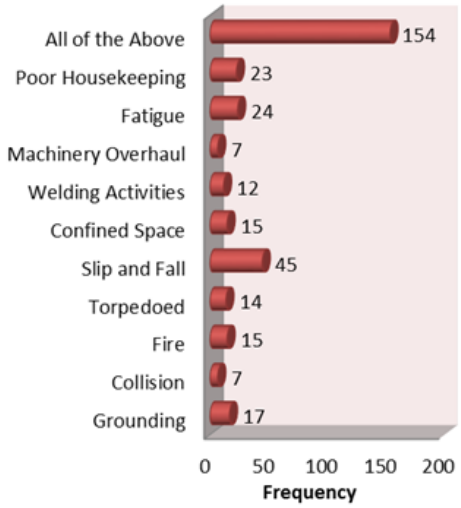
Hazards Associated with Maritime Activities

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.

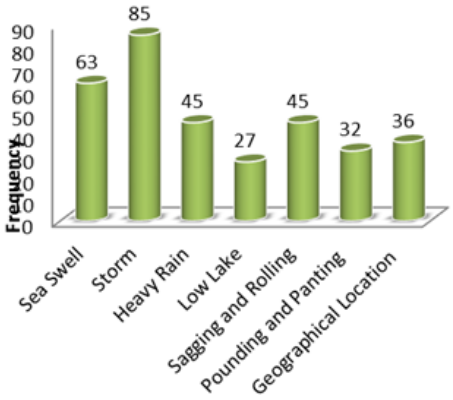
Table 3: Socio-Demographic Details of the Respondents

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



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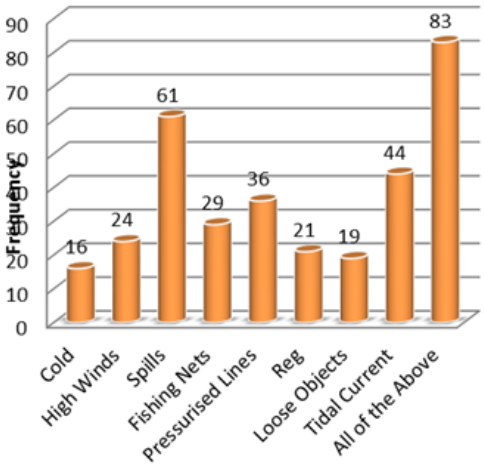
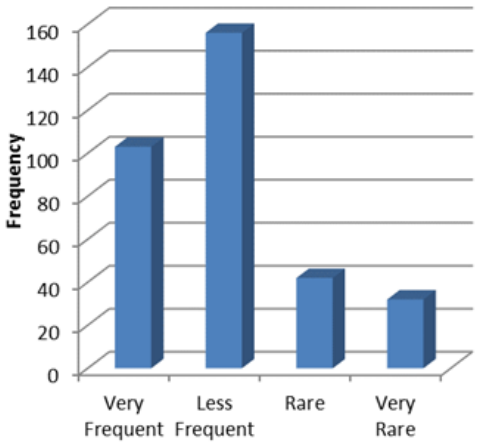


C



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

Mitigation Measures against Non-adherence of Safety Practice Standard

Table 4 depicted the mitigation measures against the non-adherence of safety practice standard among respondents. The finding indicated that the 47.5% of respondents agreed that rewarding individuals for strict compliance by company can influence mitigation measure while 44.1% disagreed and 8.4% were undecided. The variable showed mean of 3.27 and standard deviation of 1.16. 33.9% agreed that timely training and retraining can mitigate non-adherence while 52.9% disagreed and 13.2% undecided with variable mean and standard deviation was 3.03 and 1.22 respectively. 50.8% of the respondents agreed that timely report of unsafe act can mitigate non-adherence, 41.4% disagreed and 7.8% were undecided while the variable mean and standard deviation was 3.34 and 1.13 respectively. 66.7% agreed that "U- see- u act policy" can mitigate against non-adherence, 26.4% disagreed and 6.9% were undecided with mean 3.58 and standard deviation of 0.88. Non-restriction to communication can mitigate against non-adherence of safety practice was agreed by 50.5%, disagreed by 41.7% and undecided by 7.8% while the mean and standard deviation was 3.37 and 1.17 respectively. 50.2% agreed that organizational learning can mitigate against non-adherence of safety standard, 47.5% disagreed while 2.4% were undecided. The variable mean and standard deviation was 3.35 and 1.02 respectively. 62.5% of individual involved in the study agreed that job safety and hazard analysis can mitigate against non-adherence, 33.9% of the individual disagreed while 3.6% were undecided. The variable mean and standard deviation was 3.46 and 1.01 respectively. 49.6% of the participants agreed that promoting feedback and two way communication can mitigate against non-adherence of safety practice, 47.8% disagreed while 2.7% were undecided. The mean and standard deviation was 3.40 and 1.03 respectively. 68.8% of the participants agreed that daily safety meetings on board can mitigate against non-adherence of safety practice, 28.5% of the participants disagreed while 2.7% were undecided. The mean and standard deviation was 3.44 and 0.99 respectively.

IV. 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.

Table 4: Mitigation Measures against Non-adherence of Safety Practice Standard

S/N	Mitigation Measures	SA (%)	A (%)	D (%)	SD (%)	UN (%)	Total (%)	Mean	SD
1	Rewarding individuals for strict compliance by company can influence mitigation measure	48 (14.4)	110 (33.0)	88 (26.4)	59 (17.7)	28 (8.4)	333 (100)	3.27	1.16
2	Timely training and retraining can mitigate against non-adherence of safety practice	48 (14.4)	65 (19.5)	112 (33.6)	64 (19.2)	44 (13.2)	333 (100)	3.03	1.22
3	Timely report of unsafe acts can mitigate against non-adherence of safety practice	48 (14.4)	121 (36.3)	87 (26.1)	51 (15.3)	26 (7.8)	333 (100)	3.34	1.13
4	"U- see- u act policy" can mitigate against non-adherence of safety practice	113 (33.9)	109 (32.7)	33 (9.9)	55 (16.5)	23 (6.9)	333 (100)	3.58	0.88
5	Non-restriction to communication can mitigate against non-adherence of safety practice	58 (17.4)	110 (33.0)	87 (26.1)	52 (15.6)	26 (7.8)	333 (100)	3.37	1.17
6	Organizational learning can mitigate against non-adherence of safety practice	38 (11.4)	129 (38.7)	85 (25.5)	73 (21.9)	8 (2.4)	333 (100)	3.35	1.02
7	Job safety and hazard analysis can mitigate against non-adherence of safety practice	133 (39.9)	75 (22.5)	53 (15.9)	60 (18.0)	12 (3.6)	333 (100)	3.48	1.01

8	Encourage feedback and two way communication can mitigate against non-adherence of safety practice	49 (14.7)	116 (34.8)	97 (29.1)	62 (18.6)	9 (2.7)	333 (100)	3.40	1.03
9	Daily safety meetings on board can mitigate against non-adherence of safety practice	140 (42.0)	89 (26.7)	57 (17.1)	38 (11.4)	9 (2.7)	333 (100)	3.44	0.99

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

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.

On mitigation measures against the non-adherence of safety practice standard, the respondents agreed that measures such as "U- see- u act policy", job safety and hazard analysis, daily safety meetings on board, promoting feedback and two way communication, non-restriction to communication, organizational learning, timely report of unsafe act, rewarding individuals for strict compliance by company and timely training and retraining can mitigate against the non-adherence of safety practice standard. The finding showed similarity and measures with the studies of Andrei et al., (2015), Oluseye and Ogunseye (2016) and Bebeteidoh and Poku (2016). The mitigation measures are capable of preventing and minimizing the occurrence of maritime accidents at various platforms. Oluseye and Ogunseye (2016) posited that rewarding safety compliance among staff will improve the overall safety performance among crew member. Effectiveness and non-restriction of communication can improve safety standard as Catherine and Kathryn (2006) opined that communication is critical skill fundamental to efficient and safe operation in an accident prone industry such as maritime.

V. Conclusion

Maritime industry plays a vital role in the world economy, involving in estimated 90% of global trade and providing job opportunities to millions of individuals across the world. Despite these advantages, the industry operational activities are highly risky with series of consequences. Therefore, developing and improving safety culture of anticipating hazards is important to the industry. Promoting positive safety attitude among vessel's operators and workers must be carried out with essential safety understanding and needed inspiration to function at the best state of mind and safely. Organisations in collaboration with local and international safety organizations should make certain that their vessel operators and workers are adequately trained and retrain in best practices and safety protocols at sea.

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