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Investigative Analysis of Marine Tugboat Accident in Nigeria. A Case Study of Bayelsa, Delta and Rivers State

Clement A. Idiapho[1*] and Sani I. Awwal[2]

[1]Department of Marine Engineering, Niger Delta University, Bayelsa, Nigeria.
[2]Department of Marine Engineering, Federal University of Petroleum Resources, Effurun, Delta, Nigeria.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript

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ABSTRACT

The research paper showed that the major causes of boat and ferry accidents in Nigeria include human factor errors, natural factors, and technical factors. The safety of life and navigation at sea are important to coastal, flag states and the entire international shipping community in sustaining the growth of global sea trade. National governments and indeed the Federal government of Nigeria have committed substantial resources and efforts on programmes aimed at reducing the incidence of accident involving marine vessels at sea. The primary causes of boat and ferry accident considered in this paper include human, natural, and technical factors. Human factor constitutes the core causes of boat and ferry accidents in Nigeria inland waterways, as reflected in the calculated value of X^2 = (0.368), a value within the acceptance region as it is less than the theoretical value of X^2 = (7.815). The human factors include the following: overloading, over speeding, collision, night sailing without adequate light, grounding, overcrowding etc. Natural factors investigated are: sea condition (current), tides and tidal stream, severe wind, reduced visibility, stormy seas, darkness, rainstorms and waves. Technical factors include shortcomings

**Corresponding author: Email: clementidiapho@yahoo.com;*

within the ship, such as, steering failure, engine failure, corrosion or hull failure arising from defective materials or construction. These findings have implication on regulation and enforcement by relevant authorities. In view of the findings and conclusion drawn in this study, it was suggested that Government should support these agencies such as NIWA, Marine Police, NIMASA, and the Nigeria Navy if possible with equipment's, logistics in policing the waterway

Keywords: Tugboat; accident; ferry; Chi-square; water-ways.

1. INTRODUCTION

Nigeria inland waterways with about 8,600 km and extensive coastland of about 852 kilometers, boasts of the second longest waterways in Africa [1]. According to Ibeawuchi [2], the Niger and Benue River are the two longest rivers in Nigeria, which run into each other at Lokoja and dissect the country into east, west, and north sections. River Niger and Benue and other several rivers have been used for water transportation. The three main components of water transportation that could be regarded in Nigeria are ocean, coastal water and inland water transports. The coastal waterways extend from Badagry through Warri to Calabar [3].

Heavy traffic are moved through these coastal waterways especially where speed is less important than cost. Through the waterways, tons of agricultural products are transported from production areas to major industries in urban centers where they are processed through the waterways. This process incurs less cost and boosts the availability of commercial agricultural products in waterlogged areas.

According to NIWA [3], the Nigerian water ways system is channeled to about 880km of inter-coastal water ways from Lagos through Warri, Port Harcourt and calabar. Statistics from National Inland Waterways Authority (NIWA) gave approximately 3000km of under developed but developable and navigable inland water ways. A transportation regulatory agency for water in Nigeria, revealed that 22 out of 36 states in Nigeria use water as a means of transport and over 296 Nigerians were lost as a result of boat mishaps in the year 2013 [3]. Furthermore, according to Ukoji [1], data from Nigeria Watch revealed that 1607 lives were lost in 180 boat accidents between June 2006 and May, 2015. This statistics revealed that the water transportation has come to occupy a strategic place in the economy of the nation especially with the intricacies of transportation via road. Boat and ferry mishaps are more prevalent than ever before in Nigeria due to increased patronage of water transportation. According to [1] a new era of immense pressure on boat operators, other water users and increased boat accidents cumulative Fatalities on the Nigerian inland Water ways has heralded this. Related to highways, inland water ways have some public and personal uses. The pools created by dams are sometimes used for water supply purposes. Also, it is a known fact that Militancy and piracy is common to many in Nigeria but their immense contributions to the series of boat and ferry mishaps have been underestimated [4]. The continuous attacks on barges, fishing boats and passenger boats have resulted in an immeasurable loss of manpower and capital. According to Tosin, [5], attack on barges and tons of crude oil is forwarded into the black by armed militants and pirates.

While the battle to contend with boat accidents rages, Psaraftis et al. [6] cited that the deficiency of data on boat fatalities and poor mapping of incidents of boat and ferry mishaps have remained more bothersome. Neglect of the collation and management of data on lethal boat mishaps in the major waterways and creeks has hampered the effective prevention or management of boat accidents in Nigeria.

2. MATERIALS AND METHODS

According to Susan [7], research methods simply refers to the tools, techniques or process used in a research which might be survey, interviews, or participation observation. Hence, a qualitative and quantitative approach was adopted in carrying out this study. By description, a qualitative research provides knowledge of the problems or helps to develop ideas or hypothesis for potential study. Quantitative data guides in understanding the magnitude and scale of boat and ferry accidents by providing a numeric picture of its impact upon affected areas. It addresses the questions: how many and how much.

Contrary to quantitative approach, qualitative data focuses on determining the nature of the impact of a disaster upon affected populations.

According to Acaps [8], qualitative data proffer solution to questions of how and why coping strategies have adapted, or failed to adapt, to the changed circumstance.

2.1 Qualitative/Quantitative Research

Qualitative and quantitative researches are similarly considered to differ fundamentally, yet their objectives and applications overlap in numerous ways. According to Maura [9], a qualitative research is used loosely to refer to research whose findings are not subject to quantification or quantitative analysis. A Qualitative research is an exploratory research, particularly suitable for gaining an in-depth understanding of underlying reasons, opinions, and motivations [7]. It gives insights into the setting of a problem and it frequently generates ideas and hypothesis for later quantitative research [10]. Methods of qualitative data collection varies using unstructured or semi-structure techniques. Some of the common method includes focus groups (group discussions) individual interviews, and participation/ observations. The sample size is typically small, and respondents are selected to fulfill a given quota.

2.2 Sample/Sampling Technique

The sample population of 300 respondents is employed for this research work which comprises of Captains, Engineers, Quartermaster, Deckhand, Oiler, Naval officer, Marine Police, local boat operators, boat engine mechanics of boat and ferries that operate within Nigeria inland waterways. For the purposes of this study, a marine vessel operator is defined as the captain/master of the vessel or his Chief Mate, Chief Mate is considered in the absence of the Captain, since he takes over control of the affairs of the vessel when the captain is on leave or indisposed [11]. A Quartermaster is an operator of small crafts. A total of 300 respondents constituted the target population and a percentage of this total population size was taken as the sample. In order to choose a fair representative sample from the sample population, a random sampling technique was adopted.

2.3 Apparatus for Data Collection

The researcher administered a self-constructed questionnaire as apparatus for data collection through individual and group interviews covering NIMASA, ministry of transports, the Marine Police, NIWA and the Navy that operates within the Nigerian inland waterway. The marine vessels surveyed include mainly speed boat, service boats, local canoes and pontoon ferry. The questions were formulated so as to draw out information on the nature and probable causes of boat and ferry incidence they had encountered in Nigeria waterways. The questionnaires that were provided for them gave response regarding to other human, natural and technical factors which they consider as related to such incidences.

2.4 Questionnaire

According to Carl and Roger [12], a questionnaire is a list of research or surveyed questions with multiple choice answers administered to respondents and designed to mainly extract specific information about a given topic.

It serves four (4) basic purposes which include:

- to collect data;
- to make data comparable to the analysis
- to reduce formulating and asking of questions; and
- to make questions engaging and diverse.

2.5 Technique of Data Collection

Various techniques of data collection have been proposed by several researchers in carrying out research, amongst these different techniques, the most essential techniques suggested by researchers in carrying out research projects was the primary and secondary data collection methods as described by ACAPS [8].

2.6 Primary and Secondary Data

Primary data are data that are previously unknown and which have been obtained directly by the researcher for a particular research project. Primary data may include survey, observation and experimental data collected to solve the particular problem under investigation [12]. Secondary data may be published research, internet materials, media reports, and data which has been cleaned, analyzed and collected for a purpose other than the needs assessment, such as academic research or an agency or sector specific monitoring reports.

2.7 Administration of the Apparatus

A total of three hundred (300) questionnaires were administered to the respondents in both

public and private establishments operating within Nigeria's inland waterways stretching mainly from Warri to Yenagoa to Port Harcourt.

2.8 Data Analysis

The data was analyzed using the concept of Chi-Square analysis.

2.9 Definition of X^2

The X^2 test is an important extension of hypothesis testing and is used when it is wished to compare an actual, observed distribution with a hypothesized or expected distribution. It is often referred to as a' goodness of fit' test. The use of the Chi-Square test was considered appropriate for testing the validity and reliability of each hypothesis.

The formula for the calculation of X^2 is as follows:

$$X^2 = \sum \frac{(fo-fe)^2}{fe} \quad (1)$$

Where;

f_o = Observed frequency of the value;
f_e = expected frequency of the value;
X^2= calculated value; $\sum$ = summation.

2.10 Degree of Freedom

For this purpose, V = (R-1) (C – 1). The expected frequency can be computed without having to estimate the population parameters from sample statistics. (R-1) (C – 1) shows the constraint condition for the expected frequencies.

Where R = Row, C = Column total Degree of freedom, V = (R-1) (C – 1) = (4-1) (2-1) = (3) (1) = 3; $\Rightarrow$ Degree of Freedom V = 3.

2.11 Hypothesis

The objective of this project was to compare the analysis of the fatality rate of boat and ferry accident on inland waterway in Nigeria which identifies the fact that human, environmental/natural, and technical factor comprises the causes of boat and ferry accidents. Hence, in order to predict the fundamental causes of both accidents and discussing the necessary preventive measures afterwards, it is necessary to establish an X^2 (Chi-Square) analysis for obtaining trends of the accidents. This analysis represents the object of the hypothesis.

A hypothesis or significant testing is testing a belief or opinion by statistical method. It is used to decide if the observed samples differ significantly from the expected result and thus helps to decide whether to accept or reject the hypothesis. There are only four (4) possible results when we test the hypothesis:

i. We accept a true hypothesis (correct hypothesis).
ii. We reject a false hypothesis (a correct decision).
iii. When we reject a true hypothesis, it is known as a Type I error (an incorrect decision).
iv. When we accept a false hypothesis, it is known as a Type II error (an incorrect decision).

The researcher used a significance level of 0.05 (5%).

A null hypothesis is a statistical hypothesis that is tested for possible rejection under the assumption that it is true (usually that observations, are result of chance). The hypothesis contrary to the null hypothesis, usually that the observations are the result of a real effect, is known as alternative hypothesis designated as H_1. If the population parameter is equal to an assumed or hypothetical value, it is referred to as null hypothesis designated as H_0. A statistical test does not prove a null hypothesis; it rather leads to an acceptance as reasonable or a rejection as unreasonable.

- $H0_1$ symbolize that human factor constitutes the core causes of boat and ferry accidents in Nigeria inland waterways.
- $H0_2$ symbolize that natural factor constitute the core causes of boat and ferry accidents in Nigeria inland waterways.
- $H0_3$ symbolize that technical factor constitute the core causes of boat and ferry accidents in Nigeria inland waterways.
- $H0_4$ symbolize the identification of the nature of safety problem in ferry transport through root cause analysis
- $H0_5$ symbolize that stricter enforcement of maritime safety rules and regulations will improve the occurrences of accidents on inland waterways.

When the sample result fails to support the null hypothesis, we subsequently conclude that something else is true. When we reject the null hypothesis, the conclusion, we then accept is called the alternative (or research) hypothesis. The research hypothesis symbolize as $H_{1,}$ is a statement specifying that the population parameter is a value other than that specified in the null hypothesis. This is to say that the null hypothesis is a negation of the research hypothesis. The research hypothesis can neither be proved directly nor rejected directly.

When the test statistics obtained from the sample falls within the acceptance region, our decision will either be accepted H_0 and consequently rejected H_1. The implication is that the sample evidence does not establish beyond a reasonable doubt that the null hypothesis is false. On the other hand, where the test statistics falls within the rejection region, our decision will be to reject H_0 and accept H_1. The effect here is that the difference between the sample statistics and the hypothesized population parameter is statistically significant.

It is obviously not possible to make a correct decision with hundred percent certainties when a hypothesis is tested by sampling; there is always a possibility of either a Type I or Type II error but not both. The errors are split into two types because there are situations where it is much more important to avoid one type of error rather than the other. The risk associated with the two types of error is denoted by alpha and beta, thus:

P (Type I error) = alpha
P (Type II error) = beta

The alpha risk is the level of significance chosen for the hypothesis test, most commonly(5%) .

Table 1. In hypothesis

Decision	h_0 true	h_0 false
reject h_0	type i	type
accept h_0	correct	type ii error

3. RESULTS AND DISCUSSION

3.1 Presentation of Results

Data were subjected to hypothetical testing of which the valid results and their interpretations were expressly stated. It also covers the result of the questionnaire survey sent out. The sampling was strictly through the use of a self-constructed questionnaire. The total number of questionnaires sent out was 300 and 280 respondents completed and returned the questionnaire.

The Table below gives details of data collected and the nature of responses received for the 'YES' and 'NO' questions.

Table 2. Sample size selection

Respondents	Number selected
Captains	30
Engineers	60
Quartermaster	60
Deckhands	50
Oilers	40
Naval officer	20
Marine police	30
Others	10
Total	300

Table 2. shows how the questionnaires were distributed and the number of questionnaires distributed to the different groups of respondents.

The responses to the administered questionnaires as shown above in Table 3. Two hundred and eighty (280) questionnaires were completed and returned out of the 300 questionnaires administered. Twenty (20) questionnaires or 6.6%, ($\frac{20}{300}$ x 100 = 6.67%,) of the total number of respondents did not complete or return the questionnaire. These questionnaires could not be retrieved probably due to lack of willingness to complete and return them on time. $\frac{280}{300}$ X 100 = 93.3%. 93.3%, represent (280) completed questionnaires returned represent as shown in Table 4.

The responses to the administered questionnaires are shown above in Table 4, 280 questionnaires were completed and returned out of the 300 questionnaires administered. 20 of the questionnaires were not returned and could not be recovered. 6.667% represent 20 uncompleted questionnaires returned as shown, $\frac{20}{300}$ X 100 = 6.667%.

To further verify the validity of the above data obtained from the field study from the Table 1, 2 and 3 the use of Chi-Square analysis was then applied.

Table 3. Respondent's level and rate of refusal

Respondents	Number	No. of response expected	Actual response	Refusal rate
Captains	30	30	30	0
Engineers	60	60	57	3
Quartermasters	60	60	55	5
Deckhand	50	50	47	3
Oilers	40	40	35	5
Naval officer	20	20	17	3
Marine police	30	30	29	1
Others	10	10	10	0
Total	300	300	280	20

Table 4. Responses to the administered questionnaires

Respondents	No of questionnaires sent out"	No of questionnaires returned
Captains	30	30
Engineers	60	57
Quartermasters	60	55
Deckhand	50	47
Oilers	40	35
Naval officer	20	17
Marine police	30	29
Others	10	10
Total	300	280

With the use of Chi-Square Analysis, the following five hypotheses were then tested:

- $H0_1$ symbolize that human factor constitute the core causes of boat and ferry accidents in Nigeria inland waterways.
- $H0_2$ symbolize that natural factor constitute the core causes of boat and ferry accidents in Nigeria inland waterway.
- $H0_3$ symbolize that technical factor constitute the core causes of boat and ferry accidents in Nigeria inland waterways.
- $H0_4$symbolize the identification of the nature of safety problems in ferry transport through root cause analysis.
- $H0_5$ symbolize that stricter enforcement of maritime safety rules and regulations will improve the occurrences of accidents on inland waterways.

The use of the Chi-Square test was considered appropriate for testing the validity and reliability of each hypothesis. The formula used for a "Strongly Agree" or "Strongly Disagree" question from equation 1, was:

$$X^2 = \sum \frac{(fo-fe)^2}{fe}$$

Where;

fo = Observed frequency of the value;
Fe = expected frequency of the value;
X^2 = calculated value;
$\sum$ = summation.

The significant level used was 0.05 and would be adopted for this work.

The degree of freedom was calculated as follows:

Where

R = Row, C = Column total
Degree of freedom, V = (R-1) (C – 1)
R = 4, C = 2 (these values are represented in the Chi-Square distribution table, in appendix 1.
$\Rightarrow$ (4-1) (2-1)
= (3) (1) = 3;
$\Rightarrow$ Degree of Freedom, V = 3

The five null hypotheses were tested one after the other to ascertain their validity.

$$\text{Expected value} = \frac{\text{Row Total X Column Total}}{\text{Grand Total}}$$

Hypothesis 1

$H0_1$ symbolize that human factor constitute the core causes of boat and ferry accidents in Nigeria inland waterways.

From Table 5, a total of two hundred and seventy (270) respondents responded 'YES' while only ten (10) says; 'NO' an indication that 96.4%, ($\frac{270}{280}$ x 100 = 96 .4%) support the fact that human factor constitute the core causes of boat and ferry accidents while only 3.5%, ($\frac{10}{280}$ x 100 = 3.5%) disagreed.

Response to this question was analyzed as follows to obtain X^2

Table 7. shows the computation for the X^2 from the different values of fo , fe , $(f_o - fe)^2$ and $\frac{(fo-fe)^2}{fe}$. The theoretical value of X^2 obtained at the degree of freedom 3, and at the level of confidence of 0.05 was 7.815. Since the calculated value of X^2 = 0.368 which is less than the theoretical value, it therefore, follows that the null hypothesis as stated is valid.

Hypothesis 2

$H0_2$ symbolize that natural factor constitute the core causes of boat and ferry accidents in Nigeria inland waterway.

From the field study, as shown in Table 8, a total of two hundred and fifty-nine (259) respondents responded 'YES' while twenty one (21) says; 'NO' an indication that 92.5%, ($\frac{259}{280}$ X 100 = 92.5%) support the fact that environmental factor constitute the core causes of marine offshore accidents while only 7.5%, ($\frac{21}{280}$ X 100 = 7.5%) disagreed.

Response to this question was then analyzed as follows to obtain X^2 ;

The results from the computation of X^2 = 1.694 Therefore Table 10 show the second null hypothesis as stated is valid since the computation of X^2 is = 1.694 and is less than the theoretical value of 7.815. The null hypothesis stated earlier is valid.

Hypothesis 3

$H0_3$ symbolize that technical factor constitute the core causes of boat and ferry accidents in Nigeria inland waterways.

From Table. 11. as shown above, a total of two hundred and thirty (230) respondents responded

Table 5. Observed values compiled from the 'Yes' & 'No' respondents

Respondents	Yes	No	Total
Captains	29	1	30
Engineers	55	3	57
Quartermaster	54	0	55
Deckhand	47	0	47
Oiler	33	2	35
Naval officer	16	1	17
Marine police	27	2	29
Others	9	1	10
Total	270	10	280

Table 6. The value of X^2 Obtained

	"Yes" Column	"No" Column
I.	$\frac{29X\ 270}{280}$ = 27.96	$\frac{1X\ 270}{280}$ = 0.96
	$\frac{54\ X\ 270}{280}$ = 52.07	$\frac{3X\ 270}{280}$ = 2.89
II.	$\frac{55\ X\ 270}{280}$ = 53.03	$\frac{0\times270}{280}$ = 0.00
III.	$\frac{47\ X\ 270}{280}$ = 45.32	$\frac{0X\ 270}{280}$ = 0.00
	$\frac{33X\ 270}{280}$ = 31.82	$\frac{2X\ 270}{280}$ = 1.93
	$\frac{16X\ 270}{280}$ = 15.43	$\frac{1X\ 270}{280}$ = 0.96
IV.	$\frac{27X\ 270}{280}$ = 26.04	$\frac{2X\ 270}{280}$ = 1.93
V.	$\frac{9X\ 270}{280}$ = 8.68	$\frac{1X\ 270}{280}$ = 0.96

Table 7. Computation of X^2

f_o	f_e	$(f_o - f_e)$	$(f_o - fe)^2$	$\frac{(f_o - fe)^2}{f_e}$
29	27.96	1.04	1.082	0.039
54	52.07	1.93	3.725	0.072
55	53.03	1.97	3.881	0.073
47	45.32	1.68	2.822	0.062
33	31.82	1.18	1.392	0.044
16	15.43	0.57	0.325	0.021
27	26.04	0.96	0.922	0.035
9	8.68	0.32	0.102	0.012
1	0.96	0.04	0.0016	0.0017
3	2.89	0.11	0.0121	0.0004
0	0.00	0.00	0.000	0.000
0	0.00	0.00	0.000	0.000
2	1.93	0.07	0.0049	0.0025
1	0.96	0.04	0.0016	0.0017
2	1.93	0.07	0.0049	0.0025
1	0.96	0.04	0.0016	0.0017
				$X^2 = 0.368$

Table 8. Observed values compiled from the "yes" & "no" respondents

Respondents	Yes	No	Total
Captains	30	0	30
Engineers	51	6	57
Quartermasters	51	4	55
Deckhands	44	3	47
Oilers	33	2	35
Naval officer	15	2	17
Marine police	27	2	29
Others	8	2	10
Total	259	21	280

Table 9. The value of X^2 obtained

	"Yes" Column	"No" Column
I.	$\frac{30\ X259}{280}$ = 27.75	$\frac{0\ X\ 259}{280}$ = 0.00
II.	$\frac{51\ X2\ 59}{280}$ = 47.18	$\frac{6\ X\ 259}{280}$ = 5.55
III.	$\frac{51\ X\ 259}{280}$ = 47.18	$\frac{4X\ 259}{280}$ = 3.70
IV.	$\frac{44\ X\ 259}{280}$ = 40.70	$\frac{3\ X\ 259}{280}$ = 2.78
V.	$\frac{33X\ 259}{280}$ = 30..53	$\frac{2\ X\ 259}{280}$ = 1.85
VI.	$\frac{15\ X\ 259}{280}$ = 13.88	$\frac{2\ X\ 259}{280}$ = 1.85
VII.	$\frac{27\ X\ 259}{280}$ = 24.98	$\frac{2\ X\ 259}{280}$ = 1.85
VIII.	$\frac{8\ X\ 259}{280}$ = 7.40	$\frac{2\ X\ 259}{280}$ = 1.85

'YES' while fifty (50) says; 'NO' an indication that 82.1%, ($\frac{230}{280}$ x 100 = 82.1%) support the fact that technical factor constitute the core causes of marine offshore accidents in Nigeria while 17.8%, ($\frac{50}{280}$ x 100 = 17.8%) disagreed. Response to this question was then analyzed as follows to obtain X^2.

Since the sample result fails to support the null hypothesis, we subsequently conclude that something else is true, which is the alternative hypothesis H_3. This statement is specifying that the population parameter is a value other than that specified in the null hypothesis $H0_3$.

Hypothesis 4

- $H0_4$ symbolize the identification of the nature of safety problems in ferry transport through root cause analysis.

From Table 14. a total of two hundred and forty-five (245) respondents responded 'YES' while thirty five (35) says; 'NO' an indication that 87.5%, ($\frac{245}{280}$ x 100 = 87.5%) support the fact that the provision of sufficient internal buoyancy compartments in order to secure the stability of a vessel will reduce marine offshore accidents while 12.5%, ($\frac{35}{280}$ x 100 = 12.5%) disagreed. Response to this question was then analyzed as follows to obtain X^2.

The theoretical value of X^2 at the degree of freedom 3, at a level of confidence of 0.05 is 7.815. Since the calculated value of X^2 is 4.983 and is below the theoretical value, it follows therefore that the null hypothesis is valid.

- $H0_5$ symbolize that stricter enforcement of maritime safety rules and regulations will improve the occurrences of accidents on inland waterways.

Table 10. Computation of X^2

fo	fe	$(fo-fe)$	$(fo-fe)^2$	$\frac{(fo-fe)^2}{fe}$
30	27.75	2.25	5.063	0.182
51	47.18	3.82	14.592	0.309
51	47.18	3.82	14.592	0.309
44	40.70	3.30	10.89	0.268
33	30.53	2.47	6.101	0.199
15	13.88	1.12	12.544	0.090
27	24.98	2.02	4.080	0.163
8	7.40	0.60	0.360	0.049
0	0.00	0.00	0.000	0.000
6	5.55	0.45	0.203	0.036
4	3.70	0.30	0.090	0.024
3	2.78	0.22	0.048	0.017
2	1.85	0.60	0.023	0.012
2	1.85	0.15	0.023	0.012
2	1.85	0.15	0.023	0.012
2	1.85	0.15	0.023	0.012
				X^2 = 1.694

Table 11. Observed values compiled from the "yes" & "no" respondents

Respondents	Yes	No	Total
Captains	23	7	30
Engineers	51	6	57
Deckhands	48	7	55
Quartermasters	41	6	47
Oilers	29	6	35
Naval officer	11	6	17
Marine police	23	6	29

Others	4	6	10
Total	230	50	280

Table 12. The value of x^2 obtained

	"Yes" Column	"No" column
I.	$\frac{23\ X\ 230}{280}$ = 18.89	$\frac{7X\ 230}{280}$ = 5.75
II.	$\frac{51\ X\ 230}{280}$ = 41.89	$\frac{6X\ 230}{280}$ = 4.93
III.	$\frac{48X\ 230}{280}$ = 39.43	$\frac{7X\ 240}{280}$ = 5.75
IV.	$\frac{41X\ 230}{280}$ = 33.68	$\frac{6X\ 230}{280}$ = 4.93
	$\frac{29X\ 230}{280}$ = 23.82	$\frac{6X\ 230}{280}$ = 4.93
V.	$\frac{11X\ 230}{280}$ = 9.04	$\frac{6X\ 230}{280}$ = 4.93
VI.	$\frac{23X\ 230}{280}$ = 18.89	$\frac{6X\ 230}{280}$ = 4.93
VII.	$\frac{4X\ 230}{280}$ = 3.29	$\frac{6X\ 230}{280}$ = 4.93

Table 13. Computation of X^2

fo	fe	$(fo-fe)$	$(fo-fe)^2$	$\frac{(fo-fe)^2}{fe}$
23	18.89	4.11	16.892	0.894
51	41.89	9.11	82.992	1.981
48	39.43	8.57	73.445	1.863
41	33.68	7.32	53.582	1.591
29	23.82	5.18	26.832	1.126
11	9.04	1.96	3.842	0.425
23	18.89	4.11	16.892	0.894
4	3.29	0.71	0.504	0.153
7	5.75	1.25	1.563	0.272
6	4.93	1.07	1.145	0.232
7	5.75	1.25	1.563	0.272
6	4.93	1.07	1.145	0.232
6	4.93	1.07	1.145	0.232
6	4.93	1.07	1.145	0.232
6	4.93	1.07	1.145	0.232
6	4.93	1.07	1.145	0.232
				X^2 = 10.863

Table 14. Observed values compiled from the "yes" & "no" respondents

Respondents	Yes	No	Total
Captains	25	5	30
Engineers	49	8	57
Quartermasters	52	3	55
Deckhands	40	7	47
Oilers	32	3	35
Naval officer	14	3	17
Marine police	26	3	29
Others	7	3	10
Total	245	35	280

From Table 16 a total of two hundred and sixty-seven (267) respondents responded 'YES' while only (13) says; 'NO' an indication that 95.4%, ($\frac{267}{280}$ X 100 = 95.4%) support the fact that stricter enforcement of maritime safety rules and regulations will ameliorate the frequencies of

accidents onboard while 4.6%, ($\frac{13}{280}$ X 100 = 4.6%) disagreed. Response to this question was then analyzed as follows to obtain X^2.

The theoretical value of X^2 at the degree of freedom 3 at a level of confidence of 0.05 is 7.815. Since the calculated value of X^2 is 0.626 and is below the theoretical value and within the acceptance region. It follows therefore that the null hypothesis is valid. The validity of the five hypotheses above further confirmed the logical empirical analysis of the results obtained from the survey.

Table 15. The Value of X^2 Obtained

"Yes" Column		"No" column	
I.	$\frac{25X\ 245}{280}$ =	21.88	$\frac{5X\ 245}{280}$ = 4.38
II.	$\frac{49\ X\ 245}{280}$ =	42.88	$\frac{8\ X\ 245}{280}$ = 7.00
III.	$\frac{52X\ 245}{280}$ =	45.50	$\frac{3\ X\ 245}{280}$ = 2.63
IV.	$\frac{40\ X\ 245}{280}$ =	35.00	$\frac{7\ X\ 245}{280}$ = 6.13
V.	$\frac{32\ X\ 245}{280}$ =	28.00	$\frac{3\ X\ 245}{280}$ = 2.63
VI.	$\frac{14\ X\ 245}{280}$ =	12.25	$\frac{3\ X\ 245}{280}$ = 2.63
VII.	$\frac{26\ X\ 245}{280}$ =	22.75	$\frac{3\ X\ 245}{280}$ = 2.63
VIII.	$\frac{17\ X\ 245}{280}$ =	6.13	$\frac{3\ X\ 245}{280}$ = 2.63

Table 16. Computation of X^2

fo	fe	$(fo-fe)$	$(fo-fe)^2$	$\frac{(fo-fe)^2}{fe}$
25	21.88	3.12	9.734	0.445
49	42.88	6.12	37.454	0.873
52	45.50	6.50	42.250	0.929
40	35.00	5.00	25.000	0.714
32	28.00	4.00	16.00	0.571
14	12.25	1.75	3.063	0.250
26	22.75	3.25	10.563	0.464
7	6.13	0.87	0.757	0.123
5	4.38	0.62	0.384	0.088
8	7.00	1.00	1.000	0.143
3	2.63	0.37	0.137	0.052
7	6.13	0.87	0.757	0.123
3	2.63	0.37	0.137	0.052
3	2.63	0.37	0.137	0.052
3	2.63	0.37	0.137	0.052
3	2.63	0.37	0.137	0.052
				X^2 =4.983

Table 17. Observed values compiled from the "yes" & "no" respondents

Respondents	Yes	No	Total
Captains	27	3	30
Engineers	55	2	57
Quartermasters	53	2	55
Deckhands	47	0	47
Oilers	35	0	35
Naval officer	15	2	17
Marine police	27	2	29

Others	8	2	10
Total	267	13	280

Table 18. The value of x^2 obtained

	"Yes" column	"No" column
I.	$\frac{27\ X\ 267}{280}$ = 25.75	$\frac{3\ X\ 267}{280}$ = 2.86
II.	$\frac{55\ X\ 267}{280}$ = 52.45	$\frac{2\ X\ 267}{280}$ = 1.91
	$\frac{53\ X\ 267}{280}$ = 50.54	$\frac{2\ X\ 267}{280}$ = 1.91
	$\frac{47\ X\ 267}{280}$ = 44.82	$\frac{0X\ 267}{280}$ = 0.00
	$\frac{35\ X\ 267}{280}$ = 33.38	$\frac{0\ X\ 267}{280}$ = 0.00
	$\frac{15\ X\ 267}{280}$ = 14.30	$\frac{2\ X\ 267}{280}$ = 1.91
III.	$\frac{27X\ 267}{280}$ = 25.75	$\frac{2\ X\ 267}{280}$ = 1.91
IV.	$\frac{8\ X\ 267}{280}$ = 7.63	$\frac{2\ X\ 267}{280}$ = 1.91

Table 19. Computation of X^2

fo	fe	$(fo-fe)$	$(fo-fe)^2$	$\frac{(fo-fe)^2}{fe}$
27	25.75	1.25	1.563	0.061
55	52.45	2.55	6.503	0.124
53	50.54	2.46	6.052	0.119
47	44.82	2.18	4.752	0.106
35	33.38	1.62	2.624	0.079
15	14.30	0.70	0.490	0.034
27	25.75	1.25	1.563	0.061
8	7.63	0.37	0.137	0.018
3	2.86	0.14	0.019	0.007
2	1.91	0.09	0.008	0.004
2	1.91	0.09	0.008	0.004
0	0.00	0.00	0.000	0.000
0	0.00	0.00	0.000	0.000
2	1.91	0.09	0.008	0.004
2	1.91	0.09	0.008	0.004
2	1.91	0.09	0.008	0.004
				X^2 = 0.626

3.2 Discussions of Findings

Below are the findings from the study carried out during the course of this research. The researcher discovered that the major causes of boat and ferry accidents in Nigeria include human factor errors, natural factors, and technical factors. Technical failures are shortcomings within the vessel, such as, steering failure, engine failure, corrosion or hull failure arising from defective materials or construction, such as aids to navigation.

This study has found the following for each tested hypothesis:

$H0_1$: that human factor constitutes the core causes of boat and ferry accidents in Nigeria inland waterways, as reflected in the calculated value of X^2 = (0.368), a value within the acceptance region as it is less than the theoretical value of X^2 = (7.815). According to the study conducted by Psaraftis et al. (1998) on the comprehensive analysis of the human element as a factor of marine accidents; the study found out that factors related to human errors- overloading, night sailing without adequate light, overcrowding, over speeding, collision, grounding etc. constitute the single most common cause of marine accidents.

$H0_2$: the hypothesis which stated that natural factor constitute the core causes of boat and ferry accidents in Nigeria inland waterways to be true, by the 92% response rate recorded in the 'Yes' column and this was also reflected in the calculated X^2 = (1.694) value which falls comfortably within the acceptance region (7.815). On the other hand, natural phenomena such as current, tide and tidal stream, severe wind, reduced visibility (fog, heavy snow and rain), stormy seas, darkness immensely contribute to the human errors affecting the ship or those controlling her.

$H0_3$: That technical factor such as failure of navigational equipment, corrosion, engine failure constitutes the core causes of boat and ferry accidents in Nigeria inland waterways. From the increased rate of 'No' response as recorded in the "No" column and reflected in the calculated X^2 value which is = 10.863 a value just 3.048 above the acceptance region which confirms that the hypothesis was not accepted by most respondents. It also indicates that the respondents are quite aware of other primary or core causes of marine offshore accidents in Nigeria.

$H0_4$: hypothesis, shows that the provision of sufficient internal buoyancy compartments in order to secure the stability of a vessel will reduce marine offshore accidents, as clearly reflected in the calculated value of X^2 = (4.983), a value within the acceptance region as it is less than the theoretical value of X^2 = (7.815).

$H0_5$: hypothesis thus verifies that stricter enforcement of maritime safety rules and regulations will reduce the frequencies of accidents onboard as clearly reflected in the calculated value of X^2 = (0.626), a value within the acceptance region as it is less than the theoretical value of X^2 = (7.815). Increase in the 'Yes' column is an indication that the respondents are aware of the significance of the enforcement of maritime safety rules and regulations as a measure of preventing the numerous boat and ferry accidents in Nigeria.

Fig. 1 demonstrated the accident cases in the three states. In 2013, River state experienced 10 accident cases, Bayelsa state experienced 7 accident cases while Delta experienced 6 accident cases. The Comparative result for accident cases for 2013 revealed that River state experienced the highest accident cases, followed by Bayelsa state and finally Delta state. Results for 2014 revealed 10 cases in Bayelsa, 9 accident cases in River state and 8 accident cases in Delta. Comparative analysis for 2014 revealed higher accident cases in Bayelsa, Followed by River state and finally Delta state. Results for 2015 for the water-way accident revealed 10 accident cases in Delta, 7 accident cases in River state and 6 accident cases in Bayelsa. Comparative analysis of the results for the fatality rate in year 2015 shown that Delta state experienced higher accident cases, followed by River state and Bayelsa state. Accident cases for 2016 revealed 8 accident cases in River state, 7 accident cases in Bayelsa and 5 accident cases in Delta state. Comparing the results showed that River state experienced the highest accident cases followed by Bayelsa state and finally Delta state. The accident cases in 2017 revealed 5 accident cases in River state, 4 accident cases in Bayelsa and 3 accident cases in Delta. The comparative results revealed higher accident cases in River state, followed by Bayelsa state and finally Delta. Accident cases in 2018, 4 cases of accident in River state, 3 accident cases in Bayelsa state and 2 accident cases in Delta state. Comparing the results above, higher accident cases was experienced in River state, followed by Bayelsa state and Delta state.

WATER-WAY ACCIDENT

Table 20.Total water-way accident cases reported

S/ No	Years	Number of cases reported
1	2013	7
2	2014	10
3	2015	6
4	2016	7
5	2017	4
6	2018	3

Source: marine police Yenagoa, Bayelsa State

WATER-WAY ACCIDENT

Table 21.Total water-way accident cases reported

S/ no	Years	Number of cases reported
1	2013	6
2	2014	8
3	2015	10
4	2016	5
5	2017	3
6	2018	2

Source: Marine Police Warri, Delta State

WATER-WAY ACCIDENT

Table 22. Total water-way accident cases reported

S/ no	Years	Number of cases reported
1	2013	10
2	2014	9
3	2015	7
4	2016	8
5	2017	5
6	2018	4

Source: marine police Port Harcourt, rivers state

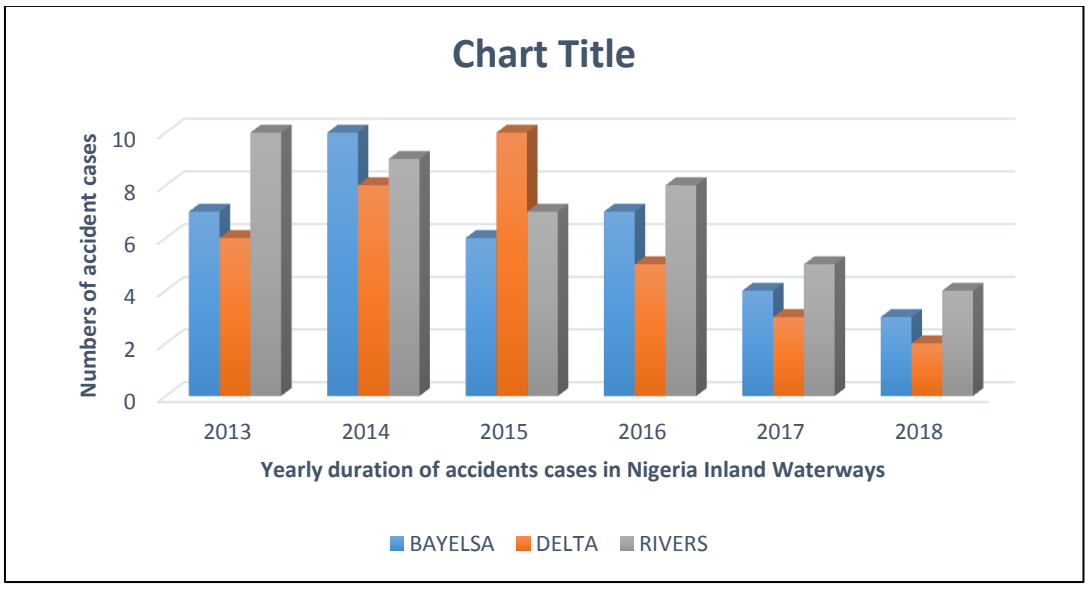

Fig. 1. Graphical illustration of water –ways accidents in Bayelsa, Delta and River State

4. CONCLUSION

The safety of life and navigation at sea are important to coastal, flag states and the entire international shipping community in sustaining the growth of global sea trade. National governments and indeed the Federal government of Nigeria have committed substantial resources and efforts on programmes aimed at reducing the incidence of accident involving marine vessels at sea. The primary causes of boat and ferry accident considered in

this paper include human, natural, and technical factors. The human factors include the following: overloading, over speeding, collision, night sailing without adequate light, grounding, overcrowding etc. Natural factors investigated are: sea condition (current), tides and tidal stream, severe wind, reduced visibility, stormy seas, darkness, rainstorms and waves. Technical factors include shortcomings within the ship, such as, steering failure, engine failure, corrosion or hull failure arising from defective materials or construction. These findings have implication on regulation and enforcement by relevant authorities. The level of regulation maintained by the flag states can reduce the contribution of these factors in boat and ferry accidents.

5. RECOMMENDATIONS

In view of the findings and conclusion drawn in this work, the following recommendations will help to prevent boat and ferry accidents on inland waterways in Nigeria and ensure sustained safety during navigation.

1. Government should support these agencies such as NIWA, Marine Police, NIMASA, and the Nigeria Navy if possible with equipment's, logistics in policing the waterway.
2. There is the need to register all non-conventional ships and to conduct regular inspections in order to ensure their continued safety.
3. Night sailing without adequate light should not be encouraged.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX

Appendix Table 1. Table of the chi square distribution

	Level of Significance α								
df	0.200	0.100	0.075	0.050	0.025	0.010	0.005	0.001	0.0005
1	1.642	2.706	3.170	3.841	5.024	6.635	7.879	10.828	12.116
2	3.219	4.605	5.181	5.991	7.378	9.210	10.597	13.816	15.202
3	4.642	6.251	6.905	7.815	9.348	11.345	12.838	16.266	17.731
4	5.989	7.779	8.496	9.488	11.143	13.277	14.860	18.467	19.998
5	7.289	9.236	10.008	11.070	12.833	15.086	16.750	20.516	22.106
6	8.558	10.645	11.466	12.592	14.449	16.812	18.548	22.458	24.104
7	9.803	12.017	12.883	14.067	16.013	18.475	20.278	24.322	26.019
8	11.030	13.362	14.270	15.507	17.535	20.090	21.955	26.125	27.869
9	12.242	14.684	15.631	16.919	19.023	21.666	23.589	27.878	29.667
10	13.442	15.987	16.971	18.307	20.483	23.209	25.188	29.589	31.421
11	14.631	17.275	18.294	19.675	21.920	24.725	26.757	31.265	33.138
12	15.812	18.549	19.602	21.026	23.337	26.217	28.300	32.910	34.822
13	16.985	19.812	20.897	22.362	24.736	27.688	29.820	34.529	36.479
14	18.151	21.064	22.180	23.685	26.119	29.141	31.319	36.124	38.111
15	19.311	22.307	23.452	24.996	27.488	30.578	32.801	37.698	39.720
16	20.465	23.542	24.716	26.296	28.845	32.000	34.267	39.253	41.309
17	21.615	24.769	25.970	27.587	30.191	33.409	35.719	40.791	42.881
18	22.760	25.989	27.218	28.869	31.526	34.805	37.157	42.314	44.435
19	23.900	27.204	28.458	30.144	32.852	36.191	38.582	43.821	45.974
20	25.038	28.412	29.692	31.410	34.170	37.566	39.997	45.315	47.501
21	26.171	29.615	30.920	32.671	35.479	38.932	41.401	46.798	49.013
22	27.301	30.813	32.142	33.924	36.781	40.289	42.796	48.269	50.512
23	28.429	32.007	33.360	35.172	38.076	41.639	44.182	49.729	52.002
24	29.553	33.196	34.572	36.415	39.364	42.980	45.559	51.180	53.480
25	30.675	34.382	35.780	37.653	40.646	44.314	46.928	52.620	54.950
26	31.795	35.563	36.984	38.885	41.923	45.642	48.290	54.053	56.409
27	32.912	36.741	38.184	40.113	43.195	46.963	49.645	55.477	57.860
28	34.027	37.916	39.380	41.337	44.461	48.278	50.994	56.894	59.302
29	35.139	39.087	40.573	42.557	45.722	49.588	52.336	58.302	60.738
30	36.250	40.256	41.762	43.773	46.979	50.892	53.672	59.704	62.164
40	47.269	51.805	53.501	55.759	59.342	63.691	66.766	73.403	76.097
50	58.164	63.167	65.030	67.505	71.420	76.154	79.490	86.662	89.564
60	68.972	74.397	76.411	79.082	83.298	88.380	91.952	99.609	102.698
70	79.715	85.527	87.680	90.531	95.023	100.425	104.215	112.319	115.582
80	90.405	96.578	98.861	101.880	106.629	112.329	116.321	124.842	128.267
90	101.054	107.565	109.969	113.145	118.136	124.117	128.300	137.211	140.789
100	111.667	118.498	121.017	124.342	129.561	135.807	140.170	149.452	153.174

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