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.
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:

$$X^2 = \sum \frac{(o-e)^2}{e}$$  (1)

Where;

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

- $H_0_1$ symbolize that human factor constitutes the core causes of boat and ferry accidents in Nigeria inland waterways.
- $H_0_2$ symbolize that natural factor constitute the core causes of boat and ferry accidents in Nigeria inland waterways.
- $H_0_3$ symbolize that technical factor constitute the core causes of boat and ferry accidents in Nigeria inland waterways.
- $H_0_4$ symbolize the identification of the nature of safety problem in ferry transport through root cause analysis
- $H_0_5$ 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 symbolized 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:

$P\ (\text{Type I error}) = \alpha$

$P\ (\text{Type II error}) = \beta$

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

| Decision | $h_0$ true | $h_0$ false |
|----------|------------|-------------|
| reject $h_0$ | type I | type II error |
| 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 were not returned and could not be recovered. 6.667% represent 20 uncompleted questionnaires returned as shown, $\frac{20}{300} \times 100 = 6.67\%$.

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, $\frac{20}{300} \times 100 = 6.67\%$.

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.

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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:

- $H_0_1$: symbolize that human factor constitute the core causes of boat and ferry accidents in Nigeria inland waterways.
- $H_0_2$: symbolize that natural factor constitute the core causes of boat and ferry accidents in Nigeria inland waterway.
- $H_0_3$: symbolize that technical factor constitute the core causes of boat and ferry accidents in Nigeria inland waterways.
- $H_0_4$: symbolize the identification of the nature of safety problems in ferry transport through root cause analysis.
- $H_0_5$: 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:

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

Where;

$fo =$ Observed frequency of the value;
$fe =$ expected frequency of the value;

$X^2 =$ calculated value;
$\Sigma =$ summation.

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

The degree of freedom was calculated as follows:

$$R = \text{Row}, \ C = \text{Column total}$$
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).

$\Rightarrow (4-1)(2-1) = (3)(1) = 3$
$\Rightarrow \text{Degree of Freedom, } V = 3$

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

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

**Hypothesis 1**

$H_0$, 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%, \((\frac{270}{280} \times 100 = 96.4\%)\) support the fact that human factor constitute the core causes of boat and ferry accidents while only 3.5%, \((\frac{10}{280} \times 100 = 3.5\%)\) 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 \(fo\), \(fe\), \((fo-fe)^2\) 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 stated is valid.

**Hypothesis 2**

H02 symbolize that natural factor constitute the core causes of boat and ferry accidents in Nigeria inland waterway.

From 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%, \((\frac{259}{280} \times 100 = 92.5\%)\) support the fact that environmental factor constitute the core causes of marine offshore accidents while only 7.5%, \((\frac{21}{280} \times 100 = 7.5\%)\) 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**

H03 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. \(\frac{29\times 270}{280} = 27.96\) | \(\frac{1\times 270}{280} = 0.96\) |
| \(\frac{54 \times 270}{280} = 52.07\) | \(\frac{3 \times 270}{280} = 2.89\) |
| II. \(\frac{55 \times 270}{280} = 53.03\) | \(\frac{0 \times 270}{280} = 0.00\) |
| III. \(\frac{47 \times 270}{280} = 45.32\) | \(\frac{9 \times 270}{280} = 0.00\) |
| \(\frac{33 \times 270}{280} = 31.82\) | \(\frac{2 \times 270}{280} = 1.93\) |
| \(\frac{16 \times 270}{280} = 15.43\) | \(\frac{1 \times 270}{280} = 0.96\) |
| IV. \(\frac{27 \times 270}{280} = 26.04\) | \(\frac{2 \times 270}{280} = 1.93\) |
| V. \(\frac{9 \times 270}{280} = 8.68\) | \(\frac{1 \times 270}{280} = 0.96\) |
Table 7. Computation of $X^2$

| $f_o$ | $f_e$ | $(f_o - f_e)$ | $(f_o - f_e)^2$ | $\frac{(f_o - f_e)^2}{f_e}$ |
|-------|-------|---------------|-----------------|-----------------------------|
| 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                       |
| 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. $\frac{30 \times 259}{280} = 27.75$ | $\frac{0 \times 259}{280} = 0.00$ |
| II. $\frac{51 \times 259}{280} = 47.18$ | $\frac{6 \times 259}{280} = 5.55$ |
| III. $\frac{51 \times 259}{280} = 47.18$ | $\frac{4 \times 259}{280} = 3.70$ |
| IV. $\frac{44 \times 259}{280} = 40.70$ | $\frac{3 \times 259}{280} = 2.78$ |
| V. $\frac{33 \times 259}{280} = 30.53$ | $\frac{2 \times 259}{280} = 1.85$ |
| VI. $\frac{15 \times 259}{280} = 13.88$ | $\frac{2 \times 259}{280} = 1.85$ |
| VII. $\frac{27 \times 259}{280} = 24.98$ | $\frac{2 \times 259}{280} = 1.85$ |
| VIII. $\frac{8 \times 259}{280} = 7.40$ | $\frac{2 \times 259}{280} = 1.85$ |

‘YES’ while fifty (50) says; ‘NO’ an indication that 82.1%, \( \frac{230}{280} \times 100 = 82.1\% \) support the fact that technical factor constitute the core causes of marine offshore accidents in Nigeria while 17.8%, \( \frac{50}{280} \times 100 = 17.8\% \) 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 $H_0$.

**Hypothesis 4**

- $H_{04}$ 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%, ($\frac{35}{280} \times 100 = 12.5\%$) 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%, ($\frac{35}{280} \times 100 = 12.5\%$) 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.

- $H_{05}$ symbolize that stricter enforcement of maritime safety rules and regulations will improve the occurrences of accidents on inland waterways.

### Table 10. Computation of $X^2$

| $f_o$ | $f_e$ | $(f_o - f_e)$ | $(f_o - f_e)^2$ | $\frac{(f_o - f_e)^2}{f_e}$ |
|-------|-------|---------------|-----------------|-----------------------------|
| 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    |
Table 12. The value of $x^2$ obtained

| “Yes” Column | “No” column |
|---------------|-------------|
| I. $\frac{23 \times 230}{280} = 18.89$ | $\frac{7 \times 230}{280} = 5.75$ |
| II. $\frac{51 \times 230}{280} = 41.89$ | $\frac{6 \times 230}{280} = 4.93$ |
| III. $\frac{46 \times 230}{280} = 39.43$ | $\frac{7 \times 240}{280} = 5.75$ |
| IV. $\frac{41 \times 230}{280} = 33.68$ | $\frac{6 \times 230}{280} = 4.93$ |
| V. $\frac{29 \times 230}{280} = 23.82$ | $\frac{6 \times 230}{280} = 4.93$ |
| VI. $\frac{11 \times 230}{280} = 9.04$ | $\frac{6 \times 230}{280} = 4.93$ |
| VII. $\frac{4 \times 230}{280} = 3.29$ | $\frac{6 \times 230}{280} = 4.93$ |

Table 13. Computation of $X^2$

| $f_o$ | $f_e$ | $(f_o - f_e)$ | $(f_o - f_e)^2$ | $\frac{(f_o-f_e)^2}{f_e}$ |
|-------|-------|---------------|-----------------|-------------------------|
| 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                   |

$X^2 = 10.863$

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%, ($\frac{267}{280} \times 100 = 95.4\%$) support the fact that stricter enforcement of maritime safety rules and regulations will ameliorate the frequencies of
accidents onboard while 4.6%, \( \frac{15}{320} \times 100 = 4.6\% \) 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. \( \frac{25}{280} \times 245 \) = 21.88 | \( \frac{5}{280} \times 245 \) = 4.38 |
| II. \( \frac{280}{280} \times 245 \times 245 \) = 42.88 | \( \frac{8}{280} \times 245 \times 245 \) = 7.00 |
| III. \( \frac{52}{280} \times 245 \times 245 \) = 45.50 | \( \frac{3}{280} \times 245 \times 245 \) = 2.63 |
| IV. \( \frac{280}{280} \times 245 \times 245 \) = 35.00 | \( \frac{7}{280} \times 245 \times 245 \) = 6.13 |
| V. \( \frac{280}{280} \times 14 \times 245 \times 245 \) = 28.00 | \( \frac{3}{280} \times 245 \times 245 \) = 2.63 |
| VI. \( \frac{280}{280} \times 26 \times 245 \times 245 \) = 12.25 | \( \frac{3}{280} \times 245 \times 245 \) = 2.63 |
| VII. \( \frac{280}{280} \times 17 \times 245 \times 245 \) = 22.75 | \( \frac{3}{280} \times 245 \times 245 \) = 2.63 |
| VIII. \( \frac{280}{280} \times 11 \times 245 \times 245 \) = 6.13 | \( \frac{2}{280} \times 245 \times 245 \) = 2.63 |

Table 16. Computation of \( X^2 \)

| fo | fe | \( (fo - fe)^2 \) | \( \frac{(fo - fe)^2}{fe} \) |
|----|----|-----------------|------------------|
| 25 | 3.12 | 9.734 | 0.445 |
| 49 | 6.12 | 37.454 | 0.873 |
| 52 | 6.50 | 42.250 | 0.929 |
| 40 | 5.00 | 25.000 | 0.714 |
| 32 | 4.00 | 16.000 | 0.571 |
| 14 | 1.75 | 3.063 | 0.250 |
| 26 | 3.25 | 10.563 | 0.464 |
| 7 | 0.87 | 0.757 | 0.123 |
| 5 | 0.62 | 0.384 | 0.088 |
| 8 | 1.00 | 1.000 | 0.143 |
| 3 | 0.37 | 0.137 | 0.052 |
| 7 | 0.87 | 0.757 | 0.123 |
| 3 | 0.37 | 0.137 | 0.052 |
| 3 | 0.37 | 0.137 | 0.052 |
| 3 | 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    |
| Marine police     | 15  | 2  | 17    |
| Naval officer     | 27  | 2  | 29    |
Table 18. The value of $x^2$ obtained

| “Yes” column | “No” column |
|---------------|-------------|
| \( \frac{27 \times 267}{280} \) = 25.75 | \( \frac{3 \times 267}{280} \) = 2.86 |
| \( \frac{55 \times 267}{280} \) = 52.45 | \( \frac{280}{2 \times 267} \) = 1.91 |
| \( \frac{280}{280} \) = 50.54 | \( \frac{280}{2 \times 267} \) = 1.91 |
| \( \frac{47 \times 267}{280} \) = 44.82 | \( \frac{0 \times 267}{280} \) = 0.00 |
| \( \frac{280}{280} \) = 33.38 | \( \frac{280}{0 \times 267} \) = 0.00 |
| \( \frac{15 \times 267}{280} \) = 14.30 | \( \frac{280}{2 \times 267} \) = 1.91 |
| \( \frac{280}{27 \times 267} \) = 25.75 | \( \frac{280}{2 \times 267} \) = 1.91 |
| \( \frac{8 \times 267}{280} \) = 7.63 | \( \frac{280}{280} \) = 1.91 |

Table 19. Computation of $X^2$

| $f_o$ | $f_e$ | $(f_o - f_e)$ | $(f_o - f_e)^2$ | \( \frac{(f_o - f_e)^2}{f_e} \) |
|-------|-------|---------------|----------------|-------------------------------|
| 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**: 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**: 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 \( \chi^2 = (1.694) \) 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**: 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 \( \chi^2 \) 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**: 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 \( \chi^2 = (4.983) \), a value within the acceptance region as it is less than the theoretical value of \( \chi^2 = (7.815) \).

**H0**: 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 \( \chi^2 = (0.626) \), a value within the acceptance region as it is less than the theoretical value of \( \chi^2 = (7.815) \). 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                        |
**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 accidents 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, 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

| 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   | 5.980 | 7.779 | 8.496 | 9.488 | 11.143 | 13.277 | 14.860 | 18.467 | 19.998 |
| 5   | 7.280 | 9.256 | 10.038 | 10.709 | 12.833 | 15.086 | 16.750 | 20.516 | 22.106 |
| 6   | 8.558 | 10.615 | 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 | 20.000 | 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 | 18.397 | 20.843 | 23.200 | 25.188 | 29.580 | 31.421 |
| 11  | 14.631 | 17.275 | 18.294 | 19.875 | 22.020 | 24.725 | 26.757 | 31.265 | 33.138 |
| 12  | 15.812 | 18.549 | 19.582 | 21.297 | 23.337 | 26.217 | 28.300 | 32.910 | 34.822 |
| 13  | 16.985 | 19.812 | 20.807 | 22.682 | 24.736 | 27.688 | 30.820 | 34.529 | 36.479 |
| 14  | 18.151 | 21.064 | 22.180 | 24.058 | 26.119 | 29.141 | 31.319 | 35.124 | 38.111 |
| 15  | 19.311 | 22.307 | 23.562 | 25.406 | 27.568 | 30.678 | 32.801 | 37.608 | 40.720 |
| 16  | 20.465 | 23.542 | 24.916 | 26.835 | 29.096 | 32.185 | 34.267 | 39.253 | 41.309 |
| 17  | 21.615 | 24.769 | 26.270 | 28.243 | 30.687 | 33.767 | 35.719 | 40.701 | 42.881 |
| 18  | 22.760 | 25.989 | 27.571 | 29.630 | 32.250 | 35.320 | 37.145 | 42.134 | 44.435 |
| 19  | 23.900 | 27.204 | 28.845 | 30.994 | 33.782 | 36.761 | 38.552 | 43.821 | 45.974 |
| 20  | 24.938 | 28.412 | 30.092 | 32.305 | 35.282 | 38.170 | 39.957 | 45.351 | 47.601 |
| 21  | 25.991 | 29.615 | 31.302 | 33.601 | 36.753 | 40.554 | 41.340 | 46.793 | 48.301 |
| 22  | 27.040 | 30.813 | 32.576 | 34.974 | 38.196 | 42.900 | 43.706 | 48.193 | 49.913 |
| 23  | 28.199 | 32.007 | 33.860 | 36.332 | 39.612 | 45.220 | 46.044 | 50.572 | 52.092 |
| 24  | 29.356 | 33.196 | 35.129 | 37.664 | 40.996 | 47.509 | 48.359 | 52.920 | 54.489 |
| 25  | 30.515 | 34.382 | 36.475 | 38.980 | 42.353 | 49.768 | 50.650 | 55.240 | 56.900 |
| 26  | 31.672 | 35.563 | 37.808 | 40.273 | 43.685 | 51.997 | 52.920 | 57.530 | 59.300 |
| 27  | 32.829 | 36.741 | 39.124 | 41.543 | 45.002 | 54.201 | 55.169 | 59.804 | 61.690 |
| 28  | 33.984 | 37.916 | 40.429 | 42.802 | 46.297 | 56.383 | 57.392 | 62.054 | 63.960 |
| 29  | 35.130 | 39.087 | 41.715 | 44.052 | 47.568 | 58.543 | 59.599 | 64.290 | 65.910 |
| 30  | 36.275 | 40.256 | 42.992 | 45.382 | 48.818 | 60.685 | 61.782 | 66.494 | 67.940 |
| 35  | 47.289 | 51.865 | 53.501 | 55.750 | 59.342 | 63.691 | 66.766 | 73.483 | 76.097 |
| 50  | 58.164 | 63.167 | 65.030 | 67.505 | 71.420 | 76.154 | 79.490 | 86.662 | 89.564 |
| 100 | 111.667 | 188.498 | 214.017 | 242.342 | 296.561 | 353.807 | 410.170 | 493.452 | 533.174 |

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Peer-review history:
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