

Impact of Rafted Timbers on Boat Accidents in Ogboinbiri Waterway, Bayelsa State: A Comprehensive Investigation and safety assessment

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Abstract: This investigative study explores the impact of rafted timbers on boat accidents within the Ogboinbiri Waterway in Bayelsa State. The research aims to conduct a comprehensive analysis and safety assessment of the interactions between rafted timber and the occurrence of boat accidents in the region. The investigation involves the collection of extensive data sets related to boat accidents and timber rafting operations, considering both historical and recent incidents. The objectives of the study is to identify the determinant risk factors associated with boat accidents in Ogboinbiri waterway related to rafted timbers and to estimate the occurrence probability of individual risk/hazard types associated with boat accidents in Ogboinbiri waterway operations in Bayelsa state. The study used a mixed method in which both primary and secondary data were used for the study. The primary data was obtained by the use of a checklist administered to randomly selected sample of boat operators, community leaders, boat accident survivors and passengers, Secondary data was obtained from the records maintained by the safety department of the National Union of Maritime Workers. The statistical methods of major component factor analysis was used to analyze the data obtained.. The analysis was implemented by the use of the SPSS version 20.1 statistical software. The result of the study indicates that rafted timbers, human error and weather condition each with Eigen value greater than 1 (Eigen>1), significantly influence or are the major causes of boat accidents in the Ogboinbiri waterway in Bayelsa state. Ultimately, this investigation contributes valuable insight to policy makers, local authorities, and stakeholders involved in water transportation and timber-related industries. The findings are expected to inform evidence-based decisions, fostering safer practice and reducing the incidence of boat accidents in the Ogboinbiri Waterway, thereby promoting the well-being of both the environment and the community.

Keywords: Boat accident, waterways, rafted timbers, occurrence probability, Bayelsa state.

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1.0 Introduction

The persistent inability of Nigeria Ports Authority (NPA), Nigeria Maritime Administration and Safety Agency (NIMASA), and National Inland Waterways Authority (NIWA) to remove wrecks from Nigerian navigable waters and channels and guarantee wreck-free navigation is one of the numerous obstacles to the safety of navigation in Nigerian waterways (Ofurumazi et al, 2023). Nigeria has a distinct geomorphologic environment, with an extensive coastland spanning approximately 852 kilometers, an intense network of over 80 rivers, 8,600 km of inland waterways, and the second-longest waterways in Africa. About 12.4% of Nigeria's estimated 94,185,000 hectares of total surface area is made up of its major rivers, lakes, and reservoirs, which are estimated to be 10,812,400 hectares and 853,600 hectares, respectively (Ita and Sado, 1985). Nigeria is divided into three sections: east, west, and north by the confluence of its two longest rivers at Lokoja (Obeta,

2013). According to Obed (2014), these rivers, along with a few others, have been used for water transportation. Therefore, the three primary modes of water transportation in Nigeria are considered to be the ocean, coastal water, and inland waterways. Particularly in the coastal waterways, where cost is more essential than speed, heavy traffic is handled. Nigerian waterways are home to a variety of boat types, including cargo ships, passenger launchers and ferries, fishing boats and vessels, oil tankers, steamers, trawlers, and other watercraft. Passengers, used to travel through Nigeria's inland and coastal waterways, including ferries and cargo ships, oil tankers, steamers, trawlers, fishing boats, and passenger launches. Waterways carry tons of agricultural products from production areas to large industries in urban centers, where they are processed. In places that are flooded, this method increases the supply of commercial agricultural products at a lower cost. IWT plays a special function in Nigeria's transportation system and has been enhanced to assist the transit of freight and

passengers with the advent of cabotage and the dredging of the lower Niger River (Akpudo, 2021). Even though the water transport network is extensive and it plays a significant role in the economy, there are numerous safety and navigability issues. Because more people are using water transportation, boat and ferry accidents are more common in Nigeria than they have ever been. Consequently, properties valued at billions of Naira have been lost, especially in the previous several decades, and an incalculable number of lives have also been lost. The issues surrounding boat accidents have not received enough attention. Nigeria's water transportation system has been severely neglected in terms of both human and physical capability, which has led to a rise in boat accidents and death rates throughout the nation. Organizations like NIWA that are tasked with overseeing the waterways have been inadequately stressed. Nigeria's water transportation system has been severely neglected in terms of both human and physical capability, which has led to a rise in boat accidents and death rates throughout the nation. The task of overseeing the waterways has fallen on organizations like NIWA, which has had inadequate funding and has been improperly run. Manage members lack the necessary skills to manage the facilities, and the equipment used to monitor these waterways is outdated. According to Nze et al, (2021), inland waterways transport is perceived globally to be a safer, affordable and environmentally friendly mode, there are of course lots of impediments against the free and safe flow of traffic along its corridors, especially in the Niger Delta areas of Nigeria. These impediments range from lack of maintenance dredging, poor regulation by relevant stakeholders, insecurity of the waterways to lack of training of boat operators, and more predominantly, the timber rafting activities which is one of the major cause of boat accident in Bayelsa State, most especially, the Ogboinbiri waterway. It is factual however, that an increase in mobility along the Niger would not only increase economic activities but would at the same time lead to exposure of the users and operators of the various routes to risks and uncertainties. It is therefore of interest to this study to estimate cost or externalities arising from the inland waterways transport operations in the routes of Bayelsa State Nigeria, so as to provide a policy guide for the Stakeholders in inland waterways transport in the state and beyond by revealing the likelihood of accidents therein in consideration of the selected route (Ogboinbiri Waterway).

In Bayelsa State, the major modes of transport are waterways and roads. The state has many transport problems that have hindered its economic development for many years. In the water transport, the State, like any other state in the Niger Delta, is traversed by a network of River Niger's distributaries, resulting in widespread swamp land. Water transport is therefore the main means of movement. Speed boat is the characteristic mode of transportation. The efficiency and capacity of speed boats is poor because they do not normally carry goods and they accommodate fewer passengers than out-board engine boats. The slowest means of travel is the out-board engine boat, while the in-board engine boat usually has the largest capacity (Ikporukpo, 1986). Water transport in Bayelsa State is confronted with such problems as slowness, lack of safety, irregularity, lack of comfort, low efficiency and capacity, among others, loss of lives and properties due to timber rafting. There is need to develop efficient water transport; through the development of long swamp bridges that will link swamp settlements with upland areas and the outside world.

Timber Rafting on the other hand, is a method of transporting felled tree trunks by tying them together to make rafts, which are then drifted or pulled downriver, or across a lake or other body of water, and this practice is very common within the Ogboinbiri Waterway as claimed by the users of the waterway. It is arguably, after log driving, the second cheapest means of transporting felled timber. Both methods may be referred to as timber floating. The tradition of timber rafting cultivated in Austria, the Czech Republic, Germany, Latvia, Poland and Spain. This practice used to be common in many parts of the world, especially North America and on all main rivers of Germany. Timber rafting allowed for connecting large continental forests, as in south western Germany, via Main, Neckar, Danube and Rhine with the coastal cities and states. Early modern forestry and remote trading were closely connected. Large pines in the black forest were called "Holländer," as they were traded to the Netherlands. Large timber rafts on the Rhine were 200 to 400m in length, 40m wide and consisted of several thousand logs. The crew consisted of 400 to 500 men, including shelter, bakeries, ovens and livestock stables. Timber rafting infrastructure allowed for large interconnected networks all over continental Europe. The advent of the railroad, steam boat vessels and improvements in trucking and road networks gradually reduced the use of timber rafts. It is still of importance in Finland. In Spain, this method of transport was used in the Ebro, Tajo, Júcar, Turia and Segura rivers, mainly and to a lesser extent in the Guadalquivir. There is documentary evidence of these uses as early as the sixteenth century, and its use was extended until the middle of the 20th century. In Russia, the use of elaborate timber rafts called continued into the 1930s

The insights shared in this study emerge from the experiences and keen observations of individuals intricately linked to the Ogboinbiri Waterway. Across the span of 2018 to 2022, the unfortunate loss of more than 30 lives has cast a shadow over this vital water route, primarily due to a recurring and often underestimated factor, collisions between boats and submerged timbers no longer securely rafted together.

Crucially, the information presented here transcends mere statistics; it encapsulates the genuine voices of local boat drivers, passengers, and fishermen intimately familiar with the nuances of navigating the Ogboinbiri Amassoma waterway. Their poignant accounts lays bare a pressing concern, the pervasive threat of unattended timbers, hidden menace responsible for a sustainable portion of the documented boat accidents. It is imperative to underscore that the authors of this study actively engaged with the affected communities. Through extensive interactions, they compiled narratives and insights that form the very fabric of this research. The reluctance exhibited by responsible agencies to address this issue, coupled with the inherent challenge of accurately determining the cause in the aftermath of accidents, prompted the authors to shed light on this underreported yet significant threat to navigation.

This study transcends the role of mere documentation; it serve as a resounding call to action. The narratives shared by the author's stands as a testament to the urgent need for comprehensive intervention. This includes, but not limited to, the removal of derelicts and the establishment of proactive measures. These actions are imperative to ensure the safety of individuals whose lives and livelihoods are intricately woven into the fabric of the Ogboinbiri Waterway.

Table 1.0

S/N	Factors	Causes Associated with Individual Factors	Associated Hazard and Effects
1	Poor Navigation and Seamanship (PNS)	i. Inadequate navigation skill (INS) ii. Poor seamanship (PS) iii. Lack of effective communication (LEC)	i. Navigation errors, collision and grounding ii. Increased risk of accidents, difficulty in maneuvering. iii. Miscommunication, delayed response
2	Equipment Failure (EF)	i. Poor maintenance of vessel equipment (PMVE) ii. Malfunctioning engines or navigation systems (MENS) iii. Inadequate communication tools maintenance (ICTM)	i. Breakdowns, system failures, emergency situation, potential occupational injury. ii. Loss of propulsion, navigation difficulties, potential occupational injury. iii. Communication breakdown, lack of coordination.
3	Weather Conditions (WC)	i. Adverse weather conditions (storms, heavy rain) (AWC) ii. Rough seas and high waves (RSHW) iii. Reduced visibility due to fog or other weather (RVF)	i. Reduced visibility, rough seas, and navigational challenges. ii. Increased risk of capsizing, potential for crew injuries. iii. Collision difficulties in navigation, potential for injuries.
4	Overloading and Improper loading (OIL)	i. Overloading of the vessels (OV) ii. Improper distribution of cargo (IDC) iii. Failure to weight and stability limits (FWSL)	i. Reduced stability, risk of capsizing, potential for injuries. ii. Unstable vessel, difficulty in maneuvering, potential injuries. iii. Increased risk of accidents, potential for injuries.
5	Human Error (HE)	i. Night navigation (NN) ii. Communication errors (CE) iii. Use of Tarpaulins (UT)	i. Collision, groundings, potential for crew injuries. ii. Coordination issues, delayed response, potential injuries. iii. Increased risk of accidents, potential for injuries.
6	Lack of Regulation Enforcement (LRE)	i. Inadequate enforcement of maritime regulations (IEMR) ii. Non-compliance with safety standards (NCSS) iii. Insufficient oversight and inspections (IOI)	i. Non-compliance, disregard for safety standards, potential for injuries. ii. Increased risk of accidents legal consequences, potential for injuries. iii. Undetected safety violations, lack of accountability, potential for injuries.
7	Security Concerns (SC)	i. Piracy and maritime security threats (PMST) ii. Insufficient security measures (ISM) iii. Lack of coordination with maritime security forces (LCMSF)	i. Threats to lives, hijacking, potential for injuries. ii. Increased vulnerability potential attacks, potential for injuries. iii. Ineffective response, compromised security, potential for injuries.
8	Rafted Timbers (RT)	i. Log Jam (LJ) ii. Snagged Timbers (ST) iii. Inadequate Rafting Techniques (IRT)	i. Collision, groundings, potential for crew injuries. ii. Drowning. iii. Death.

Source: Prepared by the author.

Studies from different authors identified the causes of major boat accidents in Nigerian Waterways as shown in table-1.0 above.

1.1 Aim of the Study

The aim of the study is to Analyze of the Impact of Rafted Timbers on Boat Accidents in the Ogboinbiri Waterway, Bayelsa State: A Comprehensive Investigation and safety assessment.

1.2 Objectives of the Study

The specific objectives of the study includes the following;

- i. To identify the determinant risk factors associated with boat accidents in Ogboinbiri waterway related to rafted timbers.

- ii. To estimate the occurrence probability of individual risk/hazard types associated with boat accidents in Ogboinbiri waterway operations in Bayelsa state.

1.3 Research Question

- i. What are the determinant risk factor associated with boat accidents in Ogboinbiri waterway related to rafted timbers?
- ii. What are the occurrence probabilities of individual risk/hazard types associated with boat accident in Ogboinbiri waterway in Bayelsa state?

2.0 Brief Review of Related Literatures

Friday & Joshua (2019) carried out a study on ‘The Statistical Value of Water Transport: A Preliminary Study of Niger Delta

Creek'. The study focused on the creek routes in some selected destination in Gbaramatu kingdom, Warri south west local government area of Delta state, to investigate whether water transportation via the creek is robust in terms of passengers' patronage and revenue generation. The study adopted the confidence interval and control chart applied to determine whether passengers' traffic is high, moderate or low. Friday & Joshua (2019) outlined different difficulties in water transportation in the creek, during the dry season passengers are exposed to the sun while during the raining season passengers are guest to rains and tarpaulin is used as rain protector. This is extremely dangerous because passengers are made to hold on to the tarpaulin from all corners. In such instances, passengers don't actually have view of any oncoming boat or distance covered. Often the case, passengers frequently miss their destination. In all of this, the boat operator is in total control of the passenger's wellbeing since no appropriate regulations on safety measures violation are established. The boat operator is exposed to the rain, and at the same time controlling passengers on the need to hold firm to the covered tarpaulin from blocking his view otherwise fatal accident can occur. Other aspect of difficulty observed are log of woods (rafted timbers), nylon, bottled water can, water hyacinth and other floating items are seen in the open waters and the creeks. The creek routes are sharp bend or curve. Most of the boat operators are not properly trained on safety precautions. The quality of the fiber is questionable however the operators are in total control of the sector determining what happens and the number of passengers to convey at any given time. Consignment is a big issue in this sector. Since most of the operators don't have indebt knowledge of the carrying capacity of the boat engine they tend to over load thereby hampering smooth takeoff of the boat, in such situation, they tend to search for shallow water to enable smooth takeoff otherwise they will return to base to reduce the number of passengers or load. Other areas of concern are excessive billing of passenger's luggage.

Departure time is not defined from source to destination; the principle of operation is whenever passengers are available movement can commence. The source departure lounge and ticketing room, manifest is not well organized or developed. Same is applicable to destination lounge. In general, the sector is in neglect state thereby allowing all comers to risk and waste human and material resources. This neglect by the appropriate authorities led to job and revenue loss.

In general, the findings showed that water transportation is robust in terms of patronage and revenue generation. Although, the analysis revealed that passenger's traffic is peaked during the dry and festive periods.

Another study by Clement and Sani (2020), on 'Investigative Analysis of Marine Tugboat Accident in Nigeria. A Case Study of Bayelsa, Delta and Rivers State', the study 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. According to Clement and Sani (2020), 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). The study adopted a qualitative and quantitative approach 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.

Clement and Sani (2020) from their study concluded that 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.

Nwokedi et al (2017), carried out a study titled 'Analysis of Vessel-Based Marine Accidents and the Economic Risks to Nigeria'. The objectives of the study among other things was to assess the impact of shipping accidents economic loss on the Nigerian marine transport gross domestic product (GDP), to examine the effect of the economic loss of offshore oil and gas (O&G) drilling accidents on the output of the marine transport subsector of Nigeria, to evaluate the impact of marine oil spill accidents on the GDP, to compare shipping accidents economic loss and insurance expenditure on shipping accidents loss control and management. Based on the findings of the study, in order to optimize the economic losses imposed by accidents in the marine industry, safety management measures and loss control tools should be focused more on shipping accidents and offshore O&G drilling accidents which impact very significantly on the output of the subsector. Moreover, since Nigeria as an International Maritime Organization (IMO) member country has over the years adopted and ratified majority of the IMO Convention instruments for Safety regulation, such as the safety of life at sea (SOLAS) 1974 as amended, standards of training certification and watch keeping (STCW) 1995 as amended, international regulations for

the control of marine pollution from ships (MARPOL) 73/78, the load lines (LL) convention of 1966, the regulations for the control of vessel collision at sea (COLREGS) 1972, the international convention on maritime search and rescue (SARS) 1979 as amended, the international ship and port facility security (ISPS) code, Port States control (PSC) etc, diligent implementation of these safety instruments will help to minimize the high degree and increase in trend of marine-accident induced output losses in the subsector. This will subsequently impact on the high expenditure on marine insurance being made at present in managing marine accidents by ensuring lowered costs of insurance premium.

Another study by Ukoji VU et al. (2015), Boat Accidents in Nigeria: General Trends and Risk Factors (June 2006-May 2015), in this study he opined that Boat mishaps are more endemic than ever before in Nigeria due to increased patronage of water transportation. This preference heralded a new era of immense

pressure on boat operators and other water users and increased boat accidents cum fatalities. Data from Nigeria Watch showed that 1607 lives were lost in 180 boat accidents between June 2006 and May, 2015. Identified human related and natural causes of such fatal boat accidents included overloading, careless driving, political instability, piracy, militancy, negligence, turbulent weather and wreckages. Findings in the article showed that fatalities spread among government security personnel including the Nigerian Navy, Army, boat operators and passengers, barge captains, militia groups and pirates. Also, finding showed that the amnesty program initiated in 2009 in the Niger Delta area contributed to the decrease in the number of boat accident fatalities in 2010 but the dissatisfaction in the management of the program among the different armed groups led to a resurgent of boat accident especially in the Niger Delta waterways.

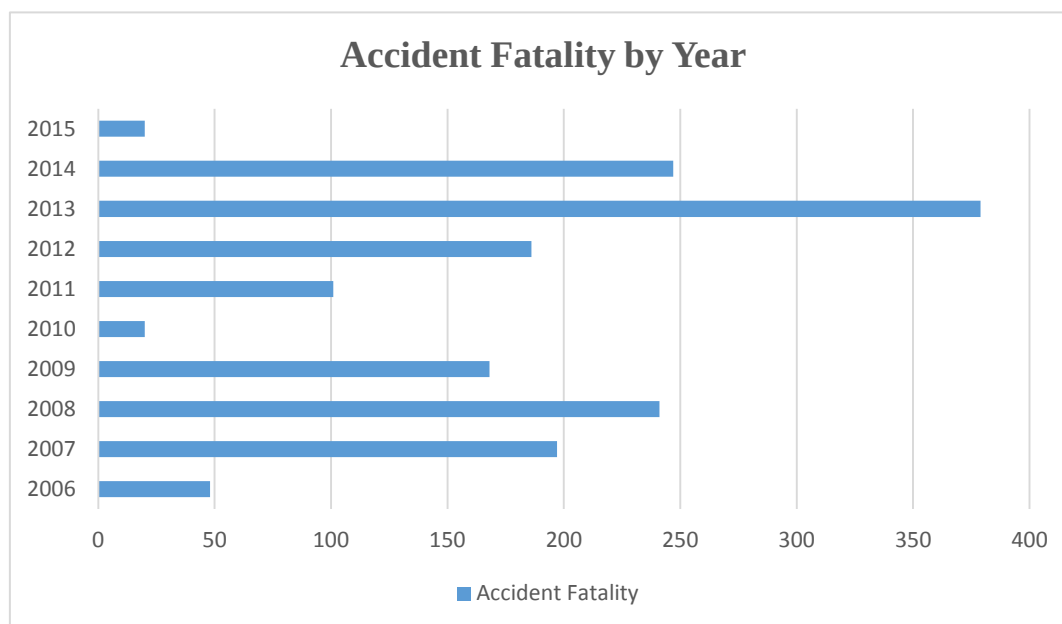


Figure 1.0: Boat Accidents Fatalities by Year (June 2006-May, 2015)

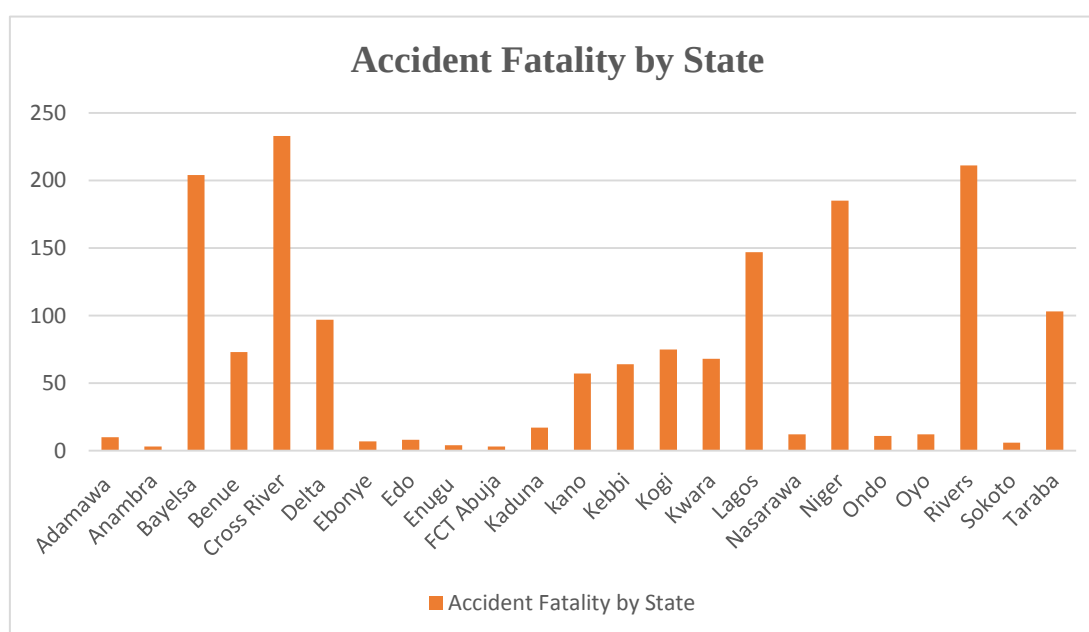


Figure 2.0: Boat Accidents Fatalities by State (June 2006-May, 2015)

Ukoji VU et al. (2015) in his study concluded that the incessant occurrence of boat mishaps in different parts of Nigeria between June, 2006 and May, 2015. The occurrence of such mishaps has a wider coverage than one imagines. About 23 out of 36 states of the Federal have at least recorded a fatal boat accident within the period reviewed. Most affected coastal states include Rivers, Bayelsa, Delta, Cross River, Lagos and Taraba states. A further analysis revealed that boat accident fatalities were rampant in Niger Delta areas due to huge activities of Multinational oil companies and the large expanse of water channels. These factors encouraged piracy and militancy which often resulted in incessant attacks on oil barges, passenger boats and security gun boats. Results showed a steady rise in boat mishap fatalities from 2006 to 2009 and a break in 2010 but another rise between 2011 and 2014. It is therefore believe that the amnesty program in 2009 had impact on the low number of militancy related boat accidents in 2010. The further increase in piracy in 2014 was linked with the grumblings in the handling of the amnesty program among the former militants who returned to creeks and engaged in piracy. This article established the fact that overloading is a major risk factor to boat mishaps in Nigeria. While militancy and piracy were restricted to many Niger Delta creeks, overloading was seen as national calamity that needs to be addressed if more lives are to be saved in Nigerian water ways. Given the above, more concerted efforts should be geared towards aggressive sensitization by the National Inland Waterways Authority. Both boat drivers/ captains and commuters have been established to contribute to the high rate of boat accidents; therefore, they should be engaged to find possible ways to stemming the number of boat accidents recorded each year. Further, the government should as a matter of urgency engage the militants to find a lasting solution to the Niger Delta crisis in order to bring enduring peace to the region.

Numerous empirical studies, including the investigation by Friday & Joshua (2019), Clement and Sani (2020), Nwokedi et al (2017) and Ukoji VU et al. (2015), have delved into the causes and implications of marine vessel (Boat) accidents in Nigeria's waterways. These studies have identified key factors and sub-factors from various perspectives. However, there exists a notable

gap in the literature regarding recent boat accidents, particularly those related to rafted timber, in Nigeria's waterway, specifically in Bayelsa State, particularly in the Ogboinbiri Waterway. This gap becomes even more pronounced when considering the tragic incidents claiming the lives of over 30 passengers in the last two years due to the same timber rafting activity. The specific information deficit pertains to the constituents of significant boat accidents in the Ogboinbiri waterway and, more critically, the ranking of the influence of timber rafting activities on these incidents.

3.0 Data and Methods

3.1 Description of Study Area

The research focuses on the marine environment of Nigeria, specifically the coastal zones and navigation waters in Bayelsa state, located in the Niger Delta region of Nigeria. The study area includes the Ogboinbiri- Amassoma waterway in Bayelsa State, with Ogboinbiri being a community in the Southern Ijaw local government area. This waterway is crucial for commercial activities, serving as a busy route for boat drivers transporting passengers and cargoes from Yenagoa metropolis to Ogboinbiri, which is a host community to multinational companies.

3.2 Research Design

The study used a survey research design method, employing primary data sourced from boat operators, National Union of Maritime Workers, community leaders and survivors of boat accidents. The primary data was sourced using questionnaire as survey instrument to obtain data from the staff of the organization (National Union of Maritime Workers) especially staff in the safety and operations department on their ratings and perceptions of the influences of Poor Navigation and Seamanship (PNS), Equipment Failure (EF), Weather Conditions (WC), Overloading and Improper loading (OIL), Human Error (HE), Lack of Regulation Enforcement (LRE), Security Concerns (SC), Timber Rafting (TR). The groups of factors and the Causes Associated with Individual Factors and associated effects are considered in the survey instrument are as shown below:

Table 2.0

S/N	Factors	Causes Associated with Individual Factors	Associated Hazard and Effects
1	Poor Navigation and Seamanship (PNS)	i. Inadequate navigation skill (INS) ii. Poor seamanship (PS) iii. Lack of effective communication (LEC)	i. Navigation errors, collision and grounding ii. Increased risk of accidents, difficulty in maneuvering. iii. Miscommunication, delayed response
2	Equipment Failure (EF)	i. Poor maintenance of vessel equipment (PMVE) ii. Malfunctioning engines or navigation systems (MENS) iii. Inadequate communication tools maintenance (ICTM)	i. Breakdowns, system failures, emergency situation, potential occupational injury. ii. Loss of propulsion, navigation difficulties, potential occupational injury. iii. Communication breakdown, lack of coordination.
3	Weather Conditions (WC)	i. Adverse weather conditions (storms, heavy rain) (AWC) ii. Rough seas and high waves (RSHW) iii. Reduced visibility due to fog or other weather (RVF)	i. Reduced visibility, rough seas, and navigational challenges. ii. Increased risk of capsizing, potential for crew injuries. iii. Collision difficulties in navigation, potential for injuries.
4	Overloading and Improper loading	i. Overloading of the vessels (OV) ii. Improper distribution of cargo (IDC)	i. Reduced stability, risk of capsizing, potential for injuries.

	(OIL)	iii. Failure to weight and stability limits (FWSL)	ii. Unstable vessel, difficulty in maneuvering, potential injuries. iii. Increased risk of accidents, potential for injuries.
5	Human Error (HE)	i. Night navigation (NN) ii. Communication errors (CE) iii. Use of Tarpaulins (UT)	i. Collision, groundings, potential for crew injuries. ii. Coordination issues, delayed response, potential injuries. iii. Increased risk of accidents, potential for injuries.
6	Lack of Regulation Enforcement (LRE)	i. Inadequate enforcement of maritime regulations (IEMR) ii. Non-compliance with safety standards (NCSS) iii. Insufficient oversight and inspections (IOI)	i. Non-compliance, disregard for safety standards, potential for injuries. ii. Increased risk of accidents legal consequences, potential for injuries. iii. Undetected safety violations, lack of accountability, potential for injuries.
7	Security Concerns (SC)	i. Piracy and maritime security threats (PMST) ii. Insufficient security measures (ISM) iii. Lack of coordination with maritime security forces (LCMSF)	i. Threats to lives, hijacking, potential for injuries. ii. Increased vulnerability potential attacks, potential for injuries. iii. Ineffective response, compromised security, potential for injuries.
8	Rafted Timbers (RT)	i. Log Jam (LJ) ii. Snagged Timbers (ST) iii. Inadequate Rafting Techniques (IRT)	i. Collision, groundings, potential for crew injuries. ii. Drowning. iii. Death

Source: Prepared by the author.

3.3 Population of the Study

The population of the study consists of the about 33 persons from the different categories, ranging from the commercial boat operators, to the National Union of Maritime Transport Workers, passengers, community leaders and survivors of boat mishap. From this population, samples were randomly selected and the survey instrument (questionnaire and checklist) delivered to each respondent. For the purpose of conducting the survey, the study adopted a purposive random sampling technique in which the respondents were purposively sampled randomly. The reason for the purposive random sampling was because the boat operators, NUMTW, passenger, community leaders and the survivors were the ones that are most often directly exposed to this boat accidents.

The sample size was determined by the use of Taro Yammane formula for determination of sample for known population that is:

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

Where :

n= sample size required

N = number of people in the population

e = allowable error (%) = 0.05

n = 30.4= 30 respondents

The sample size consists of 30 respondents in the different respective fields.

3.4 Method of Data Analysis

3.4.1 Principal Component Factor Analysis (PCA)

The study was designed to assess Impact of Rafted Timbers on Boat Accidents in the Ogboinbiri Waterway, Bayelsa State: A Comprehensive Investigation and safety assessment. The study used a mixed design method comprised of the use of primary data

from survey and secondary data obtained from company's historical records. A questionnaire was used as survey instruments to gather primary data from mostly boat operators, survivor of boat accidents, community leaders and passengers plying the Ogboinbiri-Amassoma waterway and on their perceptions of the level of the major causes of boat accident in that particular waterway. There are many causes of boat accidents in Nigeria's waterways, but the most predominant of them all according to the respondents shows that timber rafting activities is the most common cause of boat accidents in the Ogboinbiri waterway, this was determined by the use of the principal component factor (PCA) The principal component factor analysis (PCA) is a statistical method that was used to analyze the data obtained from field survey in order to determine the determinant cause of boat accidents. The major causes of accidents categories considered as earlier mentioned are:

- (i) Poor Navigation and Seamanship = PNS
- (ii) Equipment Failure = EF
- (iii) Weather Conditions =WC
- (iv) Overloading and Improper loading = OIL
- (v) Human Error = HE
- (vi) Lack of Regulation Enforcement = LRE
- (vii) Security Concerns = SC
- (viii) Rafted Timbers = RT

The individual factors that form the components of each of the above categories of contributing factors to boat accidents were discussed in previous sections under table-1. The analysis was implemented using SPSS version21 analytical software.

3.4.2 Occurrence Probability Theory

Probability theory deals with chance or stochastic process. Occurrence probability measures the likelihood that an event may occur based on historical data. The occurrence probability coefficient is a numerical value or scores that measures the likelihood that some events will occur based on the past and/or historical data. Occurrence factors associated with boat accidents

operation is a stochastic event. Therefore, frequency data on individual factors in each category of the boat accident causative factors can be used as basis to estimate the occurrence probability coefficients of each individual factors in the various groups of factors associated with boat accident in Nigeria waters. The occurrence probability P_e of an event E is given as: $P_e = \frac{F}{N}$ ----- (2)

Where: F = frequency/number of successful occurrences in the past

N = Aggregate frequencies representing number of possible outcomes.

P_e = occurrence probability coefficient showing the likelihood of occurrence of event 'e'.

The categories of factors associated with boat accident in Ogboinbiri waterway as aforementioned include PNS, EF, WC, OIL, HE, LRE, SC and TR

4.0 Result and Discussion

Table 3.0.0: Determining the major cause of boat accidents in Ogboinbiri waterway in Bayelsa State.

Descriptive Statistics			
	N	Mean	Std. Deviation
PNS	30	2.0000	.83045
EF	30	1.5333	.50742
WC	30	3.0000	.83045
OIL	30	2.0000	.83045
HE	30	3.8000	.40684
LRC	30	1.4333	.50401
SC	30	2.1667	.74664
TR	30	4.7333	.44978

Communalities		
	Initial	Extraction
PNS	1.000	.875
EF	1.000	.357
WC	1.000	.514
OIL	1.000	.683
HE	1.000	.496
LRC	1.000	.467
SC	1.000	.506
TR	1.000	.878

Extraction Method: Principal Component Analysis.

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	.326	29.077	29.077	2.326	29.077	29.077	2.129	26.607	26.607
2	.297	16.218	45.295	1.297	16.218	45.295	1.472	18.399	45.006
3	1.104	14.419	59.713	1.154	14.419	59.713	1.177	14.707	59.713
4	.978	12.220	71.933						
5	1.120	10.248	82.181						
6	.659	8.238	90.419						
7	.563	7.035	97.454						
8	1.204	2.546	100.000						

Extraction Method: Principal Component Analysis.

Component Matrix ^a			
	Component		
	1	2	3
TR	.833	.422	
LRC	-.680		
WC	.630		.309
SC	.558	.389	
HE	.525	-.467	
EF		.567	
OIL	-.372	.544	.499
PNS		-.328	.866

Extraction Method: Principal Component Analysis. a. 3 components extracted.

Table-3.0 above shows the result of the Principal Component factor Analysis (PCA) implemented using SPSS statistical software. The result indicates some of the factors that causes boat accident in Ogboinbiri waterway in Bayelsa State. The result shows that the mean weights of Timber Rafting (TR), Human Error (HE) and Weather Conditions (WC) that causes boat accidents in Bayelsa is 4.7333, 3.8000 and 3.0000 respectively, with respective standard deviations of 0.44978, 0.40684 and 0.83045. The respective average scores Poor Navigation and Seamanship (PNS) 2.0000, Equipment Failure (EF) 1.5333, Overloading and Improper loading (OIL) 2.0000, Lack of Regulation Enforcement (LRE) 1.4333 and Security Concerns (SC) 2.1667 with respective standard deviation of 0.83045, 0.50742, 0.83045, 0.50401 and 0.74664. The Eigen values which indicates the significance of the effects and influences of each category of factors that causes boat accident shows that Timber Rafting (TR), Human Error (HE) and Weather Conditions (WC) have Eigen values of 1.204, 1.120 and 1.104. The Eigen value (scores) of Poor Navigation and Seamanship (PNS), Equipment Failure (EF), Overloading and Improper loading (OIL), Lack of Regulation Enforcement (LRE) and Security Concerns (SC) are 0.326, 0.297, 0.978, 0.659 and 0.563. Thus, Poor Navigation and Seamanship (PNS), Equipment Failure (EF), Overloading and Improper loading (OIL), Lack of Regulation Enforcement (LRE) and Security Concerns (SC) having Eigen values/score less than 1 (i.e $0.326 < 1$, for Poor Navigation and Seamanship, $0.297 < 1$ for Equipment Failure, $0.978 < 1$ for Overloading and Improper loading and $0.659 < 1$ for Security Concern/Factor) are not significant. As a result are not the major cause of boat accident along the Ogboinbiri waterway in Bayelsa State.

Similarly, Rafted Timbers (RT), Human Error (HE) and Weather Conditions (WC) each with Eigen value/score greater than 1 (Eigen > 1), significantly influence boat accidents and as a result form the major causes of boat accident in Ogboinbiri waterway, predominantly the Timber Rafting.

The policy implication is that for any navigable water to be devoid of boat accident in Bayelsa waterways, the operators must prioritize the implementation of risk control, reduction and elimination measures on the major contributing factors to boat accident which include Timber Rafting (TR), Human Error (HE) and Weather Conditions (WC). This will ensure that the impacts and effects of the occurrence of boat accidents under the categories of the major contributing factors identified above cannot cause or lead to fatal boat accidents in Ogboinbiri waterway as it happened in the past years. While it is important to also implement risk control, reduction and elimination measures on the non-contributing factors such as Poor Navigation and Seamanship (PNS), Equipment Failure (EF), Overloading and Improper loading (OIL), Lack of Regulation Enforcement (LRE) and Security Concerns (SC), the most attention should be concentrated on the significant/determinant contributing factors.

The figure-4.1 below shows the presentation of the Eigen scores showing the influences of the various factors associated with boat accident in Ogboinbiri waterway in Bayelsa State.

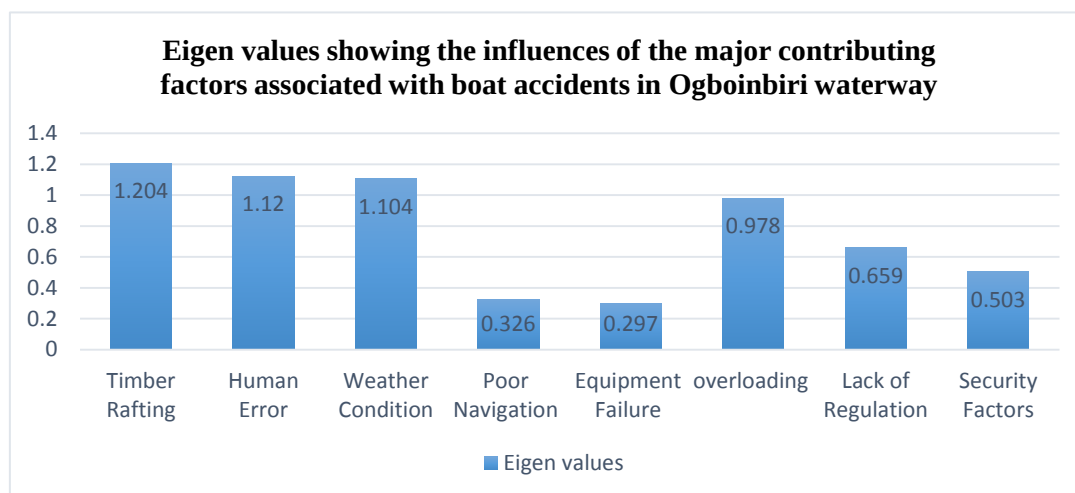


Figure 3.0 influence of Major Contributing factors associated with boat accidents in Ogboinbiri waterway.

4.1 RESULTS AND DISCUSSION OF FINDINGS

Poor Navigation and Seamanship (PNS) as a contributing factor to boat accident in Ogboinbiri waterway have individual component factors which includes:

- i. Inadequate navigation skill (INS)
- ii. Poor seamanship (PS)
- iii. Lack of effective communication (LEC)

The occurrence probability P_e of each of the individual poor navigation and seamanship factors for example is given as:

$$P_{eHE} = \frac{INS}{PNS} \text{-----} (3)$$

Where: INS = frequency of occurrence of boat accident associated with inadequate navigation skill over the years.

PNS = aggregate total occurrence of poor navigation and seamanship recorded over the period.

The occurrence probability coefficients of the remaining individual poor navigation and seamanship factors are shown respectively below.

$$\text{For the contributing factor related to Poor seamanship, the occurrence probability } P_{ePS} = \frac{PS}{PNS} \text{-----} (4)$$

For contributing factor associated with Lack of effective communication, we have

$$P_{eLEC} = \frac{LEC}{PNS} \text{-----} (5)$$

It is important to state that by the rules of probability theory:

$$\sum P_{eINS} + P_{ePS} + P_{eLEC} = 1 \text{-----} (6)$$

Similarly, the occurrence probability coefficients of the individual components of the risk of hazards in each of the EF, WC, OIL, HE, LRE, SC and RT will be determined using the occurrence probability analytical tool discussed earlier.

Using the methods discussed above, the study analyzed the data obtained in order to provide answers to the research questions.

Table-4.0: Occurrence frequency of contributing factors to boat accidents in Ogboinbiri waterway in Bayelsa State of Nigeria, and the fatality rate between 2019 and 2023.

s/n	Contributing Factors	Occurrence Frequency of individual Associated Factors and Fatality rate					Total
1	Poor Navigation and Seamanship	Associated Factors:	INS	PS	LEC	Fatality	
		Frequency:	-	2	2	2 (50%)	4
2	Equipment Failure	Associated Factors:	PMVE	MENS	ICTM	Fatality	
		Frequency:	3	-	-	1(33%)	3
3	Weather Conditions	Associated Factors:	AWC	RSHM	RVF	Fatality	
		Frequency:	8	6	3	12(71%)	17
4	Overloading and Improper loading	Associated Factors:	OV	IDC	FWSL	Fatality	
		Frequency:	10	-	-	6(60%)	10
5	Human Error	Associated Factors:	NN	CE	UT	Fatality	
		Frequency:	12	2	7	17(81%)	21
6	Lack of Regulation Enforcement	Associated Factors:	IEMR	NCSS	IOI	Fatality	
		Frequency:	2	6	-	3(38%)	8
7	Security Concerns	Associated Factors:	PMST	ISM	LCMSE	Fatality	
		Frequency:	5	-	-	2(40%)	5
8	Rafted Timbers	Associated Factors:	LJ	SNG	IRT	Fatality	
		Frequency:	12	15	10	38(90%)	42

Source: Secondary data sourced from the HSE records of the National Union of Maritime workers Association of Nigeria.

Table-4.0 above shows the occurrence frequency of the various categories of factors associated with boat accidents in Ogboinbiri waterway, Bayelsa State between 2019 and 2023. The data was obtained from the HSE records department of the National Union of Maritime workers

Association of Nigeria. It also indicates the individual factors (sub-factors) classified under Poor Navigation and Seamanship, Equipment Failure, Weather Conditions, Overloading and Improper loading, Human Error, Lack of Regulation Enforcement, Security Concerns and Rafted Timbers categories that the organization experienced/faced over the years in various boat accidents rescue operations carried out. The table-4.0 indicates that the users of this waterway, including linking creeks such as Otiam, Osiam, Isoni, Kasama, Amasomma and Ogboinbiri faced a total of 113 accidents classified under Poor Navigation and Seamanship, Equipment Failure, Weather Conditions, Overloading and Improper loading, Human Error, Lack of Regulation Enforcement, Security Concerns and Rafted Timbers over the period of these 113 accidents, 2 accidents are poor seamanship related, 2 are Lack of effective communication between boat operators (drivers), and also between boat drivers and their passengers (LEC). 3 incidents are factors related to poor maintenance of vessel (boat) equipment (PMVE), factors related to adverse weather conditions is 8 under weather condition, accidents related to rough sea/ high waves and reduced visibility due to fog are 6 and 3 accidents respectively. Overloading and improper loading contributed to 10 major along the described Ogboinbiri routes above, with a fatality rate of 60%.

About 21 accidents are linked to hazards categorized under Human Factor. Under the errors/factors, hazards related to Night Navigation of the Ogboinbiri waterway is 12, communication error/factor has occurrence frequency of 2, while the number of accidents associated with improper use of tarpaulin is 7. The frequency of incidents related to inadequate enforcement of maritime regulations (IEMR) over the period is 2, while incidents related to non-compliance with safety standards is 6. Security risk factors has frequency occurrence of 5 over the period, attributed by piracy and maritime security threats.

The frequency of occurrence of accidents related to Rafted Timbers, logjam, Logjam (LJ), Snagged Timbers (ST) and Inadequate Rafting Techniques (IRT) 12, 15 and 10 respectively, which constitutes the major accident causing factor and has the highest probability frequency of occurrence with a fatality rate of 90% between the period of 2019 and 2023.

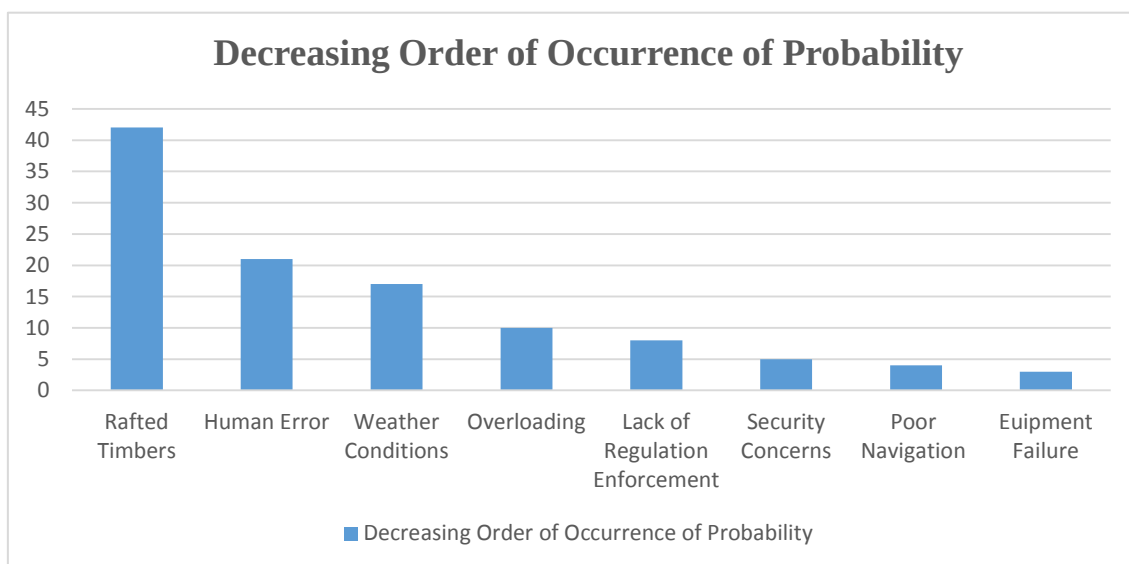


Figure- 4.0: Decreasing Order of Occurrence of Probability

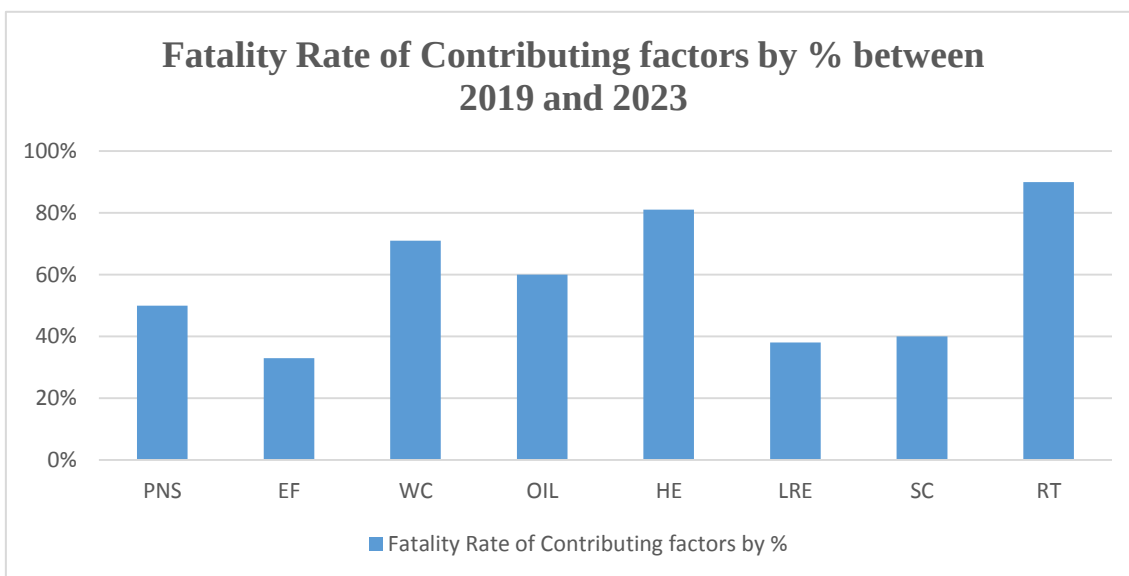


Figure- 4.1 Fatality Rate of Contributing factors by % between 2019 and 2023

Figure 4.1 shows the fatality rate of the contributing factors to boat accidents by percentage between 2019 and 2023 at the Ogboinbiri waterway in Bayelsa State. The chart shows that 50% of the fatality rate is attributed to Poor navigation system, equipment failure attributes to 32% of the fatality rate in the Ogboinbiri waterway. Weather condition attributes to 71% of the fatality rate, human error contributes to 60% of the fatality rate, while lack of regulatory enforcement contributes to 38% of the fatality rate. Security factors attributes to 40% of the fatality rate and finally, Rafted Timbers contributes to 90% of the fatality rate of the accidents.

On this comprehensive study conducted on boat accidents in the Ogboinbiri waterway, a profoundly concerning trend emerged, shedding light on a critical safety issue. Astonishingly, rafted timbers emerged as a dominant factor, contributing a staggering 90% to the overall fatality rate and has the highest occurrence probability. This revelation highlights the pressing need for a nuanced understanding of the specific risks posed by rafted timbers in water navigation.

The inherent dangers associated with these timbers demand a multifaceted approach to enhance safety protocols. The study underscore the necessity for immediate and targeted intervention, including but not limited to stricter regulations on timber transportation, enhanced monitoring mechanisms, and widespread awareness campaigns for boat operators and waterway users.

By delving into the intricacies of each incident, the study emphasizes the potential casual factors, ranging from poor visibility in waterways cluttered with rafted timbers to the challenge of navigating around them. It is imperative that stakeholders, including local authorities, maritime agencies, and community leaders, collaborate to formulate and implement effective strategies to mitigate the risks associated with rafted timber-related accidents.

Furthermore, this revelation should serve as a catalyst for community engagement and education programs to empower boat operators with the knowledge and skills necessary to navigate safely through waterways dominated by rafted timbers. Additionally, investments in advanced technologies such as real-time monitoring systems and navigational aids can significantly contribute to minimizing the occurrence and impact of accidents involving rafted timbers.

In conclusion, the study's finding paint a vivid picture of the disproportionate role played by the rafted timbers in contributing to boat accident fatalities in the Ogboinbiri waterway. Addressing this critical issue requires a comprehensive and collaborative approach, combining regulatory measures, community education, and technological advancements to ensure the safety of all waterway users.

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