ASSESSMENT OF NAVIGABILITY AND SECURITY CONDITION OF WATERWAYS IN BAYELSA STATE, NIGERIA

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Abstract

This study sought to assess the Navigability and security condition of waterways within Bayelsa state. Purposive sampling was used to select three waterways and six waterfronts (two in each senatorial district of the state) where Questionnaire, personal interviews and physical field observations were used to gather data from the field. The rivers sampled include; Forcados, Nun and Brass rivers. Multiple regression, t-test as well as simple statistical techniques were employed in analysing the data. The findings of the study reveal that waterways in the state are navigable particularly for speed boats and ferries which is the main means of water transport in the study area. However, the security condition of the waterways was revealed to be insufficient as there were very few checkpoints and police patrols along the waterways. Despite the navigable state of waterways within the state, the study recommends that dredging activities should be carried out consciously by government and agencies responsible for the management of the waterways for purposes of deepening the waterways for larger ships in the state thereby encouraging more economic activities in the area. The study also recommends more security check points and patrols along the waterways in the state in order to reduce pirates and other criminal activities within the waterways.

Keywords: **Transportation, Navigability, Security, Inland, Waterways, Safety**

Introduction

Transportation is one of the most important catalysts for socio-economic development of any place (Nwoye *et al.*, 2019). The water transportation mode uses ships and ferries to transport goods from one place to the other, and about 90% of the global cargos are transported through this mode (Sekimizu, 2013 as cited in Boadu, Otoo, Boateng and Koomson, 2021). Aside from being the oldest means of transporting goods and services, inland waterways have been associated with facilitation of commerce, provision of employment and wealth creation among many other benefits (Christodoulou, Christidis and Bisselink, 2019; Dai *et al.*, 2019; Wiercx, van Kalmthout and Wiegmans, 2019; Tanko *et al.*, 2019; Hossain *et al.*, 2019). Naturally, the waterway system offers acceptable and comparatively cheaper methods of transportation. There are many types of inland vessels in the country, such as passenger vessels, ferry, country boats, trawlers, speed boats, sand carriers, cargo carriers, etc. Despite being an important part of the economy and development, this mode of transportation is not being operated in a safe way (Mia, Uddin, Awal and Abdullah, 2021) Apart from human factors and boat/ferry safety conditions, the safety, security and navigability condition of the waterway itself is also of paramount importance. This is because a boat rider may adhere to safety guidelines and have a safe boat with all safety apparatus but may still be involved in an accident or may not arrive at his destination if there are obstructions, pirates and kidnappers or navigability conditions such as shallow depth, constricted width, steer ability challenges, turbulence as well as other factors which may not have been put into consideration before sailing (Danny and Shariman, 2013). Navigational safety means merely that vessels can navigate and operate safely, avoid collisions, groundings and minimise navigational errors to protect human life, the environment and surrounding properties. To achieve this, the International Maritime Organization (IMO), since 1959, introduced various measures in the form of conventions, recommendations and other instruments which its members continue to apply and enforce (IMO, 2017 cited in Osnin and Abdul Rahman, 2018). Despite the importance of this transportation system in the country particularly in states such as Bayelsa, Rivers and Delta, government

and agencies responsible for the management of IWT seems to pay little or no attention to it leading to consistent accidents.

The security of the waterways is an important factor in inland water transport. Safety and security are very crucial factors in water transportation sector due to the fact that various accidents such as groundings, collisions, capsizing amongst others often results in great economic loss, fatalities and contamination of the environment (Jinfen *et al.,* 2016). Piracy is one of the major security problems on waterways in Nigeria. Section 101 of the 1982 United Nations Convention on the Law of the Sea, defined maritime piracy as attacks that occur on the high sea "outside the jurisdiction of any state". Attacks that therefore take place within territorial waters are regarded as armed robbery. Hence sea piracy in this study is defined as armed robbery on inland waterways (Oyadongha, 2014). According to Onouha (2010) piracy is a term used to describe acts of armed robbery, hijacking and other malicious acts against ships in international waters. They are carried out with the intent of stealing valuables on-board or extorting money from ship owners or other third party interest by holding the ship or crew to ransom. The increasing cases of piracy sea robbery, illegal bunkering and unauthorized mid-stream discharges, among several other criminalities constitute a major source of concern to maritime administration in the Gulf of Guinea, including Nigeria (Ezem, 2012). Likewise, Igbokwe (2012) decried the increasing state of piracy and armed robbery on Nigeria's territorial waters particularly Bayelsa waterways. He contended that piracy and robbery within Nigeria's maritime domain was a disincentive to the needed inflow of foreign investment (including local businesses) to develop the economy. There is therefore the need for the security architecture to be beefed up in order to reduce the rate of incessant attacks within the waterways of Bayelsa state. According to Vanguard Newspaper, on the 3rd of April 2023, there was an occurrences of boat mishaps at the Yenagoa –Brass Waterways in which four persons lost their lives due to boat capsize near Okoroma in Nembe Local Government Area, Bayelsa State. According to the report, the boat is a cargo boat yet was overloaded with over 100 passengers onboard, as such lost its stability when it came in contact with high waves (turbulence) and mishap. It is based on the aforementioned that this study is set out to assess the safety and security conditions of boats, ferries and waterways in Bayelsa state.

Inland water transportation (IWT) is transport within navigable water bodies which include: rivers, lakes, coastal creeks, lagoons, and canals, found within the geographical dimensions of a place. Apart from human factors and boat/ferry safety conditions, the safety, security and navigability condition of the waterway itself is also of paramount importance. This is because a boat rider may adhere to safety guidelines and have a safe boat with all safety apparatus but may still be involved in an accident or may not arrive at his destination if there are obstructions, pirates and kidnappers and navigability conditions such as depth, width, steer ability, turbulence as well as other factors which may not have been put into consideration before sailing (Danny and Shariman, 2013). In areas close to obstacles such as dams, junctions, bridges, shallow waters and channels the possibility of accidents caused by human error is relatively high and the relevant coefficient reach middle values while areas with no hazards that have relatively low coefficient of hazard caused by error are in areas where navigation is unobstructed, traffic density is low or medium, depth are safe etc. (Vidan *et al.,* 2012). According to Lawal (2012) one of the major cause of accidents on waterways are the presence of wrecks. He described wrecks as vessels sunk, stranded or abandoned in harbour, dock, pier, tidal water or ports under the control of a harbour authority. Wrecks include jetsam, flotsam, lagan and all derelicts (including logs) floating or submerged in the tidal waters or the operational shores of a nation. Wrecks are viewed seriously because they constitute danger to navigation and to lifeboats engaged in rescue operations and other services. There are around 623 000 kilometres of navigable waterways in the world. Most of these navigable waterways form part of river systems, so networks of rivers and river basins are interconnected. China is the country with the largest navigable waterway network, representing 18% of the total global length of navigable waterways (Beyer, 2018). Other countries with large navigable waterways include Russia (16%), Brazil (8%) and the USA (7%). Navigable waterways in Europe represent 8% of the global length but only part of these navigable waterways is used for freight transport: around 24 000 km in China, 16 000 km in the USA and 3500 km in Europe (Beyer, 2018). In Nigeria, Obeta (2014) noted that inland waterways transverse 20 out of the 36

states within the nation and those areas adjacent to the navigable rivers represents the nation's most important agricultural and mining regions. It is also noted that about 48% of all the rural residents in the southern deltaic region of Nigeria live in remote, isolated and inaccessible communities with no motor-able roads and another 29% live in communities with limited services (Gray, 2004). For such people, IWT is absolutely imperative for survival and accessing social services such as education and health. This makes navigability of waterways a very critical and crucial factor for these categories of individuals and communities as their mobility and access to basic amenities depends completely on the navigability on the waterways.

The security of the waterways is an important factor in inland water transport. Safety and security are very crucial factors in water transportation sector due to the fact that various accidents such as groundings, collisions, capsizing amongst others often results in great economic loss, fatalities and contamination of the environment (Jinfen *et al.,* 2016). Piracy is one of the major security problems on waterways in Nigeria. Section 101of the 1982 United Nations Convention on the Law of the Sea, defined maritime piracy as attacks that occur on the high sea "outside the jurisdiction of any state". Attacks that therefore takes place within territorial waters are regarded as armed robbery. Hence sea piracy in this study is defined as armed robbery on inland waterways (Oyadongha, 2014). According to Onouha (2010) piracy is a term used to describe acts of armed robbery, hijacking and other malicious acts against ships in international waters. They are carried out with the intent of stealing valuables on-board or extorting money from ship owners or other third party interest by holding the ship or crew to ransom. The increasing cases of piracy sea robbery, illegal bunkering and unauthorized mid-stream discharges, among several other criminalities constitute a major source of concern to maritime administration in the Gulf of Guinea, including Nigeria (Ezem, 2012). Likewise, Igbokwe (2012) decried the increasing state of piracy and armed robbery on Nigeria's territorial waters particularly Bayelsa waterways. He contended that piracy and robbery within Nigeria's maritime domain was a disincentive to the needed inflow of foreign investment (including local businesses) to develop the economy. Ukoji and Ukoji (2015) opined that Militancy and piracy are well known to many in Nigeria but their immense contributions to the spate of boat mishaps have been underestimated. The incessant attacks on barges, fishing boats and passenger boats have resulted in an immeasurable loss of manpower and capital. Barges are attacked and tons of crude oil is redirected into the black market by armed militants and pirates. In the events of oil spillage during crude transfer into unauthorized vessels or in events of barge sinking, water is polluted and aquatic lives are destroyed. Often times when fishing boats are attacked, their operators are kidnapped and ransoms are paid for their release while Passenger boats are attacked and the occupants are either killed or robbed (Onuoha, 2010). According to Ukoji's research, about 198 and 126 deaths recorded between June 2006 and May 2015 were as a result of militancy and piracy respectively. Inland waterways play a major role in economic development especially in remote areas where the potential opportunities for this sector depends considerably on the specific regional context such as geographical conditions, level of road development and socio-economic conditions (Owoputi *et al.,* 2018). Based on the aforementioned, this research carried out an assessment of inland water transport and safety compliance in Bayelsa state in accordance with the National Inland Waterways Authority (NIWA)'s "13 Cardinal guidelines for safety on our Waterways". The significance of this study lies in the fact that it investigated and exposed the state of safety of IWT in Bayelsa state. The recommendations of this research if implemented accordingly is expected to reduce drastically the rate of boat and ferry accidents on waterways in the state and also create safety consciousness to the users of IWT in the state. This research is the first to compute an Inland Water Transport Safety Index (IWTSI) for the three major rivers in Bayelsa state and as such will stand out as reference for other researchers as well as for multinational oil and gas companies operating within the study area.

Study Area

This study is limited to Bayelsa state. Six jetties (Swali, Ayama, Onuebum, Nembe, Aleibiri and Sagbama) cutting across the entire state and the three major rivers (Forcados, Nun and Brass) were sampled for the study. Bayelsa state is geographically located between latitudes 04° 15′ North, 05° 22′ South and longitude 05° 22′ west and 06° 45′ East. It is one of the major oil producing States in Nigeria contributing over 40% of the daily production in the country. It is one of the six states that make up the south-south geopolitical region of Nigeria and has boundaries with Rivers State in the east, Delta State in the west and Gulf of Guinea in the south. It has a population of 1,121,693 spread over a land area of 12,000 square kilometer most of which is water or wet lands (John 2013). Mean temperature is generally 28.0°C. The State has eight local government areas (LGAs), namely; Brass, Ekeremor, Kolokuma/Opukuma, Nembe, Ogbia, Sagbama, Southern Ijaw and Yenagoa and has developed in many sectors since its creation in October 1, 1996 (Bayelsa State Government, 2008).

Vegetation is mainly the mangrove and salt water swamps, but a major part had largely been destroyed by oil exploration. (Ezenwaji *et al.,* 2013) The state is made up of mangrove and tropical rain forest with more than three quarter of this area covered by water. In the North It has a thick forest with arable lands for cultivation of various food and cash crops (Clement & Ekio, 2020). Transportation in the state is mainly water transport owing to the fact that over 70% of the state is covered by water. As such majority of the communities within Ekeremor, Southern Ijaw, Brass, Nembe and parts of Sagbama and Ogbia LGA's of the state can only be accessible by water. Road network is basically concentrated within Yenagoa, Kolokuma/Opokuma and parts of Ogbia LGAs of the state (Olowoyo, 2011).

The state is drained by so many rivers which are at their advanced stage and such rivers include Orashi which forms the State's eastern border with Rivers State, Forcados which forms the western border with Delta State, Nun, Brass, Apoi, Kugba and numerous creeks which drain the state's hinterland (Ezenwaji et al., 2013). Annual rainfall amounts range from 2,500 mm in the northern parts of the State to 4,000 mm in its southern areas, while mean temperature is generally 28.0°C (Olowoyo, 2011). Its topography is that of a moderately lowland which lies almost below sea level stretching from Ekeremor to Brass with a maze of meandering creeks and swamps which all flow southwards into the Atlantic ocean via major rivers such as Forcados, San Bartholomew, Brass, Nun, Ramos, Santa babara, St. Nicholas, Sangana, Fish-town, Ikebiri creek, Middleton, Digatoro creek, Pennington and Dobo (Clement and Ekio, 2017)

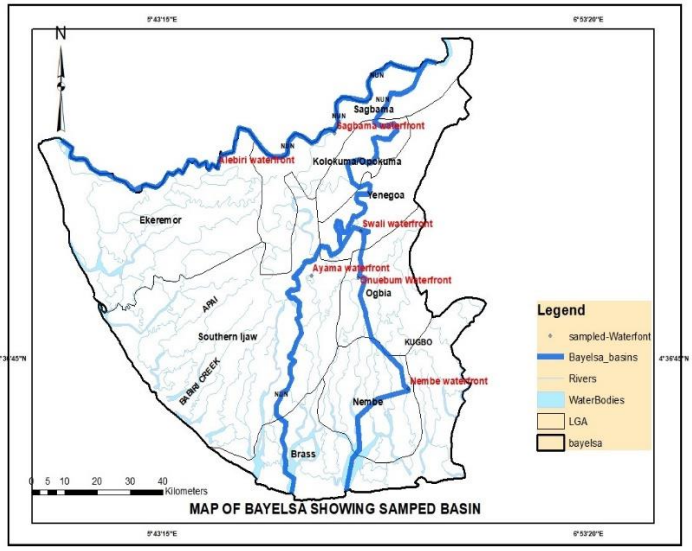

Figure 1: Study area showing sampled rivers and waterfronts
Source: Researcher, 2022

Materials and Methods

In terms of methods, the research design adopted a quantitative design using purposive and simple random sampling techniques. The researcher employed a structured questionnaire which was administered to boat and ferry operators, commuters and regulators of the inland waterways to assess their perception, knowledge and awareness of the navigability and security condition of waterways in the state. The type of data used for this study is the primary data. Primary data was collected by the researcher at the six jetties sampled across the state. This data was sourced via the researcher administering copies of the research questionnaire on targeted respondents in the study area. To understand the target population of registered boat and ferry operators in the state, the researcher embarked on a reconnaissance visit to the Maritime union offices using simple random sampling technique and got a figure 800 registered boat and ferry operators and 25% of this population was therefore used as a representative sample giving the sample size as 200. In determining the sample size based on the percentage, the formula used was: Sample size = $(\text{percentage}/100) \times$ population size Where: Percentage = 25%, Population size = 800 Calculation: Sample size = $(25/100) \times 800 = 0.25 \times 800 = 200$

Thus, the sample size of 200 was derived by taking 25% of total population of 800 registered boat and ferry operators. This method ensures that the sample represents a proportionate fraction of the entire population. The data obtained via the questionnaire were presented in tables and statistical diagrams. For the purpose of data analyses, multiple regression Analysis using the equation y= mx+b was used where y is dependent variable, x is independent variable, m is estimated slop and b is estimated intercept. This equation was used to calculate the relationship that existed between the dependent variable and the various independent variables in the study. Simple statistical techniques such as bar chats, pie charts and histograms were also used in analyzing responses from questionnaires.

Result

Table 1: Dimensions of the Rivers Studied

Rivers	Depth (m)	Width (m)	Length (m)
Nun	Source: 17	Source: 250	160,000
	Mid-point: 13	Mid-point: 200	
	End: 27	End: 1200	
Forcados	Source: 22	Source: 270	198, 000
	Mid-point: 18	Mid-point: 210	
	End: 25	End: 900	
Brass	Source: 13	Source: 200	161,000
	Mid-point: 7	Mid-point: 220	
	End: 33	End: 1700	

Source: Fieldwork, 2022

In order to assess the navigability of the waterways in the study area, the dimensions of the rivers were assessed. The dimensions of the waterways in the state are an indication of how navigable the water ways are. In terms of length, the Forcados waterway is the most navigable, followed by the Brass waterway and then the Nun waterway. From Table 4.2, the average depth and width of the Nun River is given as 19m and 550m respectively. The average depth and width of the Forcados River is 21.6m and 460m respectively while the average depth and width of the Brass River is 17.6m and 706.6m respectively. The Forcados and Brass rivers are very important waterways in the study area as their depth and width appear to be deeper and wider respectively for navigation particularly of bigger ships and barges which are used by major oil and gas companies operating within the area for the exploration and movement of crude oil in Nigeria. Also, the Nun River appears to have a width wider than that of the Forcados but not as deep as the Forcados.

The study using the questionnaire also tried to assess if residents of the area have witnessed any attempts to improve navigability through dredging of the water ways and the following responses were obtained:

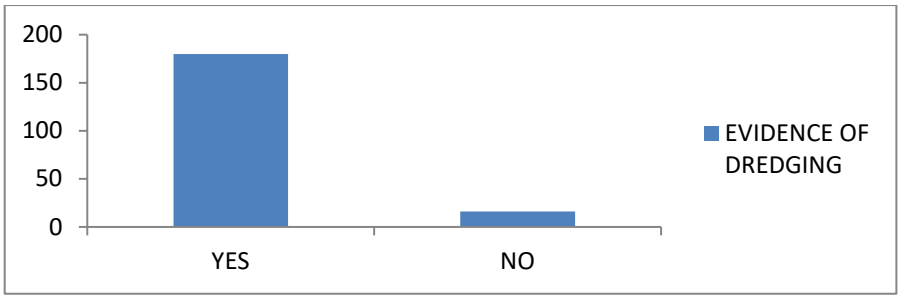

Figure 2: Responses on Ever Witnessing Dredging of Waterways

The responses of the respondents indicate that 91.83 percent of the boat drivers have witnessed the waterways being dredged while 8.16 percent have not witnessed the dredging of the waterways. From the responses, it can be said that the waterways are usually dredged for purposes of sand mining which indirectly helps to improve navigability. Furthermore, the study solicited their responses on the frequency of dredging in the study area and the following responses were obtained:

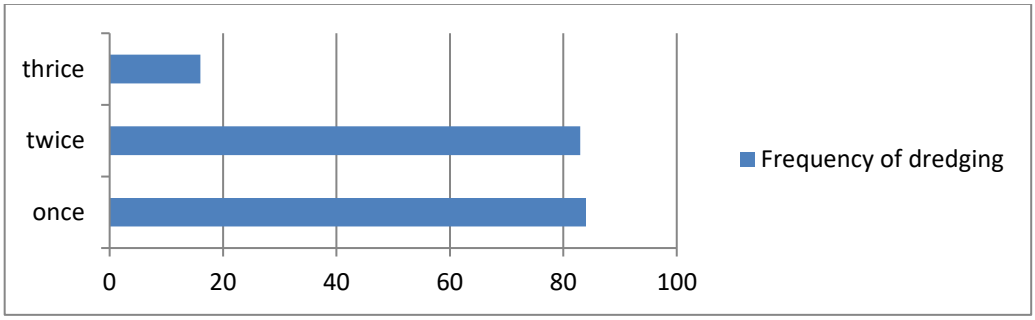

Figure 3: Frequency of Dredging

The study extracts indicated that the focus waterways were dredged once or twice a year. This is done to improve the navigability of the water ways.

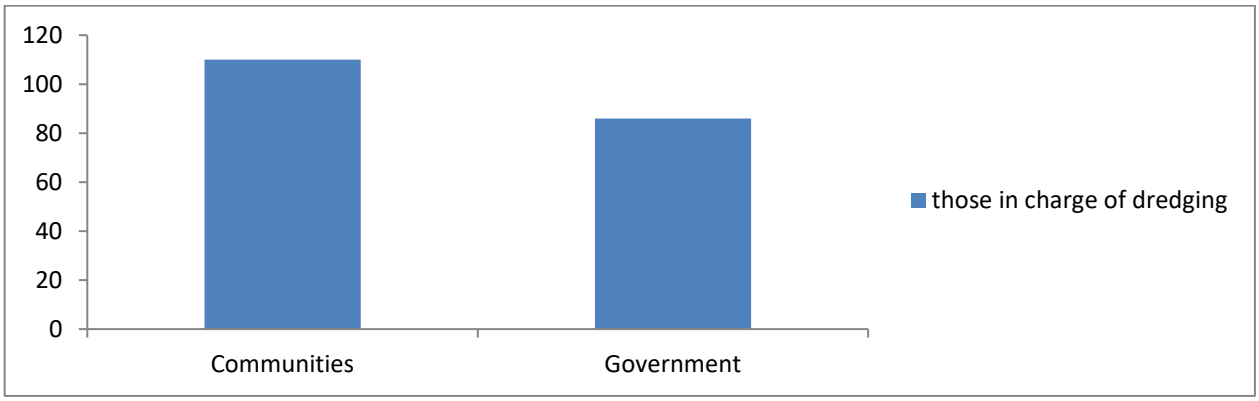

Figure 4: Those in Charge of Dredging the Waterways

The results of the study indicate that most of the times, dredging is done by the community themselves. This is usually for purposes of mining of sand for community development projects. Other times, the waterways are dredged by the government for purposes of harvesting sand for road construction and other infrastructural development purposes. This shows that neither the communities nor government has intentionally dredged the waterways to aid navigability, however, the dredging for mining has indirectly contributed to deepening the waterways at certain areas and as such helped the inland water transport in the area.

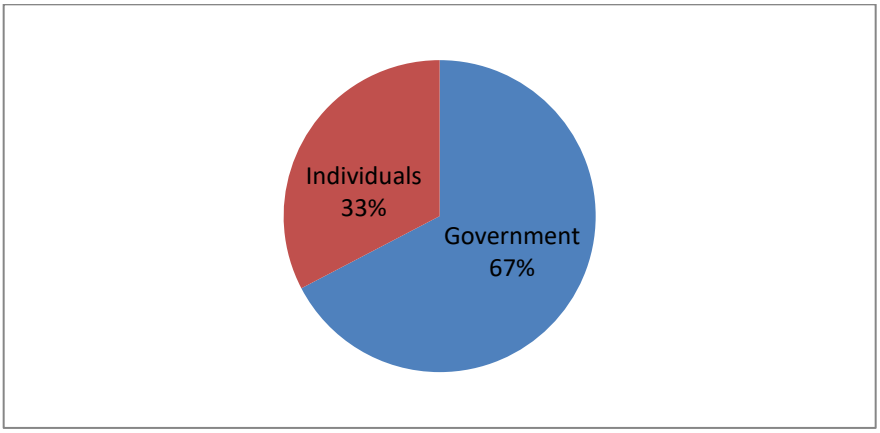

Figure 5: Those in Charge of the Maintenance of the Navigational Channel

The government is majorly in charge of the maintenance of the waterways (67 percent) while individual efforts also contributes to the maintenance of the water ways

Table 2: Dredging's contribution to safety of Forcados River Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.565[a]	.320	.286	.67353	.320	9.392	3	60	.000	2.235
a. Predictors: (Constant), channel maintenance, dredging authority, dredging times										
b. Dependent Variable: yearly maintenance										

From the regression analysis, the model indicated that R^2 = 0.320 0.320 x100 = 32.0%. This means that the dredging of the waterways which is an indicator of the navigability of the waterways contributes 32 percent to the safety of the waterway. The value R= 0.565 implies that there is a moderate impact of dredging times, dredging authority and channel maintenance on the index of inland water safety. The R^2 power of the model equals 0.320. This implies that dredging times, dredging authority and channel maintenance contribute 32 percent to the safety of the waterways. This signifies that dredging times, dredging authority and channel maintenance account for 32% change or effects observed in inland water transport safety in the model. The p value = 0.000 < 0.05 shows the estimate or analysis between the three variables is statistically significant. It thus suggests that dredging times, dredging authority and channel maintenance in the study area have a corresponding effect on waterway safety of the area but the influence is not high. In discussing the absolute explanatory power of the model, the adjusted R^2 value (0.286) gives a coefficient which implies that the model was adjusted positively to take care of errors and discrepancies in the analysis.

Table 3: Dredging's contribution to the Safety of Nun River Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.807[a]	.652	.626	.64052	.652	24.825	4	53	.000	2.660
a. Predictors: (Constant), facilities provision, dredging times, dredging authority, channel maintenance										
b. Dependent Variable: yearly maintenance										

From the regression analysis, the model indicated that R^2 = 0.652 0.652 x100 = 65.2.0%. This means that the dredging of the waterways which is an indicator of the navigability of the waterways contributes 65.2 per cent to the safety of the waterways. The value R= 0.807 implies that there is a high impact of dredging times, dredging authority, facilities provision and channel maintenance on the index of

inland water safety. The R^2 power of the model equals 0.652. This implies that dredging, dredging authority, facilities provision and channel maintenance contribute 65.2 per cent to the safety of the waterways. This signifies that dredging, dredging authority, facilities provision and channel maintenance account for 65.2% change or effects observed in inland water transport safety in the model. The p value = 0.000 < 0.05 shows the estimate or analysis between the three variables is statistically significant. It thus suggests that dredging, dredging authority, facilities provision and channel maintenance in the study area have a corresponding effect on waterway safety of the area, but the influence is moderate. In discussing the absolute explanatory power of the model, the adjusted R^2 value (0.627) gives a coefficient which implies that the model was adjusted positively to take care of errors and discrepancies in the analysis.

Table 4: Dredging's Contribution to Safety of Brass River Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.830[a]	.689	.660	.64425	.689	23.474	5	53	.000	2.759
a. Predictors: (Constant), facilities provision, dredging, dredging times, dredging authority, channel maintenance										
b. Dependent Variable: yearly maintenance										

From the regression analysis, the model indicated that R^2 = 0.689 0.689 x100 = 68.9%. This means that the dredging of the waterway which is an indicator of the navigability of the waterways contributes 68.9 percent to the safety of the waterway. The value R= 0.830 implies that there is a high impact of dredging, dredging times, dredging authority, facilities provision and channel maintenance on the index of inland water safety. The R^2 power of the model equals 0.689. This implies that dredging, facilities provision and channel maintenance contributes 68.9 percent to the safety of the waterways. This signifies that dredging, facilities provision and channel maintenance account for 68.9% change or effects observed in inland water transport safety in the model. The p value = 0.000 < 0.05 shows the estimate or analysis between the five variables is statistically significant. It thus suggests that dredging, dredging times, dredging authority, facilities provision and channel maintenance in the study area have a corresponding effect on waterway safety of the area but the influence is moderate. In discussing the absolute explanatory power of the model, the adjusted R^2 value (0.660) gives a coefficient which implies that the model was adjusted positively to take care of errors and discrepancies in the analysis.

Security Status of Waterways in the Study Area

Security of the waterways is an important factor in the inland water transport in the study area. This study looked at the security level of the inland water ways and came up with these results;

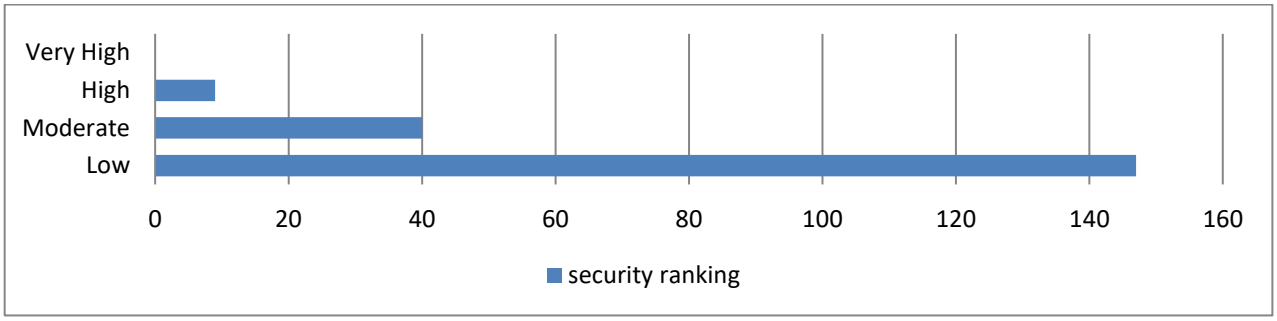

Figure 6: Security Ranking of the Waterways

From the security rankings given by the respondents as shown in figure 4.6, the level of security along the water ways can be said to be low. The low level of security along the water ways could be attributed to the location of the waterways in the creeks and also the activities of pirates in the area. We

further looked at the security measures put in place for the boatmen to sail safely and the results obtained were:

Table 5: Security measures for safety on waterways

Security measures	Frequency	(%)
Security check points along waterways	52	26
Security alarm systems	30	15
Security patrols along waterways	112	57
Signals among boatmen	2	2
Others	0	0

Source: Fieldwork, 2022

The results indicate that the major security measures put in place for the safety of the boatmen is the provision of security patrols along the waterways (57 per cent). The security patrols move up and down the waterways at given intervals on a rotational basis. Other security measures include security check points and security alarm system along the waterways. The least security measure used is the use of signals among boatmen (2 per cent). In addition to the security ranking and the security measures put up in the study area, this research looked at the causes of water way accidents in the study area and came up with the following results:

Table 6: Major Causes of Accidents along the Waterways

Major causes of accidents	Frequency	(%)
Human error like drunkenness and rough driving	69	35
Faulty vessels/boats	48	25
Security issues	16	8
Navigability on water channel	14	7
Obstacles in the waterways	45	23
Others	4	2

Source: Fieldwork, 2022

The major causes of accidents in the study waterways were human errors such as drunkenness over speeding and rough driving (35 percent). This was followed by faulty vessels and security issues. Other issues as identified by the respondents were climatic issues such as heavy rainfall, shallow rivers and passenger interference. In addition, the study tried to ascertain the frequency of accidents as a result of insecurity in the water ways of the study area yearly and the following results were obtained;

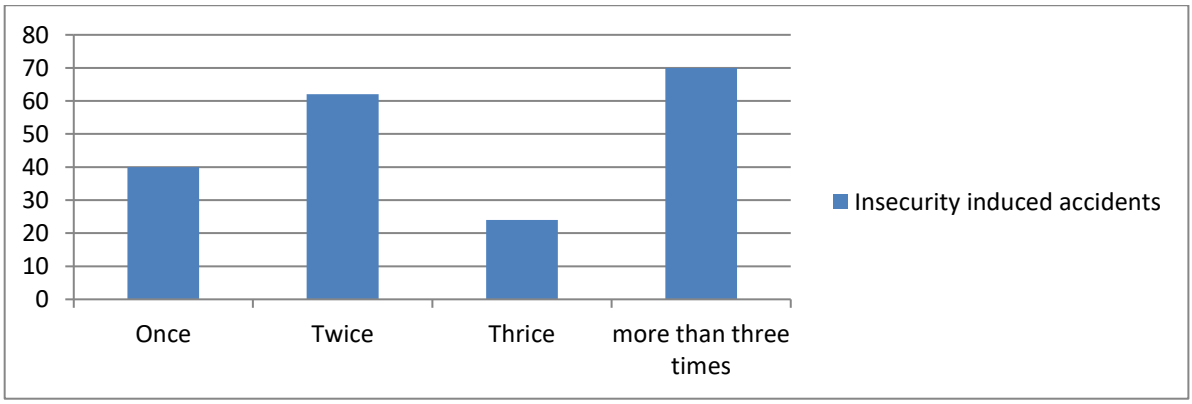

Figure 7: level of Insecurity Induced Accidents

The results from the study indicated that insecurity induced accidents occurred more than three times yearly along the water ways. As a result, we concluded that insecurity is a major issue along the waterways and needs to be handled.

Figure 8: Photograph showing gun boat used for security patrols anchored at Ayama waterfront.
Source: Fieldwork, 2022

Table 7: Security Status Contribution to Safety of Forcados River Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.192[a]	.037	-.026	.79944	.037	.586	4	61	.674	3.006
a. Predictors: (Constant), causes of accidents, security condition, security measures, frequency of accident yearly										
b. Dependent Variable: yearly maintenance										

From the regression analysis, the model indicated that R^2 = 0.037 0.037 x100 = 3.7%. This means that the security status of the waterways contributes 3.7 percent to its safety. The value R= 0.192 implies that there is a low impact of the security status of the waterways on the index of inland water safety. The R^2 power of the model equals 0.037. This implies that the security status of the waterways contributes 3.7 percent to its safety. This signifies that the security status of the waterways account for 3.7% change or effects observed in inland water transport safety in the model. The p value = 0.000 < 0.05 shows the estimate or analysis between the three variables is statistically significant. It thus suggests that the security status of the waterways in the study area have a corresponding effect on waterway safety of the area but the influence is low. In discussing the absolute explanatory power of the model the adjusted R^2 value (-0.026) gives a coefficient which implies that the model was adjusted negatively to take care of errors and discrepancies in the analysis.

Table 8: Security Status Contribution to the Safety of Nun River Model Summary

Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**Change Statistics**					**Durbin-Watson**
					R Square Change	**F Change**	**df1**	**df2**	**Sig. F Change**	
1	.457[a]	.209	.156	.92439	.209	3.901	4	59	.007	3.152
a. Predictors: (Constant), causes of accidents, security condition, frequency of accident yearly, security measures										
b. Dependent Variable: yearly maintenance										

From the regression analysis, the model indicated that R^2 = 0.209 0.209 x100 = 20.9%. This means that the security status of the waterways contributes 20.9 per cent to its safety. The value R= 0.457 implies that there is a low impact of the security status of the waterways on the index of inland water safety. The R^2 power of the model equals 0.209. This implies that the security status of the waterways contributes 20.9

per cent to the safety of the waterways. This signifies that the security status of the waterways account for 20.9% change or effects observed in inland water transport safety in the model. The p value = 0.000 < 0.05 shows the estimate or analysis between the four variables is statistically significant. It thus suggests that the security status of the waterways in the study area have a corresponding effect on waterway safety of the area but the influence is low. In discussing the absolute explanatory power of the model, the adjusted R^2 value (0.156) gives a coefficient which implies that the model was adjusted positively to take care of errors and discrepancies in the analysis.

Table 9: Security Status contribution to Safety of Brass River Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.509[a]	.259	.209	.94903	.259	5.166	4	59	.001	3.247
a. Predictors: (Constant), causes of accidents, security measures, frequency of accident yearly, security condition										
b. Dependent Variable: yearly maintenance										

From the regression analysis, the model indicated that R^2 = 0.259 0.259 x100 = 25.9%. This means that the security status of the waterways contributes 25.9 percent to the safety of the waterways. The value R= 0.509 implies that there is a moderate impact of the security status of the waterways on the index of inland water safety. The R^2 power of the model equals 0.259. This implies that the security status of the waterways contributes 25.9 percent to the safety of the waterways. This signifies that the security status of the waterways account for 25.9% change or effects observed in inland water transport safety in the model. The p value = 0.000 < 0.05 shows the estimate or analysis between the four variables is statistically significant. It thus suggests that the security status of the waterways in the study area have a corresponding effect on waterway safety of the area but the influence is low. In discussing the absolute explanatory power of the model, the adjusted R^2 value (0.209) gives a coefficient which implies that the model was adjusted positively to take care of errors and discrepancies in the analysis.

Discussion of Findings

The dimensions of the waterways in the state are an indication of how navigable the water ways are. In terms of length, the Forcados waterway is the most navigable, followed by the Brass waterway and then the Nun waterway. These rivers are very important waterways in the study area as they serve as the major channels for the exploration and movement of crude oil in Nigeria. Also, the other dimensions of the rivers (depth and width) differ which shows that navigability differs by sites of the waterways. The study also indicated that the focus waterways were dredged once yearly. This is done to improve the navigability of the waterways. These results are supported by Lawal (2012) who claimed that one of the major causes of accidents on waterways are the presence of wrecks. He described wrecks as vessels sunk, stranded or abandoned in harbour, dock, pier, tidal water or ports under the control of a harbour authority. Wrecks include jetsam, flotsam, lagan and all derelicts (including logs) floating or submerged in the tidal waters or the operational shores of a nation. According to Lawal (2012) wrecks are viewed seriously because they constitute danger to navigation and to lifeboats engaged in rescue operations and other services. In areas close to obstacles, such as dams, junctions, bridges, shallow waters and channels, the possibility of accident caused by human error is relatively high, and the relevant coefficients reach middle values while areas with no hazards that have relatively low coefficients of hazard caused by human error are in the areas where navigation is unobstructed, traffic density is low or medium, depths are safe etc.

The results indicate that the major security measures put in place for the safety of the boatmen is the provision of security patrols along the waterways. The security patrols move up and down the

waterways at given intervals on a rotational basis. Other security measures include security check points along the waterways. The least security measure used is the use of signals among boatmen. The results from the study also indicated that insecurity induced accidents occurred more than three times in a year along the water ways. As a result, we concluded that insecurity is a major issue along the waterways and needs to be handled. This is supported by the work of Vidan, Grzadziela and Bošnjak (2012) who asserted that apart from human factors and boat/ferry safety conditions, the safety, security and navigability condition of the waterway itself is also of paramount importance. This is because a boat rider may adhere to safety guidelines and have a safe boat with all safety apparatus but may still be involved in an accident or may not arrive at his destination if there are obstructions, pirates and kidnappers and navigability conditions such as shallow depths, constricted width, steer ability difficulty, turbulence as well as other factors which are not put into consideration before sailing.

Conclusion and Recommendations

With regards to navigability of waterways in the state, this research concludes that the waterways are navigable for small and medium passenger boats and ferries which are the main means of inland water transport in the state. The research also concludes that navigation will not be very suitable for larger and heavier international ships as the shallow depth, constricted width and meandering bends of most of the waterways at some points could constitute a major challenge for them. The result of the analysis of the study thus makes us to say conclusively that navigability on the waterways does not have a significant impact on the safety of inland water transportation in the study area. With regards to the security status of the waterways in the state, the study concludes that despite the presence of security patrols and few check points within the waterways, security induced accidents as well as piracy within the waterways is still prevalent. This conclusively reiterates that the security status of the waterways within the study area is low or below average. Based on the findings of this research, the following recommendations are made: Government at all levels and agencies responsible for the management of the waterways should carry out dredging of the waterways decisively for purposes of deepening the waterways to accommodate bigger ships and vessels with drafts beyond 15 metres in order to encourage more passenger and freight activities thereby, encouraging trade and more economic transactions within the study area. This dredging will also enable the major river basins within the state accommodate more water during flood seasons thereby reducing the impact of flooding which has now become a perennial event in the study area. The study also recommends that government and the agencies responsible should put up strategies for proper monitoring of the waterways particularly for the removal of obstructions like hyacinths, float jams and other obstructions that cause accidents within the waterways.

With regards to security status of the waterways, it has been adjudged that the security level is generally low despite the presence of patrols and few security checkpoints within the waterways. The low security level could be as a result of the security patrols not being enough, security personnel partnering with the criminals terrorising the waterways as well as insufficient or absence of security personnel within the available security checkpoints. This research therefore recommends that agencies responsible for the management of the inland waterways should make available more security checkpoints and personnel within the waterways. The study also recommends that there should be constant rotation of security personnel in order to avoid familiarity with the criminals within the study area.

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