Estimation of the Likelihood of Accident Occurrence on Inland Waterways Transport in Nigeria's Niger Delta

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***Abstract*— This study aims to estimate accidents and operational logistics of inland waterways transport in Delta State, Nigeria. Secondary data sourced from the records of selected jetties and the National Inland Waterways Authority (NIWA) accident data base was subjected to descriptive statistics and a probit analysis. The results reveal the occurrence of boat accidents for non-fatal cases as 0.65 while fatal accident occurrence was 0.35. The probability shows that for every journey there is approximately 35% likelihood of fatal accident and about 65% likelihood of non-fatal accidents. It concludes that waterways of Delta State, Nigeria have high likelihood of accident occurrence due to poor maintenance dredging, enforcement of regulations and lack of public – private partnerships; and thus recommends that NIWA should invest optimally and partner with the private sector to enforce and regulate the waterways operations so as to reduce the risk of travel.**

Keywords—accident; fatal; likelihood; non-fatal; probability

I. INTRODUCTION

There are huge potentials in the inland waterways of Nigeria. The key agricultural zones are adjourning to the rivers, and prominent amongst them is the area known as the middle belt from which agricultural produce are transported to the delta areas and beyond. The Ajaokuta Steel complex is a strategic industry on the Niger as the raw materials for its use comes through the delta ports and thus navigated to the company through the inland waters. Considering the total drainage of the rivers from source to mouth, Nigeria is naturally gifted with about 2,200km of route which is connected to about 880km of inter-coastal waterways from Lagos through Warri, Port Harcourt and Calabar. The under developed but navigable inland waterways measures approximately 3000km and, could be a viable venture towards the development of adjourning communities if fully developed. This would lead to the maximization of benefits accrued from harnessing the enormous potentials of the waterways.

Specifically, Nigeria has about 10,000km of inland waterways that are navigable with an extensive coastline of about 852km. This offers promising future in the logistics and supply chain network of the movement of goods from the coast to the hinterland through inland water navigation. The Rivers Niger and Benue which dissect Nigeria into East, West and Northern regions, provide the source of inland waterways transport in the country. The two rivers form a confluence at Lokoja and flow into the Atlantic Ocean, while the coastal water ways extend from Badagry, Lagos State through Warri, Delta State to Calabar in Cross River State [1].

A. Statement of Problem

Although 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. 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 Delta 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 selected routes.

B. Aim And Objectives

The aim of this paper is to estimate the likelihood of accident occurrence and operational characteristics on the waterways of Delta State in Nigeria. The specific objectives include to:

i. estimate the probability of fatal accident occurrence on the waterways

ii. determine the trend of traffic on the waterways

iii. evaluate the average cost and time of travel on the waterways.

C. Research Questions

The following questions would lead to empirical discussion and solutions to the problem of the paper and as well address the set objectives:

i. Could the probability of fatal accidents be estimated on the waterways?

ii. To what extent is the traffic trending on the waterways?

iii. What is the average cost and time of travel on the waterways?

II. LITERATURE REVIEW

Transportation is hardly demanded for its own sake; rather, the demand for transport (and consequently, the supply to cope with the growth in demand) is derived from the need of every other activity located in space [2]. The importance of an efficient transportation system in any human settlement cannot be over-emphasized. Apart from the fact that transportation network gives a settlement its form, shape and pattern, the art of traffic and transportation planning is concerned with the design and circulation systems and proper management of its services. This maximizes accessibility for essential movements between interrelated and interacting activities, giving due consideration to safety, conformity, speed and comfort [3].

[4] describes accident as an unplanned, unexpected, and undersigned (not purposefully caused) event which occurs suddenly and causes (1) injury or loss, (2) a decrease in value of the resources, or (3) an increase in liabilities. Vessel accident is an unintended happening. Its severity may vary from no vessel damage to the complete loss of the vessel, no cargo damage, to loss of the entire cargo, and no crew injuries to deaths.

In furtherance, [5] analyzed the fatality rates of boat and ferry accidents on inland waterways in Nigeria, with a special focus on the waterways of Port Harcourt. A comparative analysis was carried out with the aid of simple percentile analysis to reveal fatality rates of 19% and 6% derived for boat and ferry accidents respectively. The study concludes that there would be more patronage on the ferry services on the waterways than boat owing to low fatality rate with the ferry services against the boat service. Later on, [6] analyzed the determinants of accident involving marine vessels in Nigeria's waterways and posit that the major causes of marine vessel accidents are human error which leads to personal injury, death, property and environmental damage arising from increased transportation activities in Niger/Delta region of Nigeria. The work emphasized that there are increased risk factors on water ways which was revealed by the use of data derived from structured questionnaires that was administered via random sampling of marine vessel operators in marine terminals and anchorage locations in Niger Delta. Results show that between 75- 965% of marine vessel casualties were caused by human error. The study further revealed that the above factors significantly affect the probability of accident involving marine vessels.

III. MATERIALS AND METHODS

Probit Analysis is designed to model the probability of response to a stimulus. Since the probability of an event must lie between 0 and 1, it is impractical to model probabilities with linear regression techniques, because the linear regression model allows the dependent variable to take values greater than 1 or less than 0. The probit analysis model is a type of generalized linear model that extends the linear regression model by linking the range of real numbers to the 0-1 range

Probability is therefore a numerical value that measures the uncertainty that some events will occur based on the current operations. The probability of success or failure in a single trail is usually expressed in a ratio form [7]:

P (successful outcome) = no.of successful outcome / no. of possible outcomes   (1)

P (unsuccessful outcome) = no.of failure outcome / no. of possible outcomes   (2)

Hence, probability is a relative measure of success or failure to the total possible outcome of the event, as denoted mathematically:

{No. of successful outcome} + {No. of failure outcome} = [No. of possible outcome] (3)

IV. REULTS AND DISCUSSION

A. Data Analysis and Results

TABLE I.
ACCIDENT RATES AND CAUSES ON WARRI AND OTHER WATERWAYS IN DELTA STATE 2017 – 2021 JUNE.

S/N	From	Destination	No. of Passengers	Causes	Causalities		Fatal
					Death	Injured	Probability
1	Warri	Burutu	16	Night Driving Poor Vision Over-Loading	6	10	0.38
2		Odimodi	14	Logging	04	10	0.29
3		Ogulagha	16	Over-Loading	02	14	0.13
4		Agge	05	Oil Facilities	0	5	0
5		Oporoza (Escravos)	08	Tidal Waves	04	4	0.5
6		Okerenkoko	14	Tidal Waves Night Driving	08	06	0.57
7		0kokodiagbene	24	Head on Collison	10	14	0.42
Total			97		34	63	0.35

Source: Compiled from Operational books of NPA Jetty, Warri

Table I shows accident rates and their causes on some Inland waterways of Delta State. Probability analysis reveal that fatal accident probabilities for the Warri to Burutu, Odimodi, Ogulagha, Agge, Oporoza

Journal of Multidisciplinary Engineering Science and Technology (JMEST)
ISSN: 2458-9403
Vol. 8 Issue 11, November - 2021

(Escravos), Okerenkoko and Okokodiagbene are 0.38, 0.29, 0.13, 0, 0.5, 0.57 and 0.42 respectively. The analysis further reveals that there are high probabilities of fatal accident occurrence on Warri to Escravos (0.5) giving a 50% chance; and to Okerenkoko (0.57) implying a 57% chance. The implication of this is that the waterways of Warri to Escravos and Okerenkoku have higher risks compared to others. It is also revealed that the Warri to Agge waterways have no chance of accident fatalities making it the safest among all within the study period. In total, there is approximately 35% likelihood of fatal accident occurrence (that is accident occurrence with loss of lives) and 65% likelihood of non- fatal accident occurrence (that is accident occurrence with injuries) on the inland waterways of Delta State, Nigeria.

TABLE II. IWT Operational Performance for Warri and adjourning waterways, 2017 – 2021 June.

S/N	From	Destination	No. of Trips Per Speed Boats	Duration of Trips (Hour)	Cost of Fuel Consumed	Amount in Cost Paid Per Passenger
1	Warri	Burutu	20	1.00	50litres N7,250	N1,200
2		Odimodi	24	1:45	75litres N10,875	N2,200
3		Ogulagha	42	2:10	105litres N15,225	N3,100
4		Agge	32	2:30	120litres N17,400	N3800
5		Oporoza (Escravos)	24	3.00	150litres N21,750	N4,500
6		Okerenkoko	33	2.00	100litres N14,500	N3000
7		Okokodiagbene	15	2.00	100 Litres N14,500	N3000

Source: Compiled from Operational books of NPA Jetty, Warri

Table II shows the operational performance for the waterways of Warri and others in Delta state. It reveals the number of boats, journey times and the transport fare per passenger for Warri to Burutu, Odimodi, Ogulagha, Agge, Oporoza (Escravos), Okerenkoko, and Okokodiagbene routes. The journey times range from 1 hour to 3 hours, while energy utilized range from 50 litres to 100 litres, it equally reveals that passengers paid transport fare ranging from N1200.00 to N3000.00 for the routes

B. Discussion of Findings.

The probability of fatal accident on the inland waterways of Niger delta is significant. This implies that while fatal accident factors are significant as evidenced by the analysis and tables, there is approximately 35% likelihood or probability of fatal accident occurrence on the waterways of the Delta State. The above findings are in line with work of [8] that assessed the potential impact of unmanned vessels on maritime transportation safety, where results show that Human factor contributes to about 80% cause of accident. Our study in that line found out that Human factor error contributes to 64.7% of fatal boat mishap on the inland waterways of Delta State. This is also in tune with the findings of [9].

V. CONCLUSION AND RECOMMENDATIONS

Based on the results and findings, this paper concludes that the waterways of Delta State have high risk indices and likelihood of accident occurrence, since it is revealed that injuries were high as well as the likelihood of accident occurrence on the waterways.

In order to harness the potentials of Inland waterways transport in Nigeria; the paper recommends that the National Inland Waterways Authority (NIWA) should invest optimally on the inland waterways of the Delta State considering the huge economic potentials of the area, through continuous dredging of the waterways and the provision of adequate security and training of boat drivers to ameliorate the fatality of boat accidents on the waterways.

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JMESTN42353928
14789