International Journal of Frontiers in
Engineering and Technology Research
Journal homepage: https://frontiersrj.com/journals/ijfetr/
ISSN: 2783-0497 (Online)

(Research Article)

Check for updates

Risk analysis of inland waterways transportation on the Niger Delta Basin, Nigeria

Ibeawuchi C Nze [1,*] and Nnenna J Nze [2]

[1] *Department of Maritime Technology and Logistics, Federal University of Technology, Owerri, Nigeria.*
[2] *Department of Logistics and Transport Technology, Federal University of Technology, Owerri, Nigeria.*

International Journal of Frontiers in Engineering and Technology Research, 2023, 05(01), 096–099

Publication history: Received on 10 June 2023; revised on 04 August 2023; accepted on 05 November 2023

Article DOI: https://doi.org/10.53294/ijfetr.2023.5.1.0016

Abstract

This study aimed at analyzing accidents and risk on inland waterways transport operations in the Niger delta basin, Nigeria. Quantitative data obtained from the dada base of the National Inland waterways Authority (NIWA) were subjected to risk assessment methods. The results reveal an estimated average individual risk (AIR) value of 6.2x10-5, a fatal accident rate (FAR) of 975 fatalities per 8640 exposed hours; and accident frequency rate (AFR) value of 0.7% for the inland waterways of Niger delta. It concludes that waterways of Niger delta have high risk indices and potentials of accident occurrence due to poor maintenance dredging, enforcement of regulations; and thus recommends that NIWA should invest optimally in safety awareness and policy enforcement for sustainable waterways operations in Nigeria.

Keywords: Accident; Fatality; Inland waterways; Risk; Transport

1. Introduction

The use of water ways is one of transportation alternatives available to most shippers but it is an integral part of the overall transportation system. It is predominantly intermodal transportation because a high percentage of waterway traffic is interchanged with other transportation modes (Adeniran and Shamusideen, 2017). For the shippers who can use the water way system, it provides a low-cost alternative. Inland waterway transportation ranks at or near the top among other transportation modes in terms of ton-miles produced per unit of energy consumed, and the number of employees and man-hours as well as other resource inputs. It is an important factor in assuring the Nation of a highly competitive and efficient transportation system (Adejare, Nwilo, Olusina and Opaluwa,2011).

However, the Problems associated with inland waterways operations in Nigeria include: Lack of infrastructure including ferry services, mechanised boats and standard jetties; Poor maintenance of the waterways where most are covered with water hyacinth, sand bars and other vegetations; Lack of maintenance dredging and navigational services; Absence of regulations with respect to boat driver/ operator education and training on safety practices (Atubi,2013); and Non existence of a frame work for valuation of risks and accidents on the inland waterways of Nigeria, particularly the Niger Delta. In the light of the above, this research aims to evaluate the risk indices associated with travel on the waterways of Niger Delta basin, Nigeria. This will no doubt raise critical research questions as to what would be the estimated value of average individual risk (AIR), fatal accident rate (FAR) fatalities per number of exposed hours; and accident frequency rate (AFR) on the waterways.

2. The Risk Concept

Kristiansen (2005) asserts that the concept of risk stands central in any discussion of safety. Referring to a given system or activity, the term ‘safety’ he noted is normally used to describe the degree of freedom from danger, and the risk

* Corresponding author: Ibeawuchi C Nze

concept is a way of evaluating this. The term 'risk' is however, not only used in relation to evaluating the degree of safety and the risk concept can be viewed differently depending on the context. Engineers tend to view risk in an objective way in relation to safety, and as such use the concept of risk as an objective safety criterion. Among engineers the following definition of risk is applied:

R = P.C where P = the probability of occurrence of an undesired event (e.g. a plane crash) and C = the expected consequence in terms of human, economic and/or environmental loss. Risk is often calculated for all relevant hazards, hazards being the possible events and conditions that may result in severity. For example, a hazard with a high probability of occurrence and a high consequence has a high level of risk, and a high level of risk corresponds to a low-level safety for the system under consideration. The opposite will be the case for a hazard with a low probability and a low consequence. Safety is evaluated by summing up all the relevant risks for a specific system (Kristiansen, 2005).

2.1. Time in Transit Theory

The Time in Transit theory explains the issue of tradeoff between freight- cost-time and timely delivery which could be applicable to building an econometric model (Weng, Ge, and Han, 2016). Using the Japanese Census of Logistics, his paper examines the cost influence of distance and time across shipping modes. It is revealed by earlier researchers that business enterprises are likely to pay more for short-distance shipments by truck, ship and railroad transportation, as shown in figure1 (Appendix 1); implying that the effect of short distances on rates as per-mile freight rates tends to decline with distance as the ratio decreases (Krugman,1991).

3. Material and methods

The objective to evaluate the average individual risk (AIR) on the waterways was treated with secondary data sourced from NIWA and Marine Police by descriptive statistics considering the relationships:

- AIR = [Fatalities/year].[Journeys/person] / [Journeys/year]
- Fatal accident rate, FAR = [Fatalities/ year]. [Exposure time (journey hours/year x journey duration)] / Exposed hours
- Accident frequency rate, AFR = [DI]/ [EMP. AH]x S/1 where:
    - DI = number of injuries or work accidents per year
    - EMP = number of operators or users
    - AH = average annual hours work per operator
    - S = Scaling factor derived as worker-hours

3.1. Derivation of Quantities for the variables of AIR, FAR and AFR

The following framework is applied to the determination of the afore stated risk indices on the waterways of Niger delta basin.

- fatalities: the total number of deaths arising from boat mishaps on a waterway in the Niger Delta basin in persons.
- journeys: the total number of trips per boat multiplied by 2 indicating a to and fro journey.
- passenger/ persons: the total number of passengers or persons on board a boat multiplied by 2 for a to and fro journey.
- exposure/ journey time: the total number of times in hours taken for a to and fro trip for all trips multiplied by the number of boats (ie hrs x 2 x no. of boats).
- injuries per year: the total number of injuries arising from boat mishaps on a waterway recorded per anum in persons.
- operators: the total number of boat drivers assumed to be one driver plus one attendant for each boat multiplied by the number of boats operating on the waterway (ie 2 x number of boat).
- average annual work hours per operator: the total number of to and fro trip hours per month multiplied by 12 divided by total number of operators.
- scaling factor: derived as worker- hour equivalent to the total to and fro trip hours per month devided by number of operators.

4. Results

Table 1 shows the risk analysis indices for the selected waterways of the Niger Delta. It further reveals the extent to which a waterway is safe or otherwise and as well reveals the extent to which a user or operator is exposed to risks on the waterways. Hence the analysis reveals an average individual risk (AIR) of 5.3x10-5, 1.1x10-5, 3.4x10-6, 2.0x10-5, 2.1x10-5, 5.9x10-6, 1.8x10-5, 9.1x10-5, and 3.5x10-4 for the selected waterways of Abia, Akwa-Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ondo, and Rivers state respectively. Hence this gives an aggregate value of 6.2x10-5for the entire inland waterways of Niger delta.

Table 1 Computation of AIR, FAR and AFR for a period of 1997 to 2021

Niger Delta Basin	Fatalities	Journeys	No. of Passenger/ persons	Exposure/ Journey time	Injuries per year	No. of Operators	Average annual work hrs per operator	Scaling factor	AIR	FAR	AFR
Abia	52	4608	53736	84696	0	384	220.56	18.4	$5.3x10^{-5}$	8.5	0
Akwa- Ibom	30	5616	230856	66864	0	468	142.87	1.2	$1.1x10^{-5}$	3.9	0
Bayelsa	03	7680	80064	83976	0	640	131.21	10.9	$3.4x10^{-6}$	0.5	0
Cross River	44	6216	159000	84744	57	518	163.60	13.6	$2.0x10^{-5}$	7.2	0.9
Delta	9	6384	73128	37512	8	532	70.51	5.9	$2.1x10^{-5}$	0.7	0.13
Edo	8	4656	74376	84432	0	388	217.60	18.1	$5.9x10^{-6}$	1.3	0
Imo	12	1920	20016	65064	6	160	406.65	33.9	$1.8x10^{-5}$	1.5	0.31
Ondo	95	5472	64896	87600	285	456	192.11	16.0	$9.1x10^{-5}$	16.1	5.2
Rivers	491	6672	109872	84456	346	556	151.90	12.7	$3.5x10^{-4}$	79.9	5.2
Total	744	49224	865944	679344	702	8204	1696.92	130.7	$6.2x10^{-5}$	975	0.7

The table also shows the fatal accident rate (FAR) of 8.5, 3.9, 0.5, 7.2, 0.7, 1.3, 1.5, 16.1, and 79.9 respectively for the selected waterways. This typifies the rate at which fatal accidents occur on the respective waterways. Table also reveals the accident frequency rate (AFR) for the selected waterways, which is an indication of the extent to which an operator is exposed to injuries when a boat mishap occurs on the waterways. Thus, a value of 0%, 0%, 0%, 0.9%, 0.13%, 0%, 0.31%, 5.2%, and 5.2% was derived for the selected waterways of Abia, Akwa-Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ondo, and Rivers state respectively. Hence this gives an aggregate value of

5. Discussion

Noteworthy, the research questions dwell on the risk assessment of the selected inland waterways of the Niger delta basin. This research reveals in Table 1 the risk analysis indicators for the selected waterways in the Niger Delta. It further reveals the extent to which a waterway is safe or otherwise, and as well shows the extent to which a user or operator is exposed to risks on the waterways. Hence this analyses an average individual risk (AIR) of 5.3x10-5, 1.1x10-5, 3.4x10-6, 2.0x10-5, 2.1x10-5, 5.9x10-6, 1.8x10-5, 9.1x10-5, and 3.5x10-4 for the selected waterways of Abia, Akwa-Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ondo, and Rivers state respectively, and thus gives an aggregate value of 6.2x10-5for the entire inland waterways of Niger delta. This is in agreement with the work of (Sounge In: Kristiansen, 2005) that analysed the safety level of ferries in the UK and revealed an AIR of 6.4x10-7 [fatalities/ person]. Our analysis further confirms that the average individual risk of boat users for the selected waterways of Niger delta is not alarming, although higher than for the UK ferry users, when compared to other types of transport(for example Driving = 1.0x10-4, Railway= 2.0 x 10-6, and All accidents= 3.0 x 10-4) in the UK. These indices when measured in Nigeria and compared with the results of this study would apparently be higher due to exposed higher risks on road, ral and air transport in Nigeria.

The table also shows the fatal accident rate (FAR) of 8.5, 3.9, 0.5, 7.2, 0.7, 1.3, 1.5, 16.1, and 79.9 respectively per 518400 exposed minute equivalent to 8640 exposed hours, on the selected waterways. This typifies the rate at which fatal accidents occur on the respective waterways. These values are in tandem with Kristiansen (2005) that revealed a fatal accident rate of 8.8 [fatalities] per 108 exposed hours. Thus, an aggregate of 975 fatalities per 8640 exposed hours is revealed which is far higher than the exposed risk value of 660 per exposed 108 hours on motor bikes ride in the UK. The analysis also reveals the accident frequency rate (AFR) for the selected waterways, which is an indication of the extent to which an operator is exposed to injuries when a boat mishap occurs on the waterways. This is in tandem with some outcomes of Awals, Islam, Hoque, and Hoque (2015).

Thus a value of 0%, 0%, 0%, 0.9%, 0.13%, 0%, 0.31%, 5.2%, and 5.2% was derived for the selected waterways of Abia, Akwa-Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ondo, and Rivers state respectively with an aggregate value of 0.7%, for the entire inland waterways of Niger delta. This also is validated by the maritime waterway risk frameworks of Du, Goerlandt, and Kujala (2020) as well as that of Weng, Ge, and Han (2016)

6. Conclusion

This study that analysed accidents and risk on inland waterways transport operations in Niger delta, Nigeria was able to reveal significant risk indices. In order to achieve this aim, at least two waterways were selected from each state of the Niger Delta area, due to their strategic and economic importance. Hence the application of the risk assessment methodology further developed in this study estimated an average individual risk (AIR) value of 6.2x10-5, a fatal accident rate (FAR) of 975 fatalities per 8640 exposed hours; and an accident frequency rate (AFR) value of 0.7% that revealed that it was risky to travel on the waterways of the Niger delta.

Compliance with ethical standards

Disclosure of conflict of interest

The Authors conducted the research together and hence no conflict of interest herein.

References

[1] Adejare, Q.A., Nwilo, P.C., Olusina, J.O. and Opaluwa, Y.D. (2011). A study of Ferry Service Route Network in Lagos Lagoon-Nigeria Using Grapy Theory. Journal of Geography and regional planning 4(6), 326-337.

[2] Adeniran, A.O. and Shamusideen, A.O. (2017). Efficiency of Nigerian Transport System: Lessons derived from the developed nations. Developing Country Studies. ISSN 2224-607x (paper)2225-0565(online) 7(2), 87-93.

[3] Atubi, A.O. (2013). An Evaluation of transport infrastructure in Lagos State, Nigeria. Journal of Alterative Perspectives in the social sciences 5(3),477-494.

[4] Awals, Z.I., Islam, M.R., Hoque, M.R. and Hoque, M. (2015). Analysis of passenger Vessel Accidents in the Inland Waterways of Bangladesh. Processing of Bangladesh MARTEC 2006 Conference. Canadian Research Development Center of Science and Cultures. 39-45.

[5] Du, L., Goerlandt, F. and Kujala, P. (2020). Review and analysis of methods for assessing maritime waterway risk based on non-accident critical events detected from AIS data. Reliability Engineering and System Safety. https://doi.org/10.1016/j.ress.2020.106933

[6] Kristiansen, S. (2005).Maritime Transportation: Safety Management and Risk Analysis. Elsevier Butterworth-Heinemann, Oxford.

[7] Krugman, P. (1991). Increasing Returns and Economic Geography. Journal of Political Economy, 99 (3), 483- 497.

[8] National Inland Waterways Authority, NIWA (2006). Harnessing the Potentials of Inland Waterways Transport in Nigeria. NWA bulletin. Lokoja, Nigeria.

[9] Weng, J., Ge, Y.E., and Han, H. (2016). Evaluation of shipping accident casualties using zero- inflated negative binomial regression technique. Journal of Navigation, 69(1), 433- 448.