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Assessment of Freight Movement in the Inland Waterways System in Lagos Metropolis, Nigeria

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Abstract

The high dependence on land transportation for the movement of both passengers and freight within the Lagos metropolis is not sustainable. The advocacy for the use of Lagos waterways for freight movement must be encouraged. In achieving this, there is the need to document necessary information about water transportation. This study is therefore intended to identify the determining factors for the use of water to move freight on the inland waterways within the Lagos metropolis. Both primary and secondary data were adopted for the study. The primary data was sourced using a structured questionnaire targeting ownership/management of the marine craft (i.e., private, public, or public/private). The respondents included 47 registered members of Barge Operators Association of Nigeria (BOAN). The secondary data were sourced from the records of BOAN focusing on the details of boats and operators. Frequency distribution and charts were used for presenting and summarizing the data, whereas, the multinomial logistic regression model was employed to test the formulated hypothesis. The multinomial logistic regression results show that the determinants of the choice of water route were freight availability (Odd Ratio: 3.257), freight (Odd Ratio: 2.350), and availability of transshipment facilities (Odd Ratio: 2.159). Availability of transshipment facilities had positive and statistically significant relationships with the choice of water route (r=0.86). This study, therefore, recommends that the state government should take necessary steps to improve the inland water transport system in Lagos state.

Keywords: Inland Water Transport, Freight Movement, Route Choice, Marine Craft, Barge Operators.

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Introduction

The Inland waterways are navigable water bodies that are located inland from the coast, such as rivers, lakes, canals, wetlands, and reservoirs (Mako & Galierikovk, 2021). A navigable inland waterway is indicated by its capacity to accommodate a vessel with a weight of 50 tonnes or greater (Young-Seo & Gi-Tae, 2023). Inland canal transportation is considered a proficient means of transportation due to its superior safety and cost-efficiency compared to land transportation. In the past, inland rivers served as a primary means of transporting products. The inland canal transport was however neglected because of the advent of other transport systems, such as roads and railroads, which have led to a decline in investment and business development.

Despite the potential for inland waterways to serve as a cost-effective and environmentally friendly alternative to road transportation, several countries choose not to utilize them. In Europe, the United States, and China, inland waterways have been extensively developed and established as crucial networks for the transportation and logistics of commodities. The European Union (EU) network for complex transport and the promotion of ecologically sustainable modes of transport contribute to the maintenance of investment support and infrastructure enhancements for inland waterways in Europe (Bruna, Eliezé, & Antonio, 2022). In the present day, there is a notable global endeavour to employ inland waterways as sustainable and intricate transportation systems. Therefore, inland waterways will have a pivotal function in an eco-friendly green supply chain by using sustainable energy and acting as a foundation for intricate transportation, including autonomous vessels.

Consequently, it is imperative to investigate the potential significance of inland waterways and analyse patterns in inland waterway research to facilitate the advancement of inland waterways. This research aims to assess the status of the movement of freight on the inland waterways within the Lagos metropolis. The objectives of this study are to assess the nature of inland waterways usage within the Lagos metropolis by identifying the available routes, the types of jetties and vessels involved in freight movement, and the types of goods being transported within Lagos waters. Another objective is to analyse the determining factors in the choice of water route for freight transportation. The study, however, hypothesized that freight availability, types of freight, the value of freight, the safety of the route, security of access channel, the distance of voyage, and availability of transshipment facilities can significantly encourage the use of water transportation for freight movement.

Related Studies and Research Gap

Several studies have been conducted on inland water transport (IWT) focusing on diverse issues (Young-Seo & Gi-Tae, 2023; Durajczyk & Drop, 2021; Asborno & Hernandez, 2021; Solomon, et al., 2021; Nachtmann, 2021; Jiang et al., 2021; Aiyegbajeje & Dienne, 2021; Akinbamijo, Ipingbemi & Bayode, 2016; Ezenwaji, 2010). The study by Aiyegbajeje & Dienne (2021) highlighted the major reasons for the low patronage of water transportation for the movement of passengers. In the work of Young-Seo & Gi-Tae (2023), they used the social network analysis to analyse the research trends of inland waterways and found that Europe had a core keyword of modal shift, which refers to the conversion to eco-friendly vehicles due to the exhaust problem of land carriage, as well as the continuously implemented government policy. The results of China showed that the country's task was aimed at reducing traffic congestion in inland waterways using automatic identification system (AIS) data. In the case of the US, the problems of ship delay remain unsolved owing to old locking facilities and equipment.

Durajczyk and Drop (2021) posit that the nature (or type) of the cargo to be transported is not a concern for IWT, rather the choice of inland water route to move cargo is influenced by: (i) ports and piers adequately enabled for the reception and dispatching of the cargo by inland navigation vessels, (ii) flows of goods stable in time and regular supply with cargo, (iii) navigable waterways which allow navigation of corresponding ships, and (iv) level of use and development of the information and control systems. The influence of weather conditions (low and high water, unmovable and movable ice, strong winds, etc.) makes navigation in some inland waterways very difficult to overcome even at relatively high costs. Since there is no alternative, serious traffic breaks may occur reducing the cost-effectiveness and reliability of the water route.

Asborno and Hernandez (2021) used a stochastic approach with data from the automatic identification system (AIS) and the quantity of transported goods in the harbour of the Arkansas River from 2016 to verify a new estimation model. The importance of this study is to showcase a useful method of identifying the volumes of goods transported on waterways. Solomon et al. (2021) surveyed 25 experts to derive methods for activating the inland waterway system of Volta Lake in Ghana. The respondents commented on the administration, market, goods, and technology for the activation of IWT of Volta Lake. The institutionalisation of IWT, moderate regulation, periodic maintenance, improvement of goods, and development of infrastructure, as well as promotion of integrated transport planning, were included as factors of activation for each sector. The factors derived through the surveys were

essential to the development and improvement of Ghana's IWT, and the authors claimed that government support was required.

Bu and Nachtmann (2021) reviewed and analyzed 135 studies that focused on container of barges (COB) transportation and argued that COB facilitates intermodal transportation by transporting shipping containers on barge tows. Jiang et al. (2021) attempted to understand the navigability of inland waterways in China by investigating the oil spill map of the Yangtze River in China as input into the verification model to analyze the relationship between the thickness and area of the oil layer over time using parametric programming. The results showed that oil had spread along the direction of the current or the horizontal direction owing to convection in the inland waterway. Additionally, the impact of wind on the oil spill trajectory was found to be high when the current speed was low, and the wind speed was high. The authors stated that their research could be used as a reference to predict the transport and dispersion of oil spills in inland waterways.

Other issues that have received attention in the literature include barriers to coastal shipping development, impacts of urban freight transport, analysis of intermodal freight from China to Indian Ocean, modeling conditions influencing intermodal inland waterway transport cost competitiveness. Other areas are related to intermodal IWT cost competitiveness, IWT infrastructure development, and IWT safety issues (Özdemir, 2022; Singh & Pant, 2021; Rogerson, Santén, Svanberg, Williamsson, and Woxenius, 2020; Özdemir, 2018; Venkatesh, Zhang, Luthra, Dubey, Subramanian, & Mangla, 2017; Browne, Allen, Niemoto, & Patier, 2012; Hjelle & Fridell, 2012; Yu, Wang, Moberg, & Cruthirds, 2013; Yang, Low, & Tang, 2011; and Wiegmans & Konings, 2015). For instance, Aiyegbajeje and Dienne (2021) found that the low patronage of IWT in Lagos is a result of perceived passenger safety issues hence, the suggestion there should be an advocacy for the use of Lagos waterways for the movement of freight because of the high dependence on land transportation for the movement of both passengers and freight within Lagos metropolis is not sustainable. In achieving this, the need to document necessary information about water transportation is apparent.

Chowdhury, Paijwar and Singh, (2024) highlight the significance of strategic policy interventions, infrastructure development, and technological advancements in reinvigorating India's inland water transportation network. Their study synthesises the current state of knowledge on inland water transportation in India, offering insights into the multifaceted dimensions of its potential. Aiyegbajeje & Deinne (2021) assessed the patronage level of water transportation and found that despite the huge awareness of the availability of water transport infrastructure, there is still serious apathy for inland-waterways usage because of the safety issues. Akinbamijo, Ipingbemi

& Bayode (2016) and Ezenwaji (2010) share the view that environmental risks limit the use of the water channel, including canalization and dredging (dumping of polluted sediments into surface waters); shipping operations (oil spills; noise pollution; risks of accidents with dangerous cargoes); and impact of invasive plant and animal species. Ezenwaji (2010) studied the impact of water hyacinth within the Anambra basin and recommended an integrated control method for the highly invasive aquatic weed which surfaces on the waterways in August to February every year; these weeds block the routes by forming a mat on the waterways which makes movement difficult on the waterways.

All of these have expanded the discourse in inland water transportation. However, despite all the efforts made by previous research covering diverse areas of water transportation, there still exists a paucity of information on the determinants of freight movement on inland waterways. The study aims to identify the determinants of route choice for the movement of freight on the inland waterways of the Lagos metropolis.

Study Area

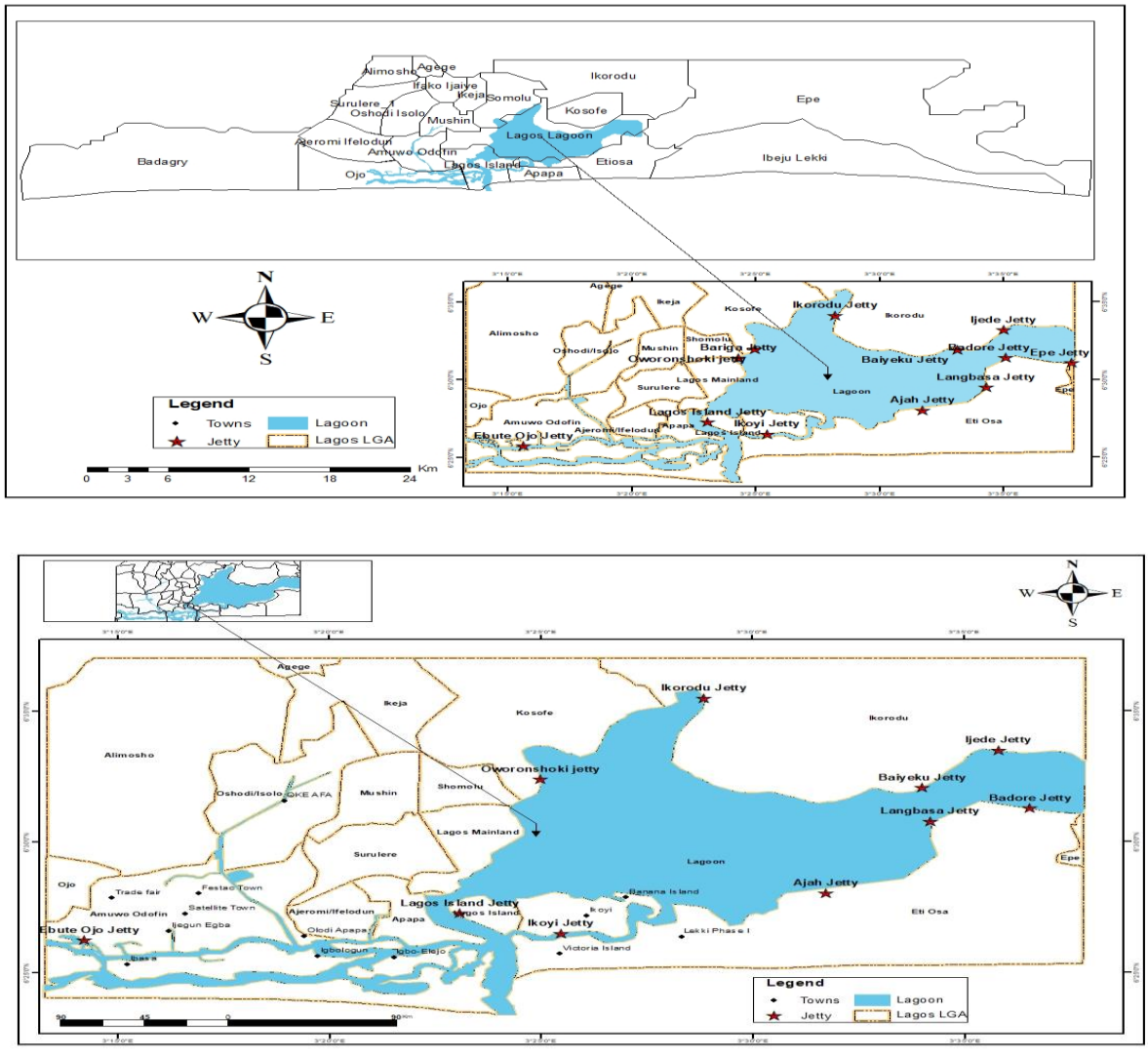
Lagos State, in south-western Nigeria, is located approximately between longitude 20°, 42' and 30°22' and 30° 22'E and Latitude 10°22' and 60°42'N. The 180km long Atlantic coastline forms the southern boundary of the State while its northern and eastern boundaries are shared with Ogun State. On the western side, the Republic of Benin borders the boundary (Balogun, Ladigbolu, & sAriyo, 2011). Lagos has a drainage system that includes a network of gutters, canals, and waterways. However, the system is often poorly maintained and overwhelmed by heavy rainfall, leading to flooding. The drainage system of the State is characterized by a maze of lagoons and waterways which constitutes about 22 percent of the State's total landmass. The major water bodies in Lagos are Lagos Lagoon, Ologe Lagoon, Porto-Novo Creek, Badagry Creeks, Ogun River, and Osun River (LASWA, 2024).

The regulation of inland water navigation in Lagos State is the responsibility of the National Inland Waterways Authority (NIWA) and the Lagos State Waterways Authority (LASWA). LASWA is charged with the granting of ferry licenses and concessions for the operation of terminals to the private sector. The agency controls nineteen (19) state-owned terminals and jetties, including five major ferry terminals at Elegbata/Ebute Ero, Ebute Ojo, Ikorodu, Badore, and Five Cowries in Ikoyi (See Fig. 1). Inland water navigation private sector stakeholder groups in the State include Association of Tourist Boat Operators and Water Transportation of Nigeria (ATBOWATAN) and the recently formed Waterfront Boat Owners and Water Transporters Association of Nigeria (WABOTAN) – their business is primarily

passenger transportation and water tourism, while members of the Barge Operators Association of Nigeria (BOAN) specialize in the transfer of containers, vehicles and general goods to and from the Lagos ports, conversely the transfer of export commodities and empty containers back to the port. There are quite several informal canoe operators traversing the Lagos waters, moving persons and perishable goods between the coastal settlements in the State.

This study focuses on freight movement within the Lagos inland waters, covering the two seaports located in Apapa, namely, the Lagos Ports Complex (LPC) and Tin-Can Island Port Complex (TIPC) and adjoining waterfronts, located at Marina/CMS, Ikorodu, Mile 2/Kirikiri, Festac Town and Lekki/Ajah axis.

Figure 1: *Map of Lagos State showing selected ferry terminals and jetties*



Source: *Authors' Analysis, 2024*

Methods

The primary data was used for this study. The structured questionnaire was adopted for the collection of primary data and key informant interviews (KII). The collection of data from the primary source was done through the administration of a structured questionnaire on owners/operators of inland water marine crafts domiciled in the area of study. Also, the key informant interview (KII) was conducted on owners and operators of barges who showed interest in the interview. Secondary data used in this study, for instance, the list of registered members of the Barge Operators Association of Nigeria (BOAN) was obtained from the records of BOAN. The structured questionnaire administered to BOAN members focused on ownership/management of the marine craft (i.e., private, public, or public/private); determinants of mode choice, years of operations, and number of marine crafts in service were administered to 47 registered members of BOAN. Other information requested includes particulars of the marine crafts owned by the owner/operator such as vessel name, age, dimension, carrying capacity, self-propelled or dumb. Requested data on the nature of their operations cover issues such as type of freight, quantity of freight, type of marine fuel used, destination of freight, trip duration to destination, trip frequency, fuel consumed, weight of goods carried per trip, and freight charge per trip.

Respondents were also requested to provide answers to determinant factors in the choice of water route, operational constraints, and regulatory impediments impacting their investments, as well as policy recommendations to the government to encourage a modal shift from land-based transportation to inland waterways. Others interviewed include the leadership of the Barge Operators Association of Nigeria (BOAN). Given the small population of inland water transport operators in Lagos, as the venture is an emerging industry, the sample size for the survey included the entire registered members of the Barge Operators Association of Nigeria (BOAN), being the only stakeholder group directly involved in the movement of freight within the Lagos waters. There were 47 members of BOAN constituting the sampling population for the study. Participation in this study was voluntary. A total of 47 questionnaire forms were made available to the chairman of the Association with detailed explanations concerning the interest of the study. Subsequently, a total of forty-seven (47) questionnaires were retrieved with a response of 100% without any form of coercion.

A number of statistical techniques were used to analyse the primary data collected from the field. Descriptive statistics such as frequency distribution and charts were used for data analysis and presentation, whereas, inferential statistics, precisely, step-wise multiple regression model was employed to test the formulated hypotheses. The analysis was done using the Statistical Package for Social Scientists (SPSS, version

22) (Borucka, 2020). The dependent variable (y) is the use of water transport for freight movement, while the independent variable (x) is the determinant factors (freight availability, types of freight, value of freight, navigable access channel, security of access channel, distance of voyage, and availability of transshipment facilities).

To assess the factors determining the use of water transportation for freight movement in Lagos State, data collected for the hypothesis which states that freight availability, types of freight, value of freight, navigable access channel, security of access channel, distance of voyage, and availability of transshipment facilities will significantly predict the use of water transportation for freight movement, was analyzed using the multinomial logistic regression models. Logistic regression analysis identifies those independent variables with the strongest contribution to the variation in the dependent variable. As already explained above, logistic regression was used for the analyses because of the dichotomous nature of the variables (Udofia, 2011). The logistic regression model is of the form:

$$\text{Logit } \{p(x)\} = \log [p(x)/1-p(x)] = a + b_1X_1 + b_2X_2 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{ eqn (1).}$$

Where: Logit (p) = log (to base e) of the odds ratio or likelihood ratio that the dependent variable is 1; p = probability of the dependent variable Where; Y = Dependent variables are: use of inland waterways to move freight; a = Y intercept; b_1-b_3 = regression coefficients.

The independent variables are: X_1 = Freight availability; X_2 = Value of freight; X_3 = Types of freight; X_4 = safety of route; X_5 = Security of access channel; X_6 = Distance of voyage; and X_7 = Availability of trans-shipment facilities.

The dependent variable (the use of inland waterways to move freight) was measured by re-grouping the responses of the operators to the questions: what is the number of cargo movements you make each day and what is the nature of the voyage? These responses were captured in a tabular form under the sub-theme – what factors influence your choice of the water route? The independent variables were measured through the responses to the questions covering variables in X_1-X_7. For instance, the independent variables were measured from the responses of the participants as follows: the responses were either yes or no. The responses in 'yes' are re-coded as 2 while 'no' is 1.

Results

Operational Characteristics of Barge-Operators

Table 1 indicates that the majority of operators involved in inland barge service owned their barges (78.7%), while 21.3% were charterers or hired the barges in their fleet. A total of 38.3% of the respondents indicated that they operate self-propelled barges in their fleet, while 61.7% of the respondents indicated that they operate non-propelled or dumb barges in their fleet. The acceptance of marine insurance by inland barge operators in Lagos seems very high, 80.9% of the respondents claim to have insurance for both vessel and cargo, 8.5% of the respondents claim to have vessel insurance only, and 10.6% of respondents claim to have cargo insurance only.

In this study, more than half of the respondents 63.8% have been in the business for 10 years or less, 27.7% have clocked more than a decade, while 8.5% have spent over thirty years in the inland barge business. For the designated route, a total of 32 (68.1%) respondents indicate they provide a tramp service (do not follow any route or schedule); 10 (21.3%) indicate they move freight within the Lagos Pilotage Area i.e. between port terminals and/or from port terminals to nearby jetties and warehouses, while 5 (10.6%) indicate move freight between the two Lagos Ports and Ikorodu.

Table 1: *Profile of inland barge operators in Lagos*

Variable	Options	Frequency
Ownership of Barge	Beneficial Owner	37
	Charterer	10
	Total	**47**
Type of Barge	Self-propelled	18
	Non-propelled	29
	Total	**47**
Marine Insurance	Vessel Only	4
	Cargo Only	5
	Vessel + Cargo	38
	Total	**47**
Length of Operations	0 – 10 years	30
	11 – 20 years	13
	Above 30 years	4
	Total	**47**
Designated Route	Lagos Pilotage Area	10
	Lagos Ports to Ikorodu.	5
	Tramp Service	32
	Total	**47**

Source: *Authors' Analysis (2024)*

Category of Freight Moved on Lagos Inland-Waterways

The respondents indicated the main category of freight moved on Lagos inland waters as general/manufactured goods, bulk cargo (construction materials), agriculture commodities (exports), and containerized goods (imports and vehicles). In Figure 2, it was shown that 32% of the respondents indicated they move mainly general goods, 8.5% of the respondents indicated they move mainly bulk cargo, 8.5% indicated they move mainly agriculture goods, while 51% of the respondents indicated they move mainly containerized goods.

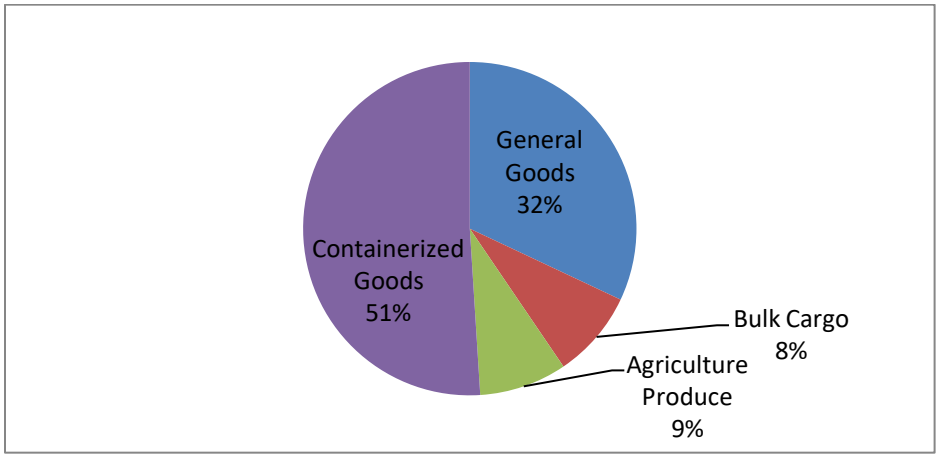


Figure 2: *Category of freight moved by inland barge operators*
Source: *Authors' Analysis (2024)*

Determinants of Route Choice

As shown in Table 2, a total of 74.9% of the respondents indicated the availability of transshipment facilities as the main reason for their choice of route, 53.2% indicated that type of freight while 63.8% of the respondents identified security of the access channel, whereas 68.1% indicated freight availability as the main reason for the choice of route. About 48.9% indicated the distance of the voyage, 42.6% indicated the value of the shipment; while 53.2% indicated the type of shipment.

Table 2: *Factors influencing choice of route*

Factors	**Strongly Influenced**	**Influenced**	**Indifferent**	**Not Influenced**	**Strongly not influenced**
Freight Availability	22 (46.8%)	10 (21.3%)	6 (12.7%)	9 (19.1)	No response
Type of Freight	8 (17.0%)	17 (36.2%)	20 (42.6%)	No Response	2 (4.3%)
Value of shipment	14 (29.8%)	6 (12.8%)	16 (34.0%)	11 (23.4%)	No response
Safety of route	21(44.7%)	20 (42.6%)	6 (12.7%)	No response	No response

Security of channel	26 (55.3%)	4 (8.5%)	15	2 (4.3%)	No response
Distance of Voyage	15 (31.9%)	8 (17.0%)	22	2 (4.3%)	No response
Transhipment Facilities	31 (66.0%)	7 (14.9%)	9	No Response	No response

Source: *Authors' analysis (2024)*

Testing the Formulated Hypothesis

The result of the hypothesis that freight availability, types of freight, value of freight, navigable access channel, security of access channel, safety of route, the distance of voyage, and availability of transshipment facilities can significantly encourage the use of water transportation for freight movement was tested using the multinomial logistic regression.

Table 3 indicated that the multinomial logistic regression results show that the determinants of the choice of water route were freight availability (Odd Ratio: 4.2176), safety (Odd Ratio: 4.199), and availability of transshipment facilities (Odd Ratio: 5.310). Availability of transshipment facilities had positive and statistically significant relationships with the choice of water route (r=0.86). The strength of logistic regression using the Nagelkerke R square value revealed that 85.9 percent (0.859) of the variability in the dependent variable (choice of water route) was explained by the set of independent variables used in the model.

Table 3: *Determinants of choice of water route*

Variables	B	SE	Wald	df	Sig.	Exp(β)	Odd ratio (e^{β})
Type of freight	-0.234	0.389	0.363	1	0.547	0.791	0.791
Value of shipment	-0.034	0.124	0.076	1	0.783	0.967	0.967
Transshipment	1.100	0.477	5.310	1	0.021*	3.003	3.003
Freight availability	0.941	0.460	4.176	1	0.041*	2.562	2.562
Safety of route	1.461	0.513	4.199	1	0.024*	2.232	0.232
Security of channel	0.299	0.456	0.429	1	0.512	0.742	0.742
Distance of voyage	0.258	0.463	0.312	1	0.577	0.772	0.772
Constant	1.766	0.814	4.708	1	0.030*	5.849	

Overall model estimation

	Chi-square	df	Sig.
Step	19.496	7	0.010*
Block	19.496	7	0.010*
Model	19.496	7	0.010*

Chi-square = 19.496*; Cox & Snell R Square = 0.368; -2 Log Likelihood = 264.367[a]; Nagelkerke R Square = 0.496; Overall model classification = 85.3; OR = Odd ratio; N=47

*Significant at a 5% confidence level

Source: *Authors' Analysis, 2024*

In addition, the goodness of fit result shows that the model adequately fits the data with p-value (sig) >0.05. The assumption is that if the Hosmer and Lemeshow Test- goodness-of-fit test statistic is greater than .05, it shows that the model is well fit; thereby, accepting the hypothesis that freight availability, types of freight, value of freight, navigable access channel, security of access channel, distance of voyage, and availability of transshipment facilities can significantly encourage the use of water transportation for freight movement. This is because there is no difference between the observed and model-predicted values, implying that the model's estimates fit the data at an acceptable level. That is, well-fitting models show significance on the *H-L goodness-of-fit test*. This desirable outcome of significance indicates that the model prediction is significantly not different from the observed (Agresti, 1996; Pampel, 2000).

The classification result shows that the classification accuracy rate is 85.3%, suggesting that the model is highly useful. The result indicated that among the predictor variables used in the model to predict the probability of the dependent variable, transshipment facilities significantly predicted the choice of water route (X^2 = 5.310, p<0.05). This is followed by safety of route (X^2 = 4.199, p<0.05) and freight availability (X^2 = 4.176, p<0.05). The odd ratio indicated that if the transshipment facility is raised by one unit (one person) the odds ratio is 5 times as large and therefore, the transshipment facilities is 5 times more likely to predict the choice of route among barge operators. Other predictor variables such as types of freight, value of freight, navigable access channel, security of access channel, and distance of voyage did not contribute significantly to the prediction of mobile telephone usage among doctors.

Discussion of Result

Several studies on the inland waterways system in Nigeria and Lagos in particular have focused on a variety of issues. Most of these issues focused mainly on passenger movements with less emphasis on freight movement. This study therefore attempted to examine the movement of freight and the determinants of route choice in the inland waterways system in Lagos metropolis. The findings of this study revealed that the availability of transshipment facilities (Odd Ratio: 5.310, p =0.021), safety of route (Odd Ratio: 4.199, p = 0.024), and freight availability (Odd Ratio: 4.176, p = 0.041) all have positive and statistically significant relationships with the choice of water route at 85.3% with Nagelkerke R Square = 0.496.

This finding further corroborates the findings in previous studies such as in the work of Chowdgury, Paijwar, and Singh, (2024) where they opined that strategic policy interventions, infrastructure development, and technological advancements are very

significant in reinvigorating inland water transportation networks. Their study further synthesizes the current state of knowledge on inland water transportation and offers insights into the multifaceted dimensions of its potential. In particular, the position of Aiyegbajeje and Deinne (2021) where they found that safety is very significant in inland water transportation aligns with the findings of this study. This study supports the view that whilst a greater part of the Lagos metropolis is connected by water, Lagos merchants and industries regard using the waterways to transport their wares as high risk. Furthermore, Trivedi, Jakhar, and Sinha (2021) in their study examined various barriers to inland waterways as a sustainable transportation mode. Rogerson, Santén, Svanberg, Williamson, & Woxenius, (2020) suggested a modal shift to inland waterways as a way of dealing with barriers in transportation.

Totakura, Narasinganallur, Jalil, and Ajith (2022) revealed that infrastructure factors were found as the most critical factor, followed by economic factors, geographical factors, and, lastly, regulatory factors affecting container shipping through inland waterways. The study revealed that as per the weights obtained for the subfactors, inadequate depth of rivers, container inventory, and repositioning emerged as significant factors that need to be addressed (Totakura et al., 2022). Some of the factors and subfactors listed in the study by Totakura et al., (2022) aligned with some of the findings in this study. Meanwhile, the expected development of inland water transport has been hampered by poor water channelization, absence of freight transshipment facilities, opaque regulatory regime, the use of poor-quality barges by operators, insecurity and multiple regulations by different agencies of government, among others.

Conclusion

The high cost of road haulage and limited rail infrastructure in a coastal metropolis like Lagos with a growing population that is well over 24 million people could be reduced with the use of waterways for haulage. The waterways offer an opportunity to transport goods at a lower cost, consuming less energy, emitting less carbon, and contributing to a better environment. Water transport in urban areas is particularly suitable for freight that is voluminous and bulky. A waterway network performs better when it is well-linked to other modes like roads, rail, and pipeline.

This study, therefore, recommends that the state government take necessary steps to improve the inland water transport system in Lagos state. Such steps include encouraging people to use water to move their goods, modernization, and standardization of water transport infrastructure, market incentives, and start-up grants, better advocacy and information sharing, human capital development, and improved regulatory regime and best practices. No doubt, a lot of work is required to

convince Lagos merchants and industries to start patronizing the waterways, which due to safety concerns, is regarded as a higher risk compared with land-based transportation. Promotional materials, media, and targeted marketing strategies are required to encourage producers and shippers to transfer their freight from road to water.

This study revealed that bulk cargo (construction materials like sand, gravel, and clinker), agriculture commodities (cocoa, cashew) packaged for export, containerized imports including automobiles (all categories), and empty containers being returned to the ports, constitute the freight mainly moved on Lagos waterways. Inland barges are also deployed to move petroleum products and fresh water, even though, this trade is very limited. The use of barges to haul freight on Lagos waterways is intrinsically linked to the access channels under the administration of the Nigerian Ports Authority (NPA). If this practice is enhanced and sustained, the economy of Lagos would be significantly boosted if waterborne freight transportation is harnessed under strong public and private sector collaboration.

Lagos is blessed with a well-connected marine environment; however, the lack of tangible investments in cargo transshipment facilities, low fleet capacity, and poor linkage of the inland terminals to other land transport modes has made the use of water transportation in the State very unattractive to shippers. The relevant agencies should showcase successful projects and operations related to the transfer of freight from road to water. There is a need to bring together stakeholders, notably service providers and users in the inland water freight business, as part of a Lagos urban goods distribution network.

However, the implementation of these recommendations may face some challenges which may include a lack of political will to produce and promote policies that could drive the initiatives. Also, the residents may be receptive to using water to move their freight due to many reasons particularly the need to get their freight to the final destination by road. This could also lead to a search for vehicles to move the freight to its final destination which may increase charges for moving the freight. Although there are strategies for overcoming these problems. The first is to increase the advocacy that will lead to policy formulation and also encourage the residents to make use of water transport to move their freight at subsidized prices aided by the government. This will help to reduce stress on the road and improve the safety of road users within the metropolis.

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