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## Comparative Analysis on the Impact of Inland Transportation on Logistics Operations in Lagos State

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### ABSTRACT

Mobility is a universally relevant and interesting topic since it is a fundamental component of the national and global production systems that are transforming the world. Individuals travel, either frequently or infrequently, not much research has been done on inland transportation in Nigeria's coastal belt and how it affects the logistics sector in Lagos State, freight's journey typically continues beyond the port. The study looked at the connection between logistics operations and inland transportation in Lagos State. The study used a correlation research approach. Using well-structured questionnaires, data for the study were obtained from inland transport providers and users. This study's population consisted of Lagos State's five inland waterway terminals. Inland waterways transport system when compared to other mode of transport like rail transport has a significant improvement in terms of development and at the same time cheaper. Operational performance served as a stand-in for inland waterways transportation, and handling, packing, storing, and delivery of commodities (cargoes) served as a stand in for logistics. The multiple correlation coefficients (R) were 0.979, and the coefficient of determination (R<sup>2</sup>) was 0.958 with p-value is less than the 0.05. The study came to the conclusion that inland waterway transportation is statistically relevant to the logistics operations in the Lagos State because of its low energy consumption, low air pollution emissions, and low external expenses. In order to improve the efficient operations of inland waterway transportation in the Lagos State, the study recommend that sufficient development of waterways channels to enable long-term transportation of goods and services between locations.

### INTRODUCTION

Mobility is a universally relevant and interesting topic since it is a fundamental component of the national and global production systems that are transforming the world. Individuals travel, either frequently or infrequently (Caiati, 2024). Before being consumed, goods must be distributed from one location to another after being extracted, made, and gathered. Individuals who require services, which are typically offered at a restricted number of locations, have to travel to get them. As a result, mobility serves a crucial purpose in society and is one of the most prevalent elements in any economy. One of the most crucial prerequisites for accomplishing the Millennium Development Goals is improved mobility for the impoverished and vulnerable populations, particularly in developing country cities (Abidoye *et al.*, 2024). Cities that have integrated transportation modes are more likely to develop into hubs for trade, commerce, industry, education, tourism, and services, as the rate of urban center growth has increased the demand for the movement of people, goods, services, and information. An effective transportation system is necessary to maintain the expansion of metropolitan areas (Bosona, 2020). However, the rate at which people, products, and services are moved about via various modes of transportation is tied to the rate at which urban centers are growing (Diao *et al.*, 2021).

The goal of inland transportation services is to get your goods faster to their intended location while keeping them in the original shipping container from which they were packaged (Bui & Nguyen, 2022). Long-distance bulk material transportation is already a common use of inland navigation, which helps port cities receive their supply of goods. One way to think of logistics as a tool is to make sure that goods and services arrive when and when needed. Without logistical help, marketing and production tasks are challenging to do. Information, inventory, transportation, warehousing, material handling, and packaging are all integrated (Tien *et al.*, 2019). Logistics' operational duty is to relocate raw materials, work-in-progress, and finished stocks geographically where needed at the most economical cost (Adeitan *et al.*, 2023). Supply chain management, manufacturing scheduling and planning, packaging and assembly, and customer support are also included in the logistics function, albeit to differing degrees. Strategic, tactical, and operational planning and execution are all included (Meredith & Shafer, 2023). Over time, Lagos State, Nigeria's interior transport providers lost out on vast coastal trade prospects because of the waterways transport policy (Ogunleye, 2020). That was implemented and focused on operations. Currently, inland transportation performance and operations are the focus of a number of policy efforts, (Etukudoh *et al.*, 2024) including pricing

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and infrastructure (public transportation subsidies). Nevertheless, simply enacting policies without considering their administrative administration or anticipated enforcement pattern is insufficient (Orbih, 2023). Logistics operations are significantly impacted by these policies, particularly in Lagos State (Sede, 2023). In contrast, not much research has been done on inland transportation in Nigeria’s coastal belt and how it affects the logistics sector in Lagos State, freight’s journey typically continues beyond the port. To move merchandise from point A to point B, a combination of transport options is therefore required. Moving products over land by truck, rail, or barge is known as inland transportation, and it is a crucial component of effective logistics. We looked at the connection between logistics operations and inland transportation in Lagos State in this paper.

**MATERIALS AND METHODS**

In order to examine the connection between logistics operations and inland transportation in Lagos State, the study used a correlational research approach. Using well-structured questionnaires, data for the study were obtained from inland transport providers and users. This study’s population consisted of Lagos State’s five inland waterway terminals. Because of the heavy traffic at the mile 2 waterway terminal, 200 respondents were chosen at random using a random sampling technique. The handling, warehousing, delivering, sorting, and packing of freight were the exogenous factors in the study. Each of the independent factors was tested to determine its effects using the endogenous variable, inland transportation.

The model

$$Y = c + b_1x_1 + b_2x_2 + \dots + b_nx_n + e \dots \dots \dots (1)$$

Where,

Y = Dependent variable

C = slope

b<sub>1</sub>, b<sub>2</sub>, b<sub>3</sub> = independent variables

e = Error term.

F ratio is used to validate the model

X<sub>1</sub>=Sorting of goods

X<sub>2</sub>= Delivery of goods

X<sub>3</sub>= Handling of freights

X<sub>4</sub>= warehousing

X<sub>5</sub>= packaging of freights

**LITERATURE REVIEW**

**Conceptual Review**

According to Gurzhiy *et al.* (2021), the planning and monitoring of physical flows is the main focus of the operational operations of the inland transport system, which are carried out in accordance with the strategic planning. A plan of actions to be carried out in accordance with the guidelines established in strategic planning for the movement of freight is the result of operations planning (Shramenko *et al.*, 2022). These activity plans cover things like traffic routing, export trailer loading, and collections for the next day. The coordination of international traffic, domestic haulage and distribution, warehouse staff, and

other aspects of the plan are all handled by different parties involved in the operational planning process between freight owners and inland transport operators. This means that the operation of an operating plan is a collaborative effort, which highlights the significance of information flow. According to Karam *et al.* (2021), some essential components of operating plans are schedule, crew assignment, connection patterns, cost/level of services trade-off, and contingency.

**Route**

Almobaideen *et al.* (2017) defined the route as the path taken to transport the items from point of origin to point of destination. This implies that the physical infrastructure employed has a direct bearing on how geographic distance is traveled. The means of transportation and the supporting infrastructure would be determined by the way. The way that it is used heavily depends on the infrastructure’s availability.

**Schedule**

The schedule needs to be appropriate and take into account the requirements for departure and arrival; for instance, a ferry should leave at a specific time in order to accommodate the time frame necessary to provide an agreed-upon service (John & Amedu, 2019). The method under the previous subheading establishes the route, taking traffic uses into account schedules; the precise performance rendered in relation to schedule is how the services level is measured; timely delivery of an agreed-upon time requires the timely receipt of the transportation order; scheduling is also impacted by unforeseen events that distinguish each transportation process. According to Stamos (2023), a number of factors, including capacity, weather, traffic, and infrastructural changes, make it challenging to gauge the quality of transportation services. A proper timetable, the execution of operations, and appropriate organization are the cornerstones of a high degree of service (Machado *et al.*, 2023). Scheduling is a crucial component of transport planning. From the time the transportation order is received until the final delivery time, the process is carried out throughout the whole transportation system.

**Crew Assignment**

Crew assignment refers to the capacity to assign and supply drivers who can effectively meet traffic demands in an economical manner while acknowledging uneven demand (Ebrahim, 2021). This engine was also referred to as the “unit used to pull the vehicle” by Martins *et al.* (2022). A driver is required for every unit. It’s common to refer to this idea as having the ability to provide in proportion to demand. Whereas crew assignment and propulsion unit concentrate on the ability to assign drivers and unit service and demand, capacity refers to the entire ability to service the demand in multiple sectors of transportation.

**Flow Distribution**

Flow distribution examines flow imbalances and determines how to allocate vehicles within the transportation network to areas of highest demand (Ebrahim, 2021). This shows how transits and distributions are planned such that passenger locations and unloading occur when the next navigation's loading is scheduled. Propulsion units and their capacity to function in tandem with traffic flows are also mentioned here. Another commuter should be easily available for the transit to another area from where the first passenger is dropped off if a passenger is transferred to that location (Wang *et al.*, 2021).

Operating empty cars and ferries across large geographic distances is an extremely expensive operation, demonstrating that expenses are borne by a single voyage or trip rather than being divided in half and carried by two (Havre *et al.*, 2024).

### Connection Pattern

The time needed to transition between modes is referred to as a connection pattern. The method, route, and scheduling are closely related to the connection patterns (Guo *et al.*, 2023). An appropriate programming of the link is necessary for it to function as a transportation system (D'Emidio *et al.*, 2024). The degree of service and overall performance of a service are affected by this crucial component, especially when an integrated transport system is used. Connection patterns may need to be changed since unanticipated events, such as car problems, delays in scheduled service, bad weather, and traffic congestion, always interrupt transportation (Rückert, 2023; Oladimeji *et al.*, 2023). This can be avoided with contingency planning; it is possible to prepare ahead of time for such occurrences.

Ribeiro *et al.* (2021) assert that significant socio-economic development depends critically on the creation of an effective, adaptable, and dynamic transportation system. The correct development of all means of transportation must receive equal priority in order to build this kind of system. According to Nnene (2020), there are multiple forms of demand for transportation, with the most evident being "revealed demand" which is determined by the actual journeys performed using the current infrastructure. The second type of demand, which is more likely to exist at any location at any time, is known as Latent demand, according to Nnene. This type of demand is made up of elements of the current demand that, for whatever reason, cannot be satisfied possibly due to infrastructure shortcomings or is sometimes referred to as "delayed demand."

According to Chilaka (2023), the waterways transit was in charge of colonial administrative functions, passenger transportation, and the distribution of stream mail. Despite not taking many management initiatives, the Inland Waterway Department was able to retain a fair amount of control over the country's network of inland waterways. The Federal Government of Nigeria

established the National Inland Waterways Authority (NIWA) by Decree No. 13 of 1997 to replace the defunct Inland Waterways department (IWD), with the explicit goal of managing Nigeria's extensive inland waterway resources. This move was made in an effort to revitalize inland waterway transport in Nigeria and make it more effective, competitive, and result-oriented. On January 1st, 1998, the Decree creating NIWA 41 and the enabling Act entered into force. The Decree gives NIWA sole management, direction, and control over Nigeria's inland waterways. According to Okeola and Balogun (2017), Nigeria's 10,000 km of navigable waterways, which stretch from its borders with Niger and Cameroon to the Atlantic Ocean, are used to exercise this power.

Inland water transport is crucial to rural development, particularly in the deltaic regions of Lagos, Rivers, Beyelsa, and AkwaIbom, according to investigations (Edo, 2023). When used to convey products and services, it has been shown to stimulate local coastal communities' rural development and economic growth particularly in situations when it is the only accessible mode of transportation. Inland water transport, according to a Nigerian inland waterway authority official, is a vital component of the social fabric of the area and helps people, particularly the impoverished, access social services, find work, and advance the country's economic goals. Rural productivity is increased by inland water transport, which is also essential to the survival of the region's dispersed villages.

In fact, reports and extensive data have shown particularly in states with coastal regions that inland waterways support various aspects of the agricultural industry as well as other businesses, such as the production of basic materials, the processing of timber products, the promotion of rural development, and crop production through fishing. According to Ansah *et al.* (2020), the form of transportation in question has been found to positively affect trade, agriculture, and industries, hence contributing to the expansion of the rural economy. Furthermore, it provides a means of production or acquisition of adequate food, fish, and other items for hundreds of millions of people, particularly in the isolated coastal areas where it is still the only mode of transportation.

The use of Nigeria's inland waterways has significantly decreased, according to Onokala and Olajide (2020). This was ascribed to a number of physical limitations preventing the Nigerian inland water transport industry from expanding and performing well. In order to ensure that this sector remains the cornerstone of trade, industrial, and economic growth, there is an immediate need for creative activities and methods that can significantly strengthen it. According to Oloruntobi *et al.* (2023), Nigeria's inland water transport sector is a "untapped gold mine for investors" in a similar vein. This demonstrates that the inland water transport sector may make a substantial economic contribution.

### The System Theory

The system theory is a philosophical approach that combines several components, each of which fulfills a specific purpose to complement and enhance the activities of other components in order to accomplish a desired outcome. According to Martyushev *et al.* (2023), a system is made up of several interconnected variables that together determine the system's personality and functionality. This assumes that there are interactions between the system's constituent parts at each level, which may have an impact on how other parts operate and ultimately lead to the system's failure.

In this sense, the waterway, ferry, and passenger all become pertinent to the theory of systems. For instance, the ferry would be useless without the waterway, and the absence of commuters would undoubtedly have an impact on passenger transportation. Furthermore, it would be challenging to overcome far-off geographic boundaries and the producer-consumer divide without transportation. According to Donnelly (2023), a system is a collection of interconnected items that come together to produce a complex oneness. These objects can be biological, like a part of the human body, or they can be physical, like an engine component in an automobile. They can even be theoretical, an integrated collection of ideas, theories, and methods in a field like operations.

Since they do take in input from their surroundings, open and closed systems are rare in real life. In open systems, the system receives and processes information from the outside world. The environment outside receives these processed inputs. As a result, an open system keeps in constant communication with its surroundings. According to the notion of systems management, every organization is a single, cohesive system made up of interconnected subsystems. Every component of the entire system depends on the others and cannot operate at its best without them. As a result, if there are elements in an organization that negatively impact one subsystem, it's probable that same elements will also negatively impact other subsystems. There may be some effects on the system as a whole from this. With the help of this paradigm, an organization is shown as a complex, interdependent natural ecosystem. This methodology is also known as the systems approach.

In a contemporary organization such as a business, different components of a system also engage in regular interactions with one another, albeit in different ways. An organization's human resources department, for instance, is a subsystem that most likely communicates with all other subsystems. Although the nature of its interactions may differ, the marketing department operates along the same concept. For instance, the marketing department may coordinate hardware usage with the IT department, handle salary administration with the accounting department, and create press releases with the public relations department.

An open system is one that interacts with its environment. Systems theory asserts that open systems are the most

common type. This is because you can describe almost anything as a system. For example, a business is an organizational system, but so too is society. If you're observing a business, you'd consider it as the system and its individual departments as subsystems. Alternatively, you may be observing a country, which is an overall system. Here, organizations like businesses and others might be the various subsystems within it.

Since most organizations, businesses or otherwise, rely upon their external environments to function to some extent, the vast majority are therefore open systems. They may rely on their environments for material inputs, as a source of labour or as a market for selling products. Even most countries are open systems, as they buy and sell products internationally.

Contrary to an open system, a closed system is one that has almost no interactions with its external environment. According to the systems approach, these are much rarer than open systems, as it's very difficult for any organization to operate independently of its environment. Its various subsystems would still be interdependent and interact constantly, but the overall system is independent and self-sustaining. It doesn't rely on its external environment to function. This can cause the system to encounter limitations, such as input constraints. A closed system would therefore be autarky, where almost no exchange occurs between it and external systems.

According to the systems approach, an organizational system has several components that help it function. These components and how they interact with each other are:

The environment of an organizational system is the setting or location in which it operates. This can dictate the resources it has access to, its relationships with other systems and even the nature of the organization's activities. If the organizational system itself is a business, then the environment might be the country, region, county or city in which it operates. Each would also have its own environment. Since you can describe anything as a system, the definition of the environment can change based on what you're describing as a system.

The only exception to this definition of environment is in the rare case of a closed system. By definition, these systems have little or no interaction with others outside of themselves and therefore operate independently of their environment. These systems are not impacted by the functioning of their external environment, as they're entirely self-sufficient. To define the environment of a closed system, you might consider a subsystem and then describe the overarching elements as its environment.

## RESULTS AND DISCUSSION

### Level of Development of Inland Water Transport in Lagos State

Within Lagos State, inland waterways are essential for passenger travel and transportation. Because of its high traffic volume, its development has greatest effect on reducing traffic congestion on the state's overused roads. The survey in table 1 below shows that descriptive analysis

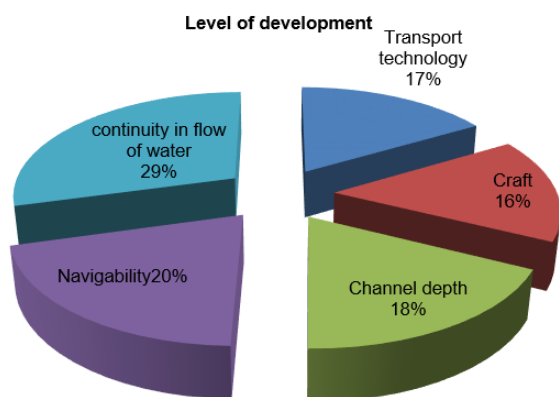
was used to examine the degree of development of inland water transport, majority of study participants or 29.3% of the sample size rated the degree of development to the continuity in the flow of water. Furthermore, 28 percent of the sample size from the study area rate of development to how often dredging is done in order to have adequate depth for effective navigation of ferry on the water will create larger vessel or craft to navigate. Development in the field of transport technology also enhances efficient and dependable means of mobility for both passengers and cargoes. Navigability width is another variable used to measure the level of development. The result of the survey also revealed that 20.3 percent of the respondents rated there is a development in the level of navigability

when compared with other developed countries using inland waterways transportation. As per the study, 16.5 percent of the sample size thought that the availability of transportation technology will affect the cost of travel and the time taken by logistics companies to deliver their goods. 15.8% of the respondents from the study area were in favor of craft availability, which will determine the amount of traffic flow. The width, depth, and continuity of the water flow in a channel, as well as the transportation equipment in use, all affect how inland waterways grow. This implies that inland waterways transport system when compared to other mode of transport like rail transport has a significant improvement in terms of development and at the same time cheaper.

**Table 1:** Distribution by level of development

Variable	Frequency	Percentage
Craft Availability	21	15.8
Channel depth	24	18.0
Navigability	27	20.3
Continuity in flow of water	39	29.3
Transport Technology	22	16.5
Total	133	100

Source: Author Fieldwork, 2025.



**Figure 1:** Representing Level of Development

Source: Author Fieldwork, 2025.

### Effect of Inland Transportation on Logistics Operations in Lagos State

In the three tables below, numbered 2, 3, and 4, multiple regression analysis was used to identify the association between inland transportation and logistics operations Lagos State. Operational performance served as a stand-in for inland waterways transportation, and handling, packing, storing, and delivery of commodities (cargoes) served as a stand in for logistics. The multiple correlation coefficients (R) were 0.979, and the coefficient of determination (R<sup>2</sup>) was 0.958. This suggested that 97% of the variance in the dependent variable was explained by the predictor variables. Additionally, the predictor variables' combined effect was 0.956, indicating a good

correlation between the combined predictors and the variable that is dependant. With a crucial p-value of 0.000 and an F-statistic of 579.047, both values were below the significance threshold of 0.05.

The suggested alternative hypothesis should be accepted and the null hypothesis should be rejected if the crucial p-value is less than the 0.05 permitted error, according to the golden rule. In the study area, the alternative hypothesis that there is a relationship between inland transportation and logistics operations Lagos State was accepted, whereas the null hypothesis that there is no relationship between inland transportation and logistics operations Lagos State was rejected because the critical p-value was 0.000 < 0.05, this was displayed in Table 3. The coefficient of the correlation between logistical operations and inland transportation was shown in Table 4.

The logistics operations were shown to be independently affected by three factors that were statistically significant. Logistics operations depend on the proper packing of items, as evidenced by the beta value of 0.452, t-value of 5.741, and critical p-value of 0.000. With a beta value of 0.326, a t-value of 1.240, and a p-value of 0.000, the delivery of goods to customers on time is believed to be important for efficient logistics operations in the research domain. Upon receipt or just prior to shipment to the customer, sorting the goods yielded a value of 0.085, a t-value of 2.692, and a p-value of 0.008. With p-values of 0.217 and 0.276, respectively, which are more than the 0.05 level of significance, the remaining two variables warehousing and handling of goods were not statistically

significant in the research region. This indicates that the transportation of inland waterways in the research area was most impacted by logistics operations.

**Table 2:** Model Summary of the Relationship between Inland Transportation and Logistics Operations Lagos State

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.979a	.958	.956	.27361

Source: *Author Fieldwork, 2025.*

**Table 3:** ANOVA of the Relationship between Inland Transportation and Logistics Operations.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	216.748	5	43.350	579.047	.000b
	Residual	9.508	127	.075		
	Total	226.256	132			

Source: *Author Fieldwork, 2025.*

**Table 4:** Coefficients of the Relationship between Inland Transportation and Logistics Operations.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	(Constant)	-.144	.064		-2.256	.026
	Packing of goods	.485	.084	.452	5.741	.000
	handling of goods	.097	.078	.084	1.240	.217
	delivery of goods	.330	.076	.326	4.365	.000
	warehousing	.080	.073	.068	1.093	.276
	sorting of goods	.086	.032	.085	2.692	.008

Source: *Author Fieldwork, 2025.*

### CONCLUSION

The study came to the conclusion that inland waterway transportation is statistically relevant to the logistics operations in the Lagos State because of its low energy consumption, low air pollution emissions, and low external expenses. Sorting and packaging of cargoes, as well as delivering them to customers on time, were critical components of corporate control and management. Additionally, it was concluded that, taking location and journey time into account, inland waterway transit is pertinent to logistical operations within Lagos State. The concept of location utility suggests that customers can find goods when it is needed due to timely delivery of cargoes. Travel time implies that consumers can have access to the shipment at their convenience. In order to improve the efficient operations of inland waterway transportation in the Lagos State, the study recommend the following procedures: Sufficient development of waterways channels to enable long-term transportation of goods and services between locations. In addition, the supply of effective cargo handling equipment will improve the consumer’s satisfaction on delivery of goods and services.

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