

## **ROUTE OPTIMIZATION AND OPERATIONAL EFFICIENCY OF LOGISTICS SERVICE PROVIDERS AT SEAPORT TERMINALS IN RIVERS STATE**

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### **Abstract**

This study examined the impact of route optimization on operational efficiency of logistics service providers at seaport terminals in Rivers State, Nigeria. Thus study used cargo throughput, delivery speed and cost minimization to proxy operational efficiency. This adopted a positivist philosophy; a quantitative methodology and an explanatory research design. The population of the study comprised 6 logistics service providers operating at seaport terminals in Rivers State. The study took a census. 7 managers from each of the 6 logistics service providers served as respondents. However, only 34 respondents provided valid data. The study used structured questionnaire to collect primary data. The simple regression analysis was used to test three null hypotheses, aided by the Statistical Package for Social Sciences (SPSS) version 22.0. The study found that route optimization has positive significant impacts on cargo throughput, delivery speed and cost minimization of logistics service providers of seaport terminals in Rivers State. In view of these findings, the study concluded that route optimization in logistics operations positively and significantly impacts operational efficiency of logistics service providers of seaport terminals in Rivers State; and recommends that, logistics service providers at seaport terminals in Rivers State that seek improved operational efficiency should continue deploy route optimization technology to plan delivery routes; track vehicle movements; and monitor traffic conditions.

**Keywords:** Cargo throughput, cost minimization, delivery speed, operational efficiency, route optimization

### **Introduction**

Seaport terminals are critical nodes in global trade, acting as gateways for the efficient movement of goods between transportation modes. In Rivers State, the effectiveness of these terminals is significantly influenced by the operational practices of third-party service providers, such as haulage service providers. One of the most impactful strategies haulage service providers adopt to enhance operational efficiency is route optimization - the use of algorithms and advanced technologies to determine the most efficient travel paths that minimize delays, fuel consumption, and costs (Kumar et al., 2020).

Inefficiency in route planning leads to prolonged turnaround times, increased operational costs, and reduced customer satisfaction. This is especially so in instances where traffic congestion and poor infrastructure frequently disrupt logistics operations (Okon et al., 2018). Implementing route optimization not only improves delivery timeline but also aligns with sustainable development goals by reducing carbon emissions and energy consumption (Zhang & Li, 2019).

The adoption of intelligent transport systems and geospatial technologies has revolutionized the logistics landscape, enabling real-time tracking and dynamic route adjustments (Abiodun et al., 2021). However, despite these advances, challenges like limited digital infrastructure and

resistance to technological change persist, and hinders widespread adoption in many developing regions (Okechukwu et al., 2020).

This enquiry was designed to examine the impact of route optimization on operational efficiency of logistics service providers at Seaport Terminals in Rivers State. Route optimization was accommodated unidimensionally, while cargo throughput, delivery speed and cost minimization were used as indicators of operational efficiency. The study is conceptualized in fig. 1.

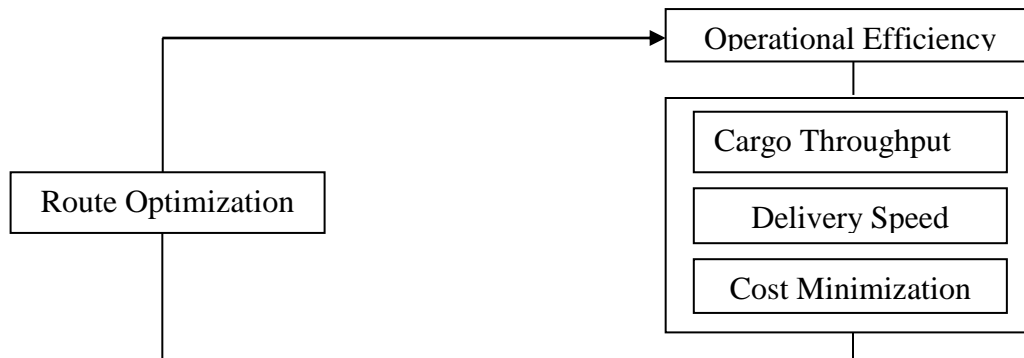


Fig. 1: Conceptual framework of impact of route optimization on operational efficiency of logistics service providers at seaport terminals in rivers state

### Theoretical Foundation

This study is anchored on supply chain management (SCM) theory - a multidisciplinary model that embody principles, strategies and practices for managing the flow of goods, services, information and finance across interconnected networks of suppliers, manufacturers, dealers and customers (Chopra & Meind, 2021). It emphasizes integration, coordination and collaboration among supply chain partners to deliver customer and achieve operational efficiency (Chopra & Meind, 2021). Integration involves aligning processes, systems and goals across different stages of the supply chain to enable seamless coordination and communication. Collaboration entails fostering mutually beneficial relationships, sharing information, and jointly solving problems to optimize overall supply chain performance (Christopher, 2016).

SCM theory also emphasizes the need for coordination and visibility throughout a supply chain to enable effective planning, execution and control of activities (Chopra & Meind, 2021). Coordination involves synchronizing production, inventory and distribution processes to meet customer demand efficiently while risks. Visibility refers to the ability to track and monitor inventory levels, order status and performance metrics in real-time, to enable proactive decision-making and responsiveness to change in demand or supply conditions (Simchi-Levi et al., 2019).

This study is premised on SCM theory because it provides a comprehensive framework for managing and optimizing complex supply chain networks. By emphasizing integration, collaboration, coordination, risk management, and continuous improvement, SCM theory enables firms to enhance operational efficiency, mitigate risks, and improve customer satisfaction. In addition, the theory emphasizes collaboration, integration and coordination between and among supply chain partners. Thus, the theory provides a comprehensive framework for understanding and optimizing the operations of different actors in the supply chain, including service providers.

### **Concept of Route Optimization**

Route optimization is the process of determining the most efficient way to deliver goods or services while considering distance, traffic, delivery timeline, and vehicle capacities. In the context of seaport terminals in Rivers State, where operations heavily depend on logistics efficiency, route optimization is an essential determinant of performance of success of logistics service providers.

Route optimization is not just about finding the shortest route, but involves the consideration multiple factors, including minimizing fuel consumption, reducing delivery time and maximizing resource utilization (Rakesh et al., 2020). Technologies like Geographic Information Systems (GIS), Artificial Intelligence (AI), and real-time traffic monitoring are often employed to achieve these goals. Wang et al. (2019) argue that route optimization enhances logistics service delivery by leveraging data inputs that facilitate effective response to changing conditions.

Efficient route planning directly influences turnaround time for cargo handling, customer satisfaction, and operational costs. Optimized routing mitigate effects of port congestion by streamlining movement of goods, thereby reducing delays. Ahmed et al. (2021) highlight that in regions with limited infrastructure, even small improvements in logistics activities yield significant cost savings. Dhal and Mahapatra (2020) opine that adoption of technology in logistics contributes to sustainable operations.

Beyond operational benefits, route optimization also hold economic and environmental merits. Reduced fuel consumption lowers costs for logistics service providers and minimizes greenhouse gas emissions, aligning with sustainable development goals. Chukwu et al. (2022) observe that effective route planning has the potential to enhance profitability of logistics service providers while reducing environmental degradation.

### **Operational Efficiency**

Operational efficiency is a critical aspect of organizational performance, encompassing effective utilization of resources to achieve desired outcomes with minimal waste or effort. At its core, operational efficiency refers to the ability of an organization to optimize processes, systems and resources to achieve maximum output. It involve streamlining workflows, eliminating bottlenecks, reducing unnecessary costs and enhancing productivity across operations (Slack et al., 2019).

A fundamental principle of operational efficiency is identifying and eliminating waste. By applying tools such as value stream mapping, root cause analysis and continuous improvement cycles, organizations can identify inefficiencies and implement targeted interventions to improve overall efficiency (Womack et al., 1990).

Operational efficiency is pivotal to superior performance; it reduces costs, enhances customer satisfaction, and confer competitive advantage. Also, in manufacturing, operational efficiency is critical for optimizing production processes and schedules; in inventory management, it leads to reduced lead time and minimizes inventory holding costs (Schmenner, 2004). Recently, the focus on operational efficiency has led to the use of advanced technology and data analytics to streamline operations, improve decision-making, and enhance agility (Bughin et al., 2018).

Key indicators commonly used to measure operational efficiency include productivity ratio, order cycle time, throughput rates, and resource utilization levels. These metrics provide insights into the efficiency of operational processes and serve as benchmarks for performance improvement initiatives (Melnik et al., 2020). However this study adopted cargo throughput, delivery speed and cost minimization to represent operational efficiency of logistics service providers.

### **Cargo throughput**

Cargo throughput refers to the total volume of merchandise handled by a port or terminal within a specific timeframe, typically measured in metric tons. It encompasses both imports and exports, including containers, bulk cargo and general cargo (Notteboom & Rodrigue, 2009). Lam and Notteboom (2014) conceive cargo throughput as the rate at which cargo is handled or processed by a terminal, within a specific timeframe.

Cargo throughput serves as a key indicator of operational efficiency of port operations because it reflects ability to efficiently manage cargo flows and meet customer demands (Tongzon, 2001). Cargo throughput is helpful in evaluating infrastructure capacity and economic activity. It is vital for assessing operational performance and competitiveness of ports worldwide. High levels of cargo throughput indicate efficient terminal operations and effective logistics management.

Cargo throughput directly impact port operations, infrastructure planning and investment decisions (Wang et al., 2020). Ports with robust cargo throughput capabilities play a pivotal role in facilitating international trade, supporting economic growth, and connecting regions to global supply chains (Brooks & Pallis, 2016). Ports with high levels of cargo throughput require efficient terminal facilities, advanced handling equipment, and streamlined logistics processes to accommodate growing demand and maintain service levels (Zhang et al., 2019).

### **Delivery speed**

Delivery speed refers to the timeline between the placement of an order and the receipt of the corresponding goods or services by the customer. Delivery speed measures the efficiency of delivery processes and is critical to meeting customers' expectation for timely order fulfillment (Wang & Fu, 2020); directly impact customer satisfaction and operational efficiency (Christopher, 2016).

Several factors influence delivery speed. These include transportation mode and distance, inventory availability, order processing efficiency, customs clearance procedures, and last-mile delivery capabilities. Effective coordination and optimization of these factors is essential for minimizing lead times and ensuring timely deliveries (Monczka et al., 2019). Delivery speed in this sense is akin to responsiveness - firms' to respond to customers' needs in terms with speed and flexibility (Nwulu & Ateke, 2018), hence is a sign of customer orientation and a mark of competitiveness (Amangala & Ateke, 2018).

By streamlining logistics processes and leveraging technology-enabled solutions, businesses can enhance their delivery speed (Wang & Fu, 2020). Prompt delivery enhances brand reputation, fosters positive word-of-mouth and strengthens customer relationships, leading to long-term

loyalty and profitability (Monczka et al., 2019). In seaport operations, delivery speed impacts efficiency of cargo handling, customer satisfaction, and overall competitiveness of the port.

### **Cost minimization**

Cost minimization involve identifying and implementing cost-saving measures, optimizing resource allocation, and eliminating inefficiencies to achieve lowest possible cost structure (Gupta & Sharma, 2020). It is the process of identifying opportunities to reduce expenses across various business functions, including procurement, production, distribution, and administration. Tersine and Garcia-Dastugue (2014) states that cost minimization involve analyzing cost drivers, negotiating favorable terms with suppliers, optimizing production processes, and implementing lean practices to achieve cost efficiency and improve profitability.

Cost minimization is a fundamental objective for organizations across industries, as it directly impacts profitability, competitiveness, and sustainability. Cost minimization is essential for organizations to maintain financial viability and achieve long-term success in today's competitive marketplace. By reducing expenses associated with production, distribution, and operations, businesses can improve profit margins, invest in growth initiatives and withstand market fluctuations more effectively (Gupta & Sharma, 2020).

Several strategies can be employed to achieve cost minimization. These include: Identifying and eliminating inefficiencies in processes and workflows to reduce waste and improve productivity (Gupta & Sharma, 2020); negotiating better contract to secure discounts or rebates, thereby reducing procurement costs (Tersine & Garcia-Dastugue, 2014); adopting lean manufacturing principles to optimize resource usage, minimize inventory levels, and eliminate non-value-adding activities (Krajewski et al., 2019); and leveraging technological solutions to enhance operational efficiency and reduce administrative overheads (Gupta & Sharma, 2020).

### **Route Optimization and Operational Efficiency**

Literature is replete with evidence of contributions of route optimization to operational efficiency. Rakesh et al. (2020) argues that route optimization minimizes fuel consumption, reduces delivery time and maximizes resource utilization. Also, route optimization is associated with reduced cargo handling time, operational costs and streamlines movement of goods (Ahmed et al., 2021). Dhal and Mahapatra (2020) states that small improvements in logistics activities yield significant cost savings and sustainable operations. Chukwu et al. (2022) observe that effective route planning enhance profitability of logistics service providers while reducing environmental degradation.

Gołabek et al. (2021) investigated optimization of logistics and distribution of the supply chain, taking into account transport costs, inventory and customer demand. As a result of the analyses and calculations performed, the optimization task was performed. With the help of the prepared software, a map of goods delivery points was determined, the total route and the route with individual points marked, and various solution methods were tested.

Mogoi and Osoro (2022) examined the impact of logistics optimization on performance of firm in agribusiness. The study found that logistics optimization in terms of transportation management, inventory management, information management and packaging management

substantially impact performance. Alo et al. (2021) adds that effective logistic optimization leads to lower cost of transporting products from factories to destinations.

The foregoing review provide insights into the impact of route optimization on operational efficiency. However, in view of the need to undertake empirical analyses, we hypothesize that:

- H<sub>1</sub>: Route optimization has no significant relationship with cargo throughput of logistics service providers.
- H<sub>2</sub>: Route optimization has no significant relationship with delivery speed of logistics service providers.
- H<sub>3</sub>: Route optimization has no significant relationship with cost minimization of logistics service providers.

## Methodology

This adopted a positivist philosophy; a quantitative methodology and an explanatory research design. The population of the comprised 6 logistics service providers at seaport terminals in Rivers State, Nigeria. In view of the small size of the population, a census was taken. 7 managers (transport, traffic, inventory, operations, IT, warehouse and safety) from each of the 6 logistics service providers (i.e. 7 x 6) provided primary data for the study. The instrument used to collect the primary data is a questionnaire structured in a 5-point Likert scale. However, only 34 respondents provided valid data which were used for the analysis.

The reliability of the research instrument was determined by subjecting it to Cronbach's Alpha test, with a threshold of 0.70 set by Nunally (1978); while its construct validity was determined through Principal Component Analysis (PCA). Table 1 shows the summary of the results of reliability and validity tests. To determine the impact of route optimization on measures of operational efficiency, the linear regression statistics was used. The Statistical Package for Social Sciences (SPSS) version 22.0 aided the data analyses.

**Table 1: Summary of results of test of reliability and test of validity**

S/N	Variables	Number of Items	Cronbach's Alpha Coefficients	Factor Loadings
1	Route Optimization	4	0.864	0.871
2	Cargo Throughput	4	0.725	0.759
3	Delivery Speed	4	0.755	0.824
4	Cost Minimization	4	0.705	0.861

Source: SPSS Output form data analyses on route optimization on measures of operational efficiency of logistics service providers at seaport in Port Harcourt (2024).

Results of the Cronbach's alpha analysis in Table 1 reveals that all the variables in the study produced high Cronbach's Alpha coefficients. This is an evidence to show that, there is inter-item consistency among the variables in the study. In other words, if this study is conducted again in a similar condition the results will be similar to the results of this study. Again, all the variables have high factor loadings greater than 0.4, indicating that the items and variables in the questionnaire measured what they were supposed to measure. These loadings indicated that there is no cross-loading hence there is discriminant validity.

## Data Analysis and Results

**Table 2: Model Summary of impact of route optimization on cargo throughput**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.619 <sup>a</sup>	.383	.364	1.349

a. Predictors: (Constant), Route Optimization

Source: SPSS Output form data analyses on route optimization on measures of operational efficiency of logistics service providers at seaport in Port Harcourt (2024).

Table 2 demonstrates that route optimization has strong positive impact on cargo throughput. This is evident in the regression coefficient (R) of 0.619. The coefficient of determination (R Square) is 0.383. This means that approximately 38% of changes in cargo throughput is attributable to route optimization, while the remaining 62% change is due to impact of variables not included in the model.

**Table 3: ANOVA<sup>a</sup> of impact of route optimization on cargo throughput**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	36.177	1	36.177	19.889	.000 <sup>b</sup>
	Residual	58.205	32	1.819		
	Total	94.382	33			

a. Dependent Variable: Cargo Throughput

b. Predictors: (Constant), Route Optimization

Source: SPSS Output form data analyses on route optimization on measures of operational efficiency of logistics service providers at seaport in Port Harcourt (2024).

Table 3 shows that route optimization significantly predict cargo throughput of logistics service providers at seaport terminals in Rivers State. This is indicated by the probability value of 0.000, which is less than the critical value of 0.05. Statistically, route optimization significantly predicts cargo throughput at  $F(1, 32) = 19.889$ ,  $p = 0.000 < 0.05$ ,  $R^2 = 0.383$ . The results also showed that the regression model is a good fit for the data.

**Table 4: Coefficients<sup>a</sup> of impact of route optimization on cargo throughput**

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	13.886	1.047		13.261	.000
	Route Optimization	.269	.060	.619	4.460	.000

a. Dependent Variable: Cargo Throughput

Source: SPSS Output form data analyses on route optimization on measures of operational efficiency of logistics service providers at seaport in Port Harcourt (2024).

Table 4 shows how much the dependent variable – cargo throughput varies with the independent variable – route optimization. The Table indicates that before the introduction of the predictor variable - route optimization, cargo throughput stood at 13.886, but at the introduction of the predictor variable, there is an additional unit. Specifically, the intercept  $B_0$  is 13.886, which is the predicted value of cargo throughput without the contributions of the predictor variable. That is, when route optimization is equal to zero, cargo throughput is 13.886. However, the slope  $B_1$  is

0.269, indicating that 1% increase in route optimization will bring about approximately 0.27% increase in cargo throughput of Third-party Service Providers of Seaport Terminals in Rivers State. Therefore, the null hypothesis which states that '*route optimization does not significantly impact on cargo throughput of logistics Service Providers at Seaport Terminals in Rivers State*' was rejected.

**Table 5: Model Summary of impact of route optimization on delivery speed**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.833 <sup>a</sup>	.653	.635	2.086

a. Predictors: (Constant), Route Optimization

Source: SPSS Output form data analyses on route optimization on measures of operational efficiency of logistics service providers at seaport in Port Harcourt (2024).

A simple regression analysis was conducted to determine the impact of route optimization on delivery speed of logistics service providers of seaport terminals in Rivers. The results as shown in Table 5 indicates that route optimization has very strong positive impact on delivery speed. This is evident in the regression coefficient (R) of 0.833. The coefficient of determination (R Square) is 0.653. This means that about 65% improvement in delivery speed is attributable to route optimization, while the remaining 35% is due to impact of external variables.

**Table 6: ANOVA<sup>a</sup> of impact of route optimization on delivery speed**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	115.068	1	115.068	26.453	.000 <sup>b</sup>
	Residual	139.197	32	4.350		
	Total	254.265	33			

a. Dependent Variable: Delivery Speed

b. Predictors: (Constant), Route Optimization

Source: SPSS Output form data analyses on route optimization on measures of operational efficiency of logistics service providers at seaport in Port Harcourt (2024).

Table 6 shows that route optimization significantly predicts delivery speed. This is indicated by the probability value of 0.000, which is less than the critical value of 0.05. Statistically, route optimization significantly predicts delivery speed at  $F(1, 32) = 26.453$ ,  $p = 0.000 < 0.05$ ,  $R^2 = 0.653$ . The results also showed that the regression model is a good fit for the data.

**Table 7: Coefficients<sup>a</sup> of impact of route optimization on delivery speed**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	8.730	1.619		5.391	.000
	Route Optimization	.480	.093	.833	5.143	.000

a. Dependent Variable: Delivery Speed

Source: SPSS Output form data analyses on route optimization on measures of operational efficiency of logistics service providers at seaport in Port Harcourt (2024).

The regression model in Table 7 indicate how much delivery speed varies with variation in route optimization. The Table shows that before the introduction of route optimization, delivery speed stood at 8.730, but at the introduction of the predictor variable, an additional unit was observed.



The intercept  $B_0$  is 8.730, which is the predicted value of delivery speed without the contributions of route optimization. That is, when route optimization is equal to zero, delivery speed is 8.730. However, the slope  $B_1$  is 0.480, indicating that 1% increase in route optimization will bring about approximately 0.20% increase in delivery speed. Therefore, the null hypothesis which states that *route optimization does not significantly impact on delivery speed of Third-party Service Providers of Seaport Terminals in Rivers State* was rejected.

**Table 8: Model Summary of impact of route optimization on cost minimization**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.487 <sup>a</sup>	.237	.214	1.446

a. Predictors: (Constant), Route Optimization

Source: SPSS Output form data analyses on route optimization on measures of operational efficiency of logistics service providers at seaport in Port Harcourt (2024).

As shown in Table 8, route optimization has moderate positive impact on cost minimization. This is evident in the regression coefficient (R) of 0.487. The coefficient of determination (R Square) is 0.237. This means that approximately 24% of change cost minimization is attributable to route optimization, while the remaining 76% change is due to external variables.

**Table 9: ANOVA<sup>a</sup> of impact of route optimization on cost minimization**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	20.837	1	20.837	9.963	.003 <sup>b</sup>
	Residual	66.928	32	2.091		
	Total	87.765	33			

a. Dependent Variable: Delivery speed

b. Predictors: (Constant), Route Optimization

Source: SPSS Output form data analyses on route optimization on measures of operational efficiency of logistics service providers at seaport in Port Harcourt (2024).

As shown in Table 9, route optimization significantly predicts cost minimization. This is indicated by the probability value of 0.000, which is less than the critical value of 0.05. This means that the impact of route optimization on cost minimization is statistically significant at  $F(1, 32) = 9.963$ ,  $p = 0.000 < 0.05$ ,  $R^2 = 0.237$ . The results also showed that the regression model is a good fit for the data.

**Table 10: Coefficients<sup>a</sup> of route optimization on cost minimization**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	15.190	1.123		13.528	.000
	Route Optimization	.204	.065	.487	3.156	.003

a. Dependent Variable: Delivery speed

Source: SPSS Output form data analyses on route optimization on measures of operational efficiency of logistics service providers at seaport in Port Harcourt (2024).

The unstandardized coefficients in the regression model in Table 10 indicate how cost minimization varies with variation in route optimization. The Table suggests that cost

minimization stood at 15.190 before the introduction route optimization, but experiences an additional unit upon the introduction of route optimization. Specifically, the intercept  $B_0$  is 15.190, which is the predicted value of cost minimization without the contributions of route optimization. That is, when route optimization is equal to zero, cost minimization is 15.190. However, the slope  $B_1$  is 0.204, indicating that 1% increase in route optimization brings about 0.20% increase in cost minimization of logistics service providers at seaport terminals in Rivers State. Therefore, the null hypothesis which states that *route optimization does not significantly impact on cost minimization of logistics Service Providers at Seaport Terminals in Rivers State* is rejected.

### **Discussion of Findings**

The simple regression analysis conducted to determine impact of route optimization on operational efficiency of logistics service providers of seaport terminals in Rivers State indicated that, route optimization has strong positive impact on cargo throughput; very strong positive impact on delivery speed; and moderate positive impact on cost minimization. The analyses also indicted that the impact of route optimization all the measures of operational efficiency is statistically significant.

The findings of this study align with the findings of Johan and Christoffer (2017) that autonomous vehicles have economic impact on logistics service providers in Sweden. This means that by gradually implementing autonomous vehicles, the Swedish logistics sector can become more economically viable. Our findings also support that of Gołabek et al. (2021) that optimized of logistics reduces transportation and inventory costs.

The current findings corroborate that of Kimitei et al. (2019) that logistic service reliability improve performance of manufacturing firms in Kenya; and that of Mogoi and Osoro (2022) that transportation, inventory, information, and packaging management are logistics optimization initiatives that impact performance agricultural company in Kenya.

Our finding are also in with the view that effective logistic optimization leads to lower costs and better transportation solution (Alo et al., 2021). Further, our findings substantiate the argument that route optimization hold economic and environmental merits; as it enhances profitability by lowering fuel consumption and operational costs; and promotes sustainability by reducing greenhouse gas emissions and environmental degradation (Chukwu et al., 2022).

### **Conclusion and Recommendations**

Based on the findings of this study and the large extent to which they cohere with findings of previous studies examined, this study concludes that route optimization has positive significant impact on operational efficiency of logistics service providers at seaport terminals in Rivers State. Therefore, this study recommends that, logistics service providers at seaport terminals in Rivers State should continue to deploy route optimization technology to plan delivery routes; track vehicles and vessels movements; and monitor traffic conditions, container locations, and equipment availability in order to improve cargo throughput, delivery speed, and minimize cost of operations.

## References

- Abiodun, A., Oladele, M., & Tunde, F. (2021). The role of intelligent transport systems in improving logistics efficiency in developing economies. *International Journal of Transport and Logistics*, 45(3), 123-135.
- Ahmed, M. O., Hassan, Y. A., & Umar, S. A. (2021). Logistics challenges and solutions in African ports: A case study of Nigerian seaports. *Journal of Transport and Supply Chain Management*, 15(1), 123-135.
- Alo, E. A., Akinwumi, A. A., & Efuntade, A. O. (2021). Effective logistic optimization through operations research transportation management techniques in the Nigerian breweries industry. *Journal of Finance and Contemporary Issue*, 1(1), 71-78.
- Amangala, E. A., & Ateke, B. W. (2018). Customer orientation of service employees and customer satisfaction. *International Journal of Social Sciences and Management Research*, 4(6), 52-59.
- Christopher, M. (2016). *Logistics & Supply Chain Management (5th edition)*. Pearson.
- Chukwu, E. E., Emecheta, E. N., & Obasi, A. U. (2022). Environmental impacts of logistics operations in Nigerian ports: A review. *African Journal of Logistics and Maritime Studies*, 10(3), 45-60.
- Dhal, R. K., & Mahapatra, S. (2020). Smart logistics: Role of artificial intelligence in improving operational efficiency. *International Journal of Logistics Research and Applications*, 24(6), 487-503.
- Gołabek, L., Stokłosa, J., Dziwulski, J. & Wyrwisz, J. (2021). Optimization of logistics and distribution of the supply chain, taking into account transport costs, inventory and customer demand. *European Research Studies Journal*, 24(2), 545-556.
- Gupta, R., & Sharma, S. K. (2020). Cost minimization strategies in manufacturing industries: A systematic review. *International Journal of Production Research*, 58(14), 4464-4491.
- Johan, B., & Christoffer, G. (2017). *The economic impact of autonomous vehicles in the logistics industry*. Unpublished Master's Thesis. Jönköping University.
- Krajewski, L. J., Ritzman, L. P., & Malhotra, M. K. (2019). *Operations management: Processes and supply chains (12th edition)*. Pearson.
- Kumar, R., Singh, J., & Sharma, P. (2020). Route optimization and its impact on supply chain efficiency: A comprehensive review. *Journal of Supply Chain Management*, 12(4), 256-268.
- Lam, J. S., & Notteboom, T. (2014). Measuring port efficiency: A critical review and implications for future research. *Transport Reviews*, 34(4), 507-532.
- Monczka, R. M., Handfield, R. B., Giunipero, L. C., & Patterson, J. L. (2019). *Purchasing and supply chain management (7th edition)*. Cengage Learning.
- Notteboom, T., & Yang, Z. (2016). Containers and globalisation: A maritime logistics perspective. *Geografiska Annaler: Series B, Human Geography*, 98(2), 87-101.
- Nunally, J. C. (1978). *Psychometric Theory*. New York: McGraw-Hill.
- Nwulu, C. S., & Ateke, B. W. (2018). Frontline employee competence development and responsiveness of quick service restaurants. *European Journal of Social Sciences Studies*, 2(10), 1-17.
- Okechukwu, C., Ayodele, O., & Nwachukwu, L. (2020). Barriers to technological adoption in the logistics sector of Sub-Saharan Africa. *African Journal of Logistics*, 15(1), 78-92.

- Okon, E., Udo, I., & Akpan, G. (2018). Traffic congestion and logistics operations: A study of Port Harcourt, Rivers State. *Nigerian Journal of Transport Studies*, 30(2), 45-60.
- Rakesh, S., Kumar, V., & Sharma, A. (2020). A framework for route optimization in urban logistics. *Journal of Operations Research and Applications*, 13(4), 278–290.
- Slack, N., Brandon-Jones, A., & Johnston, R. (2019). *Operations Management (9th edition)*. Pearson.
- Tersine, R. J., & Garcia-Dastugue, S. J. (2014). *Operations and supply chain management: The core (3rd edition)*. John Wiley & Sons.
- Tongzon, J. L. (2001). Efficiency measurement of selected Australian and other international ports using data envelopment analysis. *Transportation Research Part A: Policy and Practice*, 35(2), 107-122.
- Wang, S., Lu, C. S., Chen, G., & Zhang, X. (2020). Automated container terminal operation system: A review and future trends. *Transport Reviews*, 40(1), 1-29.
- Wang, Y., Hu, X., & Zhang, Q. (2019). Dynamic optimization in logistics: An integrated approach using GIS and machine learning. *Logistics Research and Applications*, 21(2), 134–147.
- Zhang, H., & Li, Q. (2019). Sustainability in logistics: Reducing emissions through route optimization. *Sustainable Logistics Journal*, 6(3), 112-129.