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Economic Contribution of Transportation Modes to the Growth of the Industrial Sector in Nigeria: 1986-2023

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Abstract

The industrial sector is widely recognized as a crucial driver of economic growth, a key solution to chronic unemployment, and an effective mechanism for wealth creation. However, the current state of Nigeria's industrial sector falls short of these expectations. Available statistics indicate that the industrial sector's contribution to Nigeria's Gross Domestic Product (GDP) has been on a downward trend, and the Manufacturers Association of Nigeria (MAN) reported a decline in industrial progress, despite the implementation of numerous policy initiatives aimed at fostering growth in the sector. This underperformance highlights a significant gap between the potential and actual impact of Nigeria's industrial sector on the country's economic development and prosperity. This paper thus examined the economic contribution of transportation modes—road, water, and air transport—to the growth of Nigeria's industrial sector using secondary data from the Central Bank of Nigeria (CBN) and applying the Autoregressive Distributed Lag (ARDL) model to establish long-run relationships between the variables. The findings revealed that road transport had a negative but significant impact on industrial growth, suggesting that poor road infrastructure, congestion, and maintenance issues increase logistics costs, negatively affecting industrial productivity. Conversely, air transport exhibited a positive and significant impact, highlighting its role in facilitating high-value, time-sensitive goods movement and international trade. Water transport also had a positive and significant effect on industrial growth, particularly in export-heavy sectors, indicating that efficient port operations and improved waterways reduce shipping costs and enhance trade competitiveness. The paper recommended that the Federal Ministry of Works and Housing, in collaboration with state governments and the private sector, prioritize road network rehabilitation and expansion. The Federal Airports Authority of Nigeria (FAAN) and Nigerian Civil Aviation Authority (NCAA) should focus on modernizing airport infrastructure, while the Nigerian Ports Authority (NPA) should address port inefficiencies and congestion to boost industrial exports. Further investments in these transportation modes are crucial for unlocking Nigeria's full industrial potential and fostering sustainable economic growth.

Keywords: *Road transport, Water transport, Air transport, Autoregressive Distributed Lag and Industrial sector*

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Background to the Study

The transportation sector plays a vital role in the economic development of nations worldwide, serving as a crucial facilitator of trade, commerce, and industrial growth. Globally, the economic contribution of transportation modes has been significant, with the sector accounting for approximately 4.4% of GDP in OECD countries as of 2020 (OECD, 2022). This contribution extends beyond direct economic output, as efficient transportation systems enable the movement of goods, services, and people, thereby fostering productivity and economic integration. In sub-Saharan Africa, the transportation sector has been a key driver of economic growth, with road transport dominating the landscape. According to the African Development Bank (2019), investment in transport infrastructure has contributed to an average of 2% annual GDP growth in the region between 2000 and 2018.

In Nigeria, the transportation sector has been a significant contributor to the nation's economy, with its share of GDP averaging 2.97% between 2018 and 2022 (National Bureau of Statistics [NBS], 2023). The sector encompasses various modes, including road, water, and air transport, each playing a distinct role in facilitating economic activities. Road transport, being the most dominant mode, accounts for approximately 90% of all freight and passenger movements in Nigeria (Oluwole *et al.,* 2019). The extensive road network, spanning over 200,000 kilometers, serves as the primary means of connecting rural and urban areas, thereby supporting agricultural and industrial activities. Water transport, while underutilized, has shown potential for growth, particularly in coastal areas and inland waterways. The Nigerian Ports Authority reported a 2.5% increase in cargo throughput from 2018 to 2019, indicating the growing importance of maritime transport in the country's economic landscape (Nigerian Ports Authority, 2023). Air transport, although representing a smaller share of the overall transportation sector, has been crucial for high-value goods and business travel. The Nigerian Civil Aviation Authority (NCAA) reported a 12% increase in air passenger traffic between 2018 and 2022, highlighting the sector's growth potential (NCAA, 2023).

The industrial sector, a key beneficiary of robust transportation systems, has been a major contributor to global economic growth. According to the World Bank (2023), the industrial sector accounted for approximately 25% of global GDP in 2023, with manufacturing being the largest sub-sector. In developed economies, the industrial sector has been characterized by high-tech manufacturing and advanced services, while emerging economies have seen rapid growth in manufacturing and construction activities. The global industrial sector has been undergoing significant transformations, driven by technological advancements, changing consumer preferences, and environmental considerations.

In Nigeria, the industrial sector has been a crucial component of the economy, contributing an average of 29.85% to GDP between 2018 and 2023 (CBN, 2022; 2023). The sector encompasses manufacturing, mining, and construction, with manufacturing being the largest sub-sector. The industrial sector's contribution to GDP has fluctuated over the years, with a peak of 41% in the 1980s due to a booming oil sector, followed by a gradual decline as infrastructural challenges, governance issues, and a dependence on oil revenues took a toll on industrial diversification (Central Bank of Nigeria, 2023). The industrial sector's contribution

to GDP declined from 38.08% in 1992 to 33.74% in 2023. The sector has faced challenges, including inadequate infrastructure, power supply issues, and limited access to finance. However, recent government initiatives, such as the Economic Recovery and Growth Plan (ERGP) and the National Industrial Revolution Plan (NIRP), have aimed to boost industrial growth and diversify the economy away from oil dependence, but in spite of these measures, the industrial sector continues to decline. Therefore, it is in the interest of this paper to conduct an analysis of how the economic contribution of transportation modes has impacted the growth of the industrial sector in Nigeria between 1986 and 2023 using available empirical evidence and appropriate techniques.

Research Questions

The following questions were addressed by the paper:

i. What impact does road transport has on the growth of the industrial sector in Nigeria?
ii. How has air transport has impacted on the growth of the industrial sector in Nigeria.
iii. To what extent does water transport impact on growth of the industrial sector in Nigeria.

The paper addressed the following hypotheses:

H_{01}: Road transport has no significant impact on growth of the industrial sector in Nigeria.
H_{02}: Air transport has no significant impact on growth of the industrial sector in Nigeria.
H_{03}: Water transport has no significant impact on growth of the industrial sector in Nigeria.

Literature Review

Conceptual Clarifications

Transportation modes such as road transport, water transport, and air transport play a crucial role in economic development and contribute significantly to the Gross Domestic Product (GDP) of countries worldwide. Each mode of transport has distinct characteristics and serves different sectors of the economy, providing essential services that facilitate the movement of goods, people, and resources. Understanding the contributions of these transportation modes to GDP requires a conceptual review of each mode, examining how scholars and researchers define them. Road transport is perhaps the most pervasive mode of transportation globally, providing crucial linkages between rural and urban areas, and connecting local economies to national and international markets. Road transport includes the movement of people and goods using vehicles such as cars, buses, trucks, and motorcycles on paved or unpaved roads. It plays an essential role in "last-mile" delivery, ensuring that goods reach their final destinations from larger transportation hubs. According to Buehler et al. (2020), road transport is crucial for the distribution of goods and services, particularly in developing nations where road infrastructure often represents the most accessible and cost-effective means of transport. Road transport's contribution to GDP is often measured through indicators such as the value-added of road freight and passenger transport services, fuel consumption, and the production and sales of motor vehicles. The economic impact of road transport is also linked to job creation in logistics, infrastructure development, and vehicle manufacturing sectors (Deb & Deb, 2019).

While road transport is essential for short-distance travel and the distribution of goods, water transport is particularly critical for the global economy, especially in facilitating international trade. Water transport refers to the movement of goods and passengers over waterways, including oceans, rivers, and canals, using ships, ferries, and barges. Water transport is highly efficient for moving large quantities of goods over long distances at relatively low costs compared to other modes of transport. According to Stopford (2019), maritime shipping handles approximately 80% of global trade by volume, making it a key driver of international commerce. The contribution of water transport to GDP can be assessed through measures such as port activity, shipping tonnage, and the value of goods transported by sea. Additionally, the shipping industry plays a vital role in sectors such as energy, raw materials, and manufacturing, where bulk transportation is necessary (Notteboom *et al.,* 2021). Water transport also generates employment opportunities, especially in port operations, shipbuilding, and maritime logistics. Thus, its influence on economic growth is dynamic, extending beyond direct transportation services to broader supply chain dynamics.

Air transport, although often viewed as the most expensive mode of transport, plays a significant role in modern economies due to its speed and global reach. Air transport includes the movement of passengers and goods via airplanes, helicopters, and other airborne vehicles. Air transport is particularly vital for time-sensitive goods such as perishable products, pharmaceuticals, and high-value electronics, as well as for facilitating international business travel and tourism. Scholarly literature highlights the high-speed nature of air transport as a major advantage, enabling swift connections between distant markets, thereby promoting globalization (Abate *et al.,* 2020). Air transport contributes to GDP through its impact on tourism, trade, and high-value cargo transport. Indicators of air transport's economic contributions include passenger volumes, cargo tonnage, and airport infrastructure development (Button, 2020). Furthermore, air transport creates employment opportunities not only within the aviation sector but also in tourism, hospitality, and trade. The International Air Transport Association (IATA) has estimated that the aviation industry directly contributes about 3.6% of global GDP, highlighting its strategic importance for international trade and economic development (IATA, 2021).

At its core, industrial sector growth refers to the expansion and development of manufacturing, mining, construction, and related activities within an economy. This growth is typically measured by increases in output, productivity, employment, and technological advancements within these industries. Anyanwu *et al.* (2020) defined industrial sector growth as the sustained increase in the value-added contribution of manufacturing, mining, and construction activities to a country's Gross Domestic Product (GDP) over time. They emphasize that this growth is not merely quantitative but also qualitative, involving improvements in production processes, product diversification, and technological innovation. This definition highlights the multidimensional nature of industrial growth, encompassing both economic expansion and structural transformation.

Theoretical Framework

The theoretical underpinning for this paper is the Harrod-Domar Growth Model, initially developed by Roy Harrod in 1939 and Evsey Domar in 1946. The Harrod-Domar model

posits that economic growth is primarily driven by the accumulation of capital and investment, emphasizing the importance of savings and the productivity of investments in fostering economic development. According to the model, an increase in the level of investment leads to an expansion in productive capacity, which consequently boosts output and GDP. The theory is rooted in the assumption that capital investment is a key determinant of long-term economic growth, particularly through infrastructure development in sectors like transportation (Harrod, 1939; Domar, 1946).

In the context of this paper, the Harrod-Domar model helps explain the relationship between investment in transportation infrastructure—such as road, water, and air transport—and economic growth in Nigeria. By improving these transportation modes, the country can lower logistical costs, enhance market access, and stimulate industrial productivity, which ultimately contributes to GDP growth. For instance, road transport improvements can reduce the cost of moving goods domestically, while investments in port infrastructure facilitate international trade, especially in key sectors like oil exports. The model highlights the importance of continuous investment in transportation as a means of driving industrial expansion and economic progress.

However, like any theory, the Harrod-Domar model has its criticisms. One of the main criticisms comes from Robert Solow (1956), who argued that the model's exclusive focus on capital accumulation overlooks other important factors, such as technological innovation and labour productivity, which are critical for sustained long-term growth. Solow suggested that without incorporating technological progress, the Harrod-Domar model risks presenting an overly simplistic view of economic development. Additionally, Gramlich (1994) critiqued the model for not accounting for inefficiencies in investment, especially in the context of developing countries. In Nigeria, for example, while significant investments have been made in road and port infrastructure, corruption, poor planning, and maintenance issues have limited the full economic benefits of these investments (Adewumi & Ologunde, 2020).

Despite these criticisms, the Harrod-Domar model remains relevant to this paper by providing a theoretical framework for understanding how investments in transportation infrastructure can drive economic growth. As transportation improvements lower, operational costs and increase productivity, they help stimulate industrial output growth. The model's emphasis on capital investment aligns with the core argument of this research: that enhancing transportation infrastructure is vital for sustained industrial growth and broader economic development.

Empirical Review

Empirical studies have extensively examined the relationship between contribution of transportation modes—road, water, and air—to GDP and industrial sector growth. These studies have utilised different methodologies, time frames, and variables, providing valuable insights into how transportation investments stimulate broader economic activities. A review of such studies helps in contextualizing the current research within established findings and identifying gaps in the literature, particularly concerning the transportation sector's impact on

industrial growth. Rodriguez and Yao (2023) explored the impact of port infrastructure on industrial growth through a cross-country analysis covering 2000 to 2020. Using a multi-country comparative framework and a fixed-effects model, they investigated how investments in port infrastructure facilitated industrial expansion by lowering trade costs and improving the efficiency of bulk goods transport. Their findings showed that countries with well-developed port infrastructure experienced more substantial industrial growth, particularly in export-heavy sectors such as manufacturing and raw materials. However, countries with poorly developed ports faced significant bottlenecks, which curtailed industrial output. One limitation of the study was its aggregation of countries with diverse economic and infrastructural conditions, potentially leading to generalized findings that may not apply equally across all contexts. Furthermore, the study could have benefitted from exploring the political and social barriers that affect port infrastructure development in different countries, which were not deeply examined in the analysis.

In another study, Graham and Ramirez (2022) examined the influence of air transport on industrial growth in emerging markets from 2000 to 2020. Using a time-series econometric model, they analysed the relationship between air transport infrastructure investments and industrial output across various sectors, including high-value manufacturing and logistics-intensive industries. The findings indicated that air transport infrastructure had a significant positive effect on industrial growth, particularly in industries that rely on the rapid movement of goods and access to international markets. Countries with more developed air transport networks experienced greater industrial productivity and export performance. However, the study primarily focused on large emerging markets, potentially overlooking smaller economies where air transport infrastructure may not be as developed. Additionally, the study did not account for environmental concerns, such as the carbon emissions associated with increased air transport, which could impact long-term sustainability. While the quantitative model was robust, incorporating environmental and regulatory factors could have provided a more holistic view of air transport's impact on industrial growth.

Jiang and Tan (2021) conducted a study on the role of air transport infrastructure in promoting industrial growth in Southeast Asia, covering the period from 1998 to 2019. They employed a panel regression analysis to examine the relationship between air transport investment and industrial productivity across several Southeast Asian nations. The findings revealed that air transport infrastructure positively influenced industrial output by improving connectivity to global markets and reducing logistics costs. Industries such as electronics, pharmaceuticals, and textiles benefitted the most from air transport investments due to their reliance on timely deliveries. However, the study's focus on only Southeast Asian countries might limit the generalizability of the findings to other regions with different economic structures or levels of infrastructure development. Moreover, the research concentrated heavily on quantitative data, without exploring the qualitative factors such as government policies, regulatory frameworks, or the challenges of maintaining air transport infrastructure, which are critical for understanding the full impact of air transport on industrial growth.

Kendrick and Wong (2021) analysed the effects of road transport inefficiencies on industrial performance in sub-Saharan Africa from 1990 to 2018. Using a panel data regression model, the researchers assessed how poor road infrastructure and logistical inefficiencies impacted industrial output in various sub-Saharan countries. The findings indicated that road transport inefficiencies, such as inadequate road networks, congestion, and poor maintenance, significantly hindered industrial performance by raising transportation costs and disrupting supply chains. This was especially pronounced in landlocked countries where reliance on road transport for both domestic and international trade is high. While the study provided valuable insights, its broad regional scope may have masked important country-specific factors, as not all sub-Saharan countries face the same level of road transport challenges. Additionally, the study focused predominantly on quantitative measures, leaving out qualitative aspects like governance, corruption, or regional conflict, which can also play significant roles in road transport inefficiencies.

Tunde and Emmanuel (2021) conducted a study on the relationship between road transport infrastructure and industrial output in Nigeria, covering the period from 2000 to 2019. Utilizing an OLS regression analysis, the study found that road transport infrastructure had a positive but marginally significant impact on industrial output. The researchers argued that while road infrastructure is vital for moving raw materials and finished goods, issues such as poor road maintenance, frequent traffic congestion, and underinvestment limited its overall contribution to industrial growth. The findings suggested that although road transport is a critical driver of industrial performance, significant improvements are needed to fully unlock its potential. However, the study's reliance on secondary data and the use of a single-country focus limited its comparative scope, and it did not consider other transportation modes that could complement road transport in enhancing industrial productivity. Including other variables like governance quality or corruption indices might have provided a more comprehensive view of the factors influencing road transport infrastructure's effectiveness in Nigeria.

Adams and Larsen (2020) explored the impact of maritime transport on industrial output in developing economies between 1995 and 2018. The study employed a panel data analysis using data from several developing countries, with a focus on how improvements in port infrastructure and waterway logistics influenced industrial production and export performance. The researchers found that efficient maritime transport significantly boosted industrial output, particularly for export-oriented industries like manufacturing and raw material extraction. By reducing shipping costs and improving access to international markets, maritime transport infrastructure enhanced trade competitiveness, which in turn stimulated industrial growth. However, the study aggregated data from different countries with varying levels of port development, which may obscure the specific challenges faced by individual nations. Additionally, the reliance on panel data without a detailed country-by-country analysis limits the precision of the findings. Including more qualitative case studies could have provided a deeper understanding of the unique maritime transport challenges in different regions. Despite these limitations, the study provides strong evidence of the vital role maritime transport plays in industrial growth in developing economies.

Methodology

This study employed an *ex post facto* research design, which analyses existing data to identify causal relationships between transportation modes (road, water, and air) and industrial growth. Since variables such as transportation infrastructure and GDP contribution are pre-existing and cannot be manipulated, the ex post facto design allows the study to assess the impact of these independent variables retrospectively, drawing on secondary data sources and previously recorded economic indicators. This paper employed secondary data sourced from the Central Bank of Nigeria (CBN) Statistical Bulletin. The data focuses on the contributions of transportation modes—road, water, and air—to the industrial sector's growth in Nigeria. It is the aim of this paper to derive the impact of transportation modes on the growth of the industrial sector in Nigeria. To begin with, the paper presents the following baseline regression equation:

$$INDG_t = \alpha_0 + \alpha_1 RT_t + \alpha_2 AT_t + \alpha_3 WT_t + u_t \qquad (1)$$

Where:
INDG = industrial sector growth
RT = Road Transport
AT = Air Transport
WT = Water Transport
α_0 = Intercept or autonomous parameter estimates for transportation modes
$\alpha_1 - \alpha_3$ = Coefficients of transportation modes (Road Transport, Water Transport, and Air Transport)
u_t = The white noise error term.

Based on *apriori* expectations, the coefficients of Road Transport, Water Transport, and Air Transport are expected to be positive $(\alpha_1 > 0; \alpha_2 > 0; \alpha_3 > 0)$ and have a significant impact on industrial sector growth in Nigeria. All the variables are in terms of their contributions to GDP. After verifying the stationarity of the time series data, the next crucial phase involved assessing the potential long-run relationship among these variables. To accomplish this, the study utilized the cointegration technique, which allows for the detection of equilibrium associations between non-stationary series within a stationary context. This method is particularly valuable in examining the long-term dynamics between transportation modes and industrial sector growth in Nigeria.

To capture the essence of the long-run relationship between transportation modes and the growth of the industrial sector in Nigeria, the paper utilised the Bounds cointegration test derived from the Auto Regressive Distributive Lags (ARDL) model. This approach allows for a comprehensive analysis of how different transportation modes, including road, water, and air transport, contribute to industrial sector growth over time. The ARDL model is particularly suitable for this research as it can accommodate variables with different orders of integration and provides insights into both short-run dynamics and long-run equilibrium relationships. The ARDL model is captured as:

$$INDG_t = \alpha_0 + \sum_{j=0}^{n} \alpha_1 \Delta INDG_{t-j} + \sum_{j=0}^{n} \alpha_2 \Delta RT_{t-j} + \sum_{i=0}^{o} \alpha_3 \Delta AT_{t-i} + \sum_{k=0}^{p} \alpha_4 \Delta WT_{t-k} + \alpha_5 INDG_{t-1} + \alpha_6 RT_{t-1} + \alpha_7 AT_{t-1} + \alpha_8 WT_{t-1} + u_t \quad (2)$$

Empirical Results and Discussions

Descriptive Statistics Results

Descriptive statistics offer a summary of key characteristics of variables, such as their central tendency, dispersion, and shape of distribution. In this study, the descriptive statistics provide an overview of the data for four key variables: Industry Growth (INDG), Road Transport (RT), Water Transport (WT), and Air Transport (AT).

Table 1: Descriptive Statistics

	INDG	RT	AT	WT
Mean	29.45352	769.0837	55.12968	4.362602
Median	28.63082	396.8276	17.52455	2.863974
Maximum	38.08422	3876.248	274.8900	13.58000
Minimum	18.36758	3.557166	1.022099	0.803148
Std. Dev.	5.157279	1027.754	76.14550	3.572845
Skewness	-0.08639	1.571275	1.631143	0.935426
Kurtosis	2.181321	4.441425	4.673569	2.669005
Jarque-Bera	1.108477	18.92611	21.28531	5.715269
Probability	0.574510	0.000078	0.000024	0.057404
Observations	38	38	38	38

Source: Researcher's Computation Using EViews-10 (2024)

INDG shows moderate growth with an average of 29.45% annually and a median of 28.63%. The data ranges from 18.37% to 38.08%, indicating fluctuating industrial growth. With a standard deviation of 5.16, slight left-skewness (-0.08639), and platykurtic distribution (kurtosis 2.18), INDG displays normal distribution according to the Jarque-Bera test. RT dominates the transportation sector with a mean contribution of ₦769.08 billion annually. However, it exhibits high volatility, evidenced by a standard deviation of ₦1027.75 billion and a wide range from ₦3.56 billion to ₦3876.25 billion. The distribution is strongly right-skewed (1.571) and leptokurtic (4.44), deviating significantly from normality.

WT contributes the least, averaging ₦4.36 billion annually. It shows moderate variability with a standard deviation of ₦3.57 billion and ranges from ₦0.80 billion to ₦13.58 billion. The distribution is right-skewed (0.935) and slightly platykurtic (2.67), marginally deviating from normality. AT contributes more than WT but less than RT, averaging ₦55.13 billion annually. It displays high volatility, ranging from ₦1.02 billion to ₦274.89 billion, with a standard deviation of ₦76.15 billion. The distribution is right-skewed (1.631) and leptokurtic (4.67), significantly deviating from normality.

Unit Root Test

Non-stationary variables often exhibit trends, making it difficult to accurately model their relationships. In this study, the Augmented Dickey-Fuller (ADF) test was employed to assess the stationarity of the variables.

Table 2: Summary of Unit Root Test Results

Variable	ADF Test @ Levels	ADF Test @ 1st Difference	Order of Integration
INDG	-1.784872 (-2.943427)	-6.271596 (-3.632900)*	I(1)
AT	-3.190025 (-2.971853)**	Nil	I(0)
RT	-2.879757 (-2.615817)*	Nil	I(0)
WT	-0.416854 (-3.544284)	-4.064424 (-3.544284)**	I(1)

Note:** *,**, significant at 1, 5 and 10%.* Critical values are in ( )

Source: Researcher's Computation Using EViews-10 (2024)

Air Transport (AT) and Road Transport (RT) were found to be stationary at level I(0), indicating stability in their contributions to GDP over time. AT showed stationarity with a test statistic of -3.190025, significant at the 5% level, while RT was stationary with a test statistic of -2.879757, significant at the 1% level. This stationarity suggests that both air and road transport data exhibit consistency and do not require differencing for further analysis. In contrast, Industry Growth (INDG) and Water Transport (WT) were non-stationary at level but achieved stationarity after first differencing. INDG became stationary with a test statistic of -6.271596, significant at the 1% level, while WT achieved stationarity with a test statistic of -4.064424, significant at the 5% level. The need for differencing indicates the presence of trends or drift components in these variables over time, possibly due to external economic factors or policy changes.

Co-integration Results

If variables are cointegrated, it means that while they may individually exhibit trends, their relationship remains stable in the long run. For this paper, the Bound Test for Cointegration was conducted.

Table 3: Bound Test-Co-integration Results

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	9.598656	10%	2.37	3.2
k	3	5%	2.79	3.67
		1%	3.65	4.66

Source: Researcher's Computation Using EViews-10 (2024)

The Bound Test results yielded an F-statistic value of 9.598656, which is significantly higher than the critical values at all levels of significance, including the 5% level. At the 5% significance level, the lower bound critical value (I(0)) is 2.79, and the upper bound critical value (I(1)) is 3.67. Since the F-statistic of 9.598656 is well above the upper bound critical

value of 3.67, the null hypothesis of no levels relationship is rejected. This implies that there is a statistically significant cointegration relationship between the transportation modes (RT, WT, and AT) and industrial growth (INDG) in Nigeria.

ARDL and Long Run Estimates

The study has established that there is a co-integrating relationship between transportation modes and the growth of the industrial sector in Nigeria. Given this finding, the research now proceeds to estimate the error correction and long-run models.

Table 4: ARDL-ECM and Long-run Result
Dependent Variable: INDG

Short-Run Estimates				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D(INDG(-1))	0.6821	0.1390	4.9077	0.0012
D(RT)	-0.0111	0.0075	-1.4851	0.1758
D(RT(-1))	-0.0032	0.0073	-0.4354	0.6748
D(RT(-2))	0.0094	0.0077	1.2254	0.2553
D(RT(-3))	0.0167	0.0086	1.9407	0.0883
D(RT(-4))	-0.0007	0.0101	-0.0694	0.9464
D(RT(-5))	-0.0471	0.0124	-3.8087	0.0052
D(AT)	0.1485	0.0735	2.0186	0.0782
D(AT(-1))	-0.8276	0.1102	-7.5078	0.0001
D(AT(-2))	-0.7960	0.1186	-6.7137	0.0002
D(AT(-3))	-0.7462	0.1182	-6.3145	0.0002
D(AT(-4))	-0.8525	0.1363	-6.2571	0.0002
D(AT(-5))	-0.5715	0.1487	-3.8428	0.0049
D(WT)	2.3514	1.6436	1.4306	0.1904
D(WT(-1))	15.1886	3.0198	5.0296	0.0010
D(WT(-2))	11.7577	2.6144	4.4973	0.0020
D(WT(-3))	10.3514	2.3995	4.3141	0.0026
D(WT(-4))	14.2637	2.5978	5.4907	0.0006
D(WT(-5))	5.7456	2.8325	2.0284	0.0770
CointEq(-1)*	-0.6928	0.1995	-3.4725	0.0000
Long Run Estimates				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
RT	-0.0003	0.0002	-2.0317	0.0169
AT	0.6380	0.1146	5.5676	0.0005
WT	10.3194	1.3129	7.8599	0.0000
C	44.6191	1.4292	31.2195	0.0000
R-squared	0.9119			
Adjusted R-squared	0.7723			
Durbin-Watson stat	1.8868			

Source: Researcher's Computation Using EViews-10 (2024)

The CointEq(-1) term represents the error correction mechanism in the ARDL model, which reflects how quickly deviations from the long-run equilibrium are corrected. The coefficient of 0.1995 suggests that 19.95% of any disequilibrium or deviation from the long-run industrial growth path, due to changes in transportation modes (road, water, air), is corrected

in each period. Although this is a relatively slow adjustment rate, it indicates that while the system takes time to fully return to equilibrium, transportation infrastructure investments do gradually restore balance to the relationship between transport contributions and industrial growth. ARDL Long-Run Estimates presented provide valuable insights into the relationship between various transportation modes—Road Transport (RT), Water Transport (WT), and Air Transport (AT)—and Industry Growth (INDG) in Nigeria.

The coefficient for Road Transport (RT) is -0.0003, with a t-statistic of -2.0317 and a probability value of 0.0169, which is significant at the 5% level. This negative coefficient indicates an inverse relationship between road transport investment (measured in ₦ billion annually) and industrial growth in the long run. Specifically, a ₦1 billion increase in road transport contributions is associated with a 0.0003% decrease in industry growth. Air Transport (AT) has a positive and significant coefficient of 0.638, with a t-statistic of 5.5676 and a p-value of 0.0005, showing a strong statistical relationship at the 1% significance level. This suggests that air transport has a positive long-run impact on industrial growth. Specifically, a ₦1 billion increase in air transport contributions is associated with a 0.638% increase in the annual growth rate of the industrial sector. The coefficient for Water Transport (WT) is 10.3194, with a t-statistic of 7.8599 and a p-value of 0.0000, which is significant at the 1% level. Unlike road transport, water transport exhibits a highly significant positive relationship with industrial growth. A ₦1 billion increase in water transport investment results in a 10.3194% increase in industrial growth.

Discussion of Findings

Findings from the paper showed that road transport had a negative but significant impact on the growth of the industrial sector in Nigeria. This negative impact (which is contrary the *apriori* expectations) shows that despite the crucial role road transport plays in moving goods and services within the country, inefficiencies such as poor road conditions, congestion, and inadequate infrastructure have constrained its contribution to industrial growth. These inefficiencies increase the costs of transportation, reduce productivity, and hinder the efficient distribution of raw materials and finished products across industrial areas. This finding aligns with the work of Tunde and Emmanuel (2021), who highlighted that road transport in many African countries, particularly in Nigeria, suffers from underinvestment and mismanagement, leading to increased logistics costs and delayed deliveries. Similarly, Kendrick and Wong (2020) found that poor road infrastructure in developing economies significantly reduces industrial output by disrupting supply chains and making market access more difficult. The negative impact suggests that substantial improvements in road infrastructure are needed to unlock its full potential in supporting industrial growth in Nigeria.

On the other hand, findings revealed that air transport has a positive and significant impact on the growth of the industrial sector in Nigeria. This positive impact reflects air transport's role in facilitating the fast movement of high-value, time-sensitive goods, which is particularly important for industries engaged in global trade and supply chains. The efficiency of air transport in moving goods quickly and connecting businesses with international markets has

led to its strong contribution to industrial growth. This finding is consistent with Graham and Ramirez (2022), who found that in countries with well-developed air transport networks, industries reliant on rapid logistics and exports—such as pharmaceuticals, electronics, and perishables—experienced higher growth rates. Similarly, Jiang and Tan (2021) found that air transport investments in emerging economies significantly boost industrial productivity by reducing delays and improving access to international markets. The positive relationship highlights the critical role that air transport plays in modernizing industries and enhancing their competitiveness globally.

Furthermore, the study showed that water transport also has a positive and significant impact on the growth of the industrial sector in Nigeria. Water transport, particularly through ports and inland waterways, is essential for facilitating international trade and bulk transportation of goods. The positive impact suggests that investments in water transport infrastructure, such as the modernization of ports and improved logistics, have greatly enhanced the industrial sector's ability to export products, access raw materials, and reduce transportation costs for bulk commodities. This finding aligns with the study by Adams and Larsen (2020), which demonstrated that efficient maritime transport systems significantly boost industrial output by lowering shipping costs and enhancing trade competitiveness. Similarly, Rodriguez and Yao (2023) observed that water transport is especially critical for export-driven industries in developing economies, as it provides the most cost-effective means of moving large volumes of goods over long distances. The positive impact on Nigeria's industrial growth highlights the importance of ongoing investment in port infrastructure and the need to address bottlenecks such as congestion and inefficient customs processes.

Conclusion and Recommendations

Based on the discussion so far, the conclusion centres around the primary objective of examining the economic contribution of transportation modes—road transport, air transport, and water transport—to the growth of Nigeria's industrial sector between 1986 and 2023. First, findings showed that road transport has a negative but significant impact on industrial growth, suggesting that inefficiencies in road infrastructure, such as poor maintenance and congestion, undermine its economic potential. This highlights the critical nature of addressing road transport inefficiencies to enhance industrial performance. The air transport displayed a positive and significant impact on industrial growth, emphasizing its crucial role in facilitating rapid logistics and access to global markets, which supports industries reliant on time-sensitive goods; and the water transport also had a positive and significant effect, particularly in export-heavy sectors, signalling the importance of efficient port infrastructure in reducing costs and improving trade competitiveness.

Based on the findings, the following recommendations were raised:

i. To address the negative impact of road transport on Nigeria's industrial sector, the Federal Ministry of Works and Housing, in collaboration with state governments and private sector stakeholders, should prioritize road network rehabilitation and expansion, especially along industrial corridors. Public-private partnerships (PPPs) can mobilize funding for road projects, while Federal Road Maintenance Agency

(FERMA) should focus on regular maintenance and deploying intelligent transport systems to improve traffic management and logistics efficiency.

ii. To enhance the positive contribution of air transport, Federal Airports Authority of Nigeria (FAAN) and Nigerian Civil Aviation Authority (NCAA) should modernize key airports with advanced cargo-handling capabilities. Investments in air transport infrastructure, supported by Ministry of Aviation policies, will improve global logistics access for industries, particularly those dealing with time-sensitive goods. Integrating air logistics with special economic zones (SEZs) will further boost industrial growth and access to international markets.

iii. Given water transport's positive impact, the Nigerian Ports Authority (NPA) must modernize port infrastructure, streamline customs processes, and reduce congestion. The Nigerian Shippers' Council (NSC) should collaborate with international partners to create efficient shipping routes, lowering logistics costs and enhancing export competitiveness.

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Appendix: Table A: Data Presentation

Year	Industry Growth Annual (INDG, Percentage))	Road Transport (RT Annual, ₦' Billion))	Water Transport (WT Annual, ₦' Billion))	Air Transport (AT, Annual, ₦' Billion))
1986	33.16	3.56	0.80	1.02
1987	33.22	3.85	0.85	1.11
1988	32.94	4.16	0.94	1.17
1989	35.74	4.51	0.84	1.18
1990	35.76	5.23	0.85	1.38
1991	37.33	5.94	1.01	1.41
1992	38.08	9.03	0.95	1.93
1993	33.50	15.20	1.39	2.82
1994	31.63	33.46	1.32	3.81
1995	36.91	52.37	1.52	4.64
1996	37.82	68.00	1.72	5.26
1997	35.61	78.16	1.94	6.37
1998	28.99	101.03	2.03	6.82
1999	29.67	119.14	2.13	7.69
2000	34.17	130.50	2.31	9.20
2001	28.57	145.79	2.53	10.53
2002	23.28	180.24	2.51	14.03
2003	26.27	231.01	2.55	15.37
2004	28.68	386.90	2.75	16.76
2005	28.49	406.75	2.97	18.29
2006	26.02	466.92	3.21	22.41
2007	24.60	499.17	3.54	25.44
2008	24.97	505.16	3.59	25.75
2009	21.46	533.85	3.78	29.20
2010	25.32	619.14	4.23	32.67
2011	28.35	670.80	5.04	56.49
2012	27.31	784.81	5.57	65.61
2013	26.04	893.13	6.22	76.91
2014	24.95	1,017.16	7.15	84.41
2015	20.38	1,156.29	8.07	95.74
2016	18.37	1,358.68	8.92	94.50
2017	22.55	1,564.81	9.43	105.86
2018	26.01	2,058.94	9.86	149.35
2019	27.65	2,727.53	10.12	198.62
2020	28.58	2,368.88	8.60	151.05
2021	31.87	3,042.85	9.41	206.54
2022	31.24	3,876.25	11.54	268.67
2023	33.74	3,095.99	13.58	274.89

Source: CBN, 2022; 2023