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Department of Economics

Infrastructure, Urbanization, and Economic Development in Nigeria

Edward Wasurum[1]
[1]Economics Department, Faculty of Social Science, Ignatius Ajuru University of Education, Rumuolumeni, Port Harcourt: edward.wasurum@iaue.edu.ng (https://orcid.org/0009-0003-1032-7613)

Agbalagba Oghenetejiri Hannah[2]
[2]College of Petroleum Administration and Management, Department Entrepreneurship, Federal University of Petroleum Resources, Effurun, Delta State, Nigeria: agbalagba.hannah@fupre.edu.ng
https://orcid.org/0009-0003-8798-366X

Abstract

This study examines the effects of infrastructure provision and urbanization on economic development in Nigeria using annual time-series data covering the period 1990–2023. Unlike previous studies that focused primarily on individual infrastructure sectors or employed Gross Domestic Product (GDP) as a measure of development, this study adopts the Human Development Index (HDI) as a multidimensional indicator and jointly examines the effects of clean water supply, paved road infrastructure, electricity supply, government health expenditure, telecommunications infrastructure, and urban population growth. Secondary data were obtained from the Central Bank of Nigeria, the National Bureau of Statistics, the World Development Indicators, the International Telecommunication Union, and the United Nations Development Programme. The Autoregressive Distributed Lag (ARDL) bounds testing approach was employed to estimate the short-run and long-run relationships among the variables. The findings indicate that infrastructure provision and urbanization exert significant long-run effects on economic development, although the magnitude and significance vary across infrastructure components. The results underscore the importance of integrating physical and social infrastructure with effective urban planning to enhance human development outcomes. The study contributes to the literature by providing a comprehensive framework that captures the combined effects of infrastructure and urbanization on HDI in Nigeria. It recommends sustained investment in quality infrastructure, strengthened institutional capacity, and coordinated urban development policies to promote inclusive and sustainable economic development.

Keywords: Infrastructure provision; Urbanization; Economic development; Human Development Index; Autoregressive Distributed Lag (ARDL); Nigeria; Sustainable development.

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1. Introduction

Infrastructure and urbanization are widely acknowledged as essential catalysts for economic growth, especially in developing nations where the quality and accessibility of public goods directly impact productivity, human capital development, and total wellbeing. According to the World Bank (2019) and Calderón & Servén (2010), building infrastructure and moving to cities are important for economic growth, especially in developing nations. Infrastructure, such as transportation networks, energy supply, water systems, communication facilities, and social amenities, is what makes productive activity possible. It helps industries thrive, creates jobs, and enhances social welfare by making it easier for people, products, and services to move around (Estache & Garsous, 2012). Urbanization, which is the fast growth of cities and metropolitan areas, is necessary for economic development because it encourages structural change, increases worker productivity, and makes it easier for people to go to markets and new ideas (United Nations, 2018). Building infrastructure and urbanization don't necessarily go hand in hand. When cities grow too quickly or without appropriate planning, it can put too much stress on the infrastructure that is already there, cause traffic congestion, and make it harder to attain sustainable development targets (UN-Habitat, 2020). Many emerging countries have this problem worse than others since their cities grow quicker than the roads and other public facilities they need. Nigeria is one of the fastest-growing cities in sub-Saharan Africa. The number of people living in cities is expanding swiftly because people are relocating from rural areas to cities and the population is growing on its own. Because of this fast increase, there is a large need for housing, transportation, sanitation, electricity, and other critical services (Akinwale, 2010; Okoye et al., 2021). Infrastructure issues are frequent, as shown by substandard roads, intermittent power supply, bad water and waste management systems, and not enough good housing (Olaseni & Alade, 2012). Urbanization has led to the concentration of economic activity in major cities such as Lagos, Abuja, and Port Harcourt; nevertheless, the benefits of this growth have not been shared fairly.The unfair distribution of infrastructure has made regional inequalities worse and made the divide between people who live in cities and those who live in rural areas even bigger (Adeniran, 2017; Obokoh & Goldman, 2016). Poor infrastructure, bad urban planning, and a lack of cooperation amongst government agencies mean that Nigeria is not taking full use of the benefits of urbanization. The connection between building infrastructure and urbanization affects how quickly and how long economic expansion may last. Although both variables are designed to mutually promote growth. Nigeria's history illustrates a persistent disparity between escalating urbanization and insufficient infrastructural development. The United Nations (2018) says that the country's urban population is growing by more than 4% each year, making it one of the fastest-growing cities in sub-Saharan Africa. But the growth hasn't been matched by advances in key infrastructure including transportation networks, energy, water supply, housing, and waste management. This discrepancy has put a lot of demand on the current facilities, which has led to traffic bottlenecks, inefficiency, and a lower quality of life in cities. The government has tried to repair Nigeria's infrastructure problems via laws and programs, but they are still there. Poor water and sanitation systems put people's health at risk, and the shortage of affordable housing has contributed to the expansion of slums and informal settlements (Olaseni & Alade, 2012; Akinwale, 2010). These issues make it much less probable that urbanization will help the economy thrive in a way that lasts. Investing in infrastructure in major cities like Lagos, Abuja, and Port Harcourt has made regional inequalities worse, which has meant that smaller towns and peri-urban areas have been

ignored (Adeniran, 2017; Obokoh & Goldman, 2016). The unequal distribution of infrastructure makes the gap between cities and rural areas even larger and slows down growth and national unity. The enduring presence of these difficulties signifies a significant deficiency in comprehending the intricate relationships among infrastructure provision, urbanization, and economic development in Nigeria. Despite the growing body of empirical literature on infrastructure development and economic growth, important knowledge gaps remain. Existing studies have largely concentrated on individual infrastructure sectors, such as electricity (Ashakah, 2025), transportation (Mercillinus et al., 2026), port infrastructure (Ndalu & Okene, 2024), and agricultural or institutional infrastructure (Utuk et al., 2024), with relatively little attention devoted to examining the combined effects of multiple dimensions of infrastructure within a single analytical framework. Consequently, the interconnected roles of physical infrastructure (paved roads, electricity supply, and telecommunications) and social infrastructure (clean water supply and government health expenditure) have not been comprehensively investigated in relation to economic development in Nigeria. Furthermore, although recent studies have increasingly examined urbanization as a determinant of economic growth, most have analysed urbanization independently of infrastructure development, despite the fact that both processes are closely interconnected and mutually reinforcing (Jemiluyi & Jeke, 2024). In addition, the majority of Nigerian studies have relied primarily on Gross Domestic Product (GDP) or GDP per capita as indicators of economic performance (Ashakah, 2025; Ndalu & Okene, 2024; Mercillinus et al., 2026). While these indicators capture economic output, they do not adequately reflect improvements in human welfare, education, and health, which are fundamental dimensions of sustainable development. Consequently, empirical evidence on the combined influence of infrastructure provision and urbanization on the Human Development Index (HDI) in Nigeria remains limited. Another important limitation in the existing literature is that relatively few studies have simultaneously estimated both the short-run and long-run effects of multiple infrastructure indicators and urbanization within a unified econometric framework. Most previous studies focused on a limited number of explanatory variables or specific sectors, thereby providing only a partial understanding of the complex relationship between infrastructure, urbanization, and development outcomes. This limitation restricts the formulation of integrated infrastructure and urban development policies capable of addressing Nigeria's rapidly expanding urban population and persistent infrastructure deficit. This study addresses these gaps by simultaneously examining the effects of clean water supply infrastructure, paved road infrastructure, electricity supply, government health expenditure, telecommunications infrastructure, and urban population growth on economic development in Nigeria. Unlike previous studies that predominantly employed GDP-based measures of economic performance, this study adopts the Human Development Index (HDI) as a multidimensional indicator of development, thereby providing a broader assessment of infrastructure outcomes that incorporates improvements in health, education, and living standards. Furthermore, by employing the Autoregressive Distributed Lag (ARDL) bounds testing approach, the study estimates both the short-run and long-run dynamics of infrastructure provision and urbanization, thereby providing more comprehensive and policy-relevant evidence for promoting inclusive and sustainable development in Nigeria. Against this background, this study investigates the relationship between infrastructure provision, urbanization, and economic development in Nigeria. Specifically, it examines the influence of clean water supply infrastructure, paved road infrastructure, electricity supply, government health expenditure, telecommunications infrastructure, and urban population growth on the Human Development Index between 1990 and 2023.The remainder of the paper is organized as follows. Section 2 reviews the relevant theoretical and empirical literature. Section 3 presents the research

methodology. Section 4 discusses the empirical results, while Section 5 concludes the study and offers policy recommendations.

2.0 Review of the Literature

2.1 Clarification of Concepts

2.1.1 Infrastructure

Infrastructure provision gives an economy the physical and organizational bases it needs for economic and social activities. Roads, railroads, electricity, water, telecommunications, education, and healthcare all made people happier and helped them work better (Calderón & Servén, 2010; Estache & Garsous, 2012). Infrastructure makes markets work better, decreases the costs of making and selling things, and makes it easier to get products and services. In countries like Nigeria that are still developing, infrastructure is important for industrialization, urban growth, and lowering poverty. Estache and Garsous (2012) say that infrastructure encompasses things like transportation networks, power supply, water and sanitation, telecommunications, and social services.

2.1.2 Urbanization

When people relocate from rural areas to cities and the population grows naturally, this is called urbanization (United Nations, 2018). Structural change happens when economies go from being based on farming to being based on industry and services. Urbanization helps the economy by making it easier for people to work and do business, as well as by encouraging new ideas. Urban growth can lead to traffic jams, job loss, a lack of housing, and damage to the environment if the right infrastructure and planning aren't in place (UN-Habitat, 2020). This study characterizes urbanization as alterations in settlement patterns, land utilization, and population distribution.

2.1.3 Economic development

Economic development raises people's income, job opportunities, education, health, and quality of life (Todaro & Smith, 2020). Economic growth focuses on increasing production, while economic development focuses on structural transformation, wealth distribution, and social advancement. It shows how well an economy can create jobs, lower poverty, and make people better at what they do. Rising per capita income, employment diversification, and human development indices (Todaro & Smith, 2015) show that living standards, productive capacity, and structural change are all getting better all the time. This study will utilize the Human Development Index to evaluate economic development.

2.2 Theoretical Literature

This study is based on the Endogenous Growth Theory, which says that long-term economic growth comes from things inside the economy, like human capital, new technologies, and infrastructure (Romer, 1986; Lucas, 1988). The premise is that when the government and corporations spend money on things that are good for the economy, like education, research, and infrastructure, it makes the economy grow by creating more jobs and higher returns to scale. Infrastructure is thought to be public capital that helps labour and private investment be more productive, fosters new ideas, lowers transaction costs, and

makes production more efficient (Aschauer, 1989). For the economy to grow, there must be well-developed infrastructure, such as transportation networks, energy sources, and communication systems. These technologies make costs lower, link markets, and help cities and industries thrive. Urban Growth and Agglomeration Theory (Alonso, 1964; Henderson, 1974; Fujita, 1989) offers a spatial-economic paradigm for comprehending growth. Agglomeration economies, which happen when firms and people cluster together in space, improve economic performance in cities. Infrastructure makes it easy to go around and communicate with other people. Urban centres, on the other hand, promote new ideas, specialization, and economies of scale. When cities grow without the necessary infrastructure, it causes traffic bottlenecks, a lack of housing, and challenges with delivering services that make people less productive. The infrastructure Led Development Theory claims that building up public infrastructure over and over again helps economies grow and compete, especially in new countries like Nigeria. Strong coordination between institutions and policies is needed for industrialization and private and international investment to work well and last a long time. These ideas help us understand how infrastructure, urbanization, and economic growth work together in Nigeria. Endogenous Growth Theory links internal investment to long-term productivity. Urban expansion and Agglomeration Theory emphasizes spatial efficiency, while Infrastructure-Led Development Theory regards infrastructure as a catalyst for expansion. They all show how Nigeria's long-term economic growth is affected by urbanization and infrastructure.

2.3 Empirical literature

Recent empirical evidence indicates that infrastructure development remains a fundamental determinant of economic growth and human development, particularly in developing countries where infrastructure deficiencies constrain productivity, investment, and social welfare. Contemporary studies have increasingly shifted from examining individual infrastructure sectors in isolation to investigating the complementary roles of transport, energy, water supply, telecommunications, governance, and urbanization in promoting sustainable development. This broader perspective recognizes that the developmental impact of infrastructure depends not only on physical investment but also on institutional quality, policy effectiveness, and the pace of urban expansion. Using annual Nigerian data from 1990 to 2023, Ashakah (2025) employed the Autoregressive Distributed Lag (ARDL) model to examine the relationship between electricity infrastructure and economic growth. The findings revealed that electricity consumption exerts a positive and statistically significant effect on economic growth in both the short and long run, indicating that reliable electricity supply enhances industrial productivity, employment generation, and long-term economic performance. The study further argued that although investments in electricity infrastructure may involve short-term adjustment costs, they generate substantial developmental benefits over time. Similarly, Ndalu and Okene (2024) investigated the impact of port infrastructure and logistics efficiency on Nigeria's economic growth using annual data covering 2006–2022. Applying the ARDL technique, the authors found that improvements in port infrastructure significantly increased trade efficiency, attracted foreign investment, and promoted economic growth. The study concluded that efficient transport infrastructure lowers transaction costs, facilitates international trade, and enhances national competitiveness. Focusing on transport infrastructure, Mercillinus et al. (2026) examined the effect of transportation infrastructure investment on Nigeria's economic growth between 1980 and 2021. Their ARDL estimates revealed positive and statistically significant short-run and long-run relationships, suggesting that improvements in road infrastructure reduce production costs,

enhance market accessibility, encourage regional integration, and stimulate sustainable economic growth. Examining infrastructure from a broader perspective, Ifoghere and Olele (2024) analysed the effects of transportation, road, water, and telecommunication infrastructure on Nigeria's economic growth using annual data from 1990 to 2023. Their findings indicated that infrastructure development generally exerts a positive influence on economic growth, although the magnitude of the impact varies across sectors. The authors concluded that improvements in infrastructure quality and efficient allocation of public investment are more important than merely increasing infrastructure expenditure. The relationship between infrastructure and institutional quality has also attracted increasing scholarly attention. Utuk et al. (2024) investigated the effects of transport infrastructure and institutional quality on agricultural performance in Nigeria. Their findings showed that road infrastructure significantly improved agricultural productivity, while institutional quality strengthened the effectiveness of infrastructure investments. The study emphasized that infrastructure projects generate greater developmental benefits when accompanied by sound governance, transparency, and effective public institutions. Recent empirical studies have equally highlighted the importance of health-related public expenditure as an essential component of infrastructure-led development. Musa et al. (2025) examined the relationship between electricity consumption, government health expenditure, and sustainable development in Nigeria using cointegration techniques. Their findings revealed that both electricity infrastructure and government health expenditure significantly improved sustainable development, suggesting that investments in social infrastructure complement physical infrastructure in promoting long-run welfare improvements. Digital infrastructure has become another important area of contemporary research. Ebehung and Ogar (2025) reported that telecommunications infrastructure contributes positively to Nigeria's economic performance, although its effect was relatively modest compared with transport and electricity infrastructure. The study recommended strengthening public-private partnerships and expanding digital infrastructure investment to improve productivity, innovation, and service delivery. Likewise, recent evidence suggests that digital connectivity has become an indispensable component of modern infrastructure capable of enhancing competitiveness, financial inclusion, and knowledge diffusion across developing economies. Urbanization has also emerged as a major determinant of economic development in recent empirical literature. Jemiluyi and Jeke (2024) investigated the urbanization-growth nexus in Nigeria using ARDL, Dynamic Ordinary Least Squares (DOLS), and Fully Modified Ordinary Least Squares (FMOLS) techniques. Contrary to conventional expectations, the authors found that urbanization alone did not significantly promote economic growth. However, when complemented by investments in education and human capital development, urbanization significantly enhanced long-run economic performance, implying that the developmental benefits of urban growth depend largely on complementary investments in human capital and infrastructure. At the continental level, recent evidence also supports the complementary relationship between infrastructure and urbanization. Using panel data for forty-two African countries between 2005 and 2021, a two-step System Generalized Method of Moments (GMM) analysis found that urbanization positively influences infrastructure development, although the magnitude of the effect varies across transport, electricity, water, and digital infrastructure. The study further showed that economic growth and trade openness significantly accelerate infrastructure development, reinforcing the need for integrated infrastructure and urban planning policies across African economies. Collectively, recent empirical evidence consistently supports the proposition that infrastructure development remains a major driver of economic development. Nevertheless, contemporary studies also demonstrate that infrastructure investment alone is insufficient to guarantee sustainable development. Rather, its effectiveness depends on complementary factors such as institutional quality, governance effectiveness,

human capital development, digital transformation, and well-managed urbanization. Despite these advances, most existing Nigerian studies continue to employ Gross Domestic Product (GDP) as the principal measure of economic performance while focusing on individual infrastructure sectors. Comparatively fewer studies have jointly examined multiple dimensions of physical and social infrastructure together with urbanization using the Human Development Index (HDI) as a multidimensional indicator of development. This gap provides the motivation for the present study, which integrates these variables within a single ARDL framework to evaluate both the short-run and long-run effects of infrastructure provision and urbanization on economic development in Nigeria.

3.0 **Research Methodology**

3.1 **Research Design**

This study used an ex-post facto and correlational research approach, suitable for analysing pre-existing correlations among variables without intervention. The approach enables the researcher to examine the interplay between infrastructure provision and urbanization in shaping economic development in Nigeria across time. The study aims to identify the short-term and long-term dynamics of variables using historical data within an econometric framework (Gujarati & Porter, 2010).

3.2 **Model Specification**

This study is anchored on the Endogenous Growth Theory developed by Romer (1986) and Lucas (1988), which posits that long-run economic development is driven by internal factors such as infrastructure investment, human capital accumulation, technological progress, and innovation. The theory argues that public investment in productive infrastructure enhances labour productivity, reduces transaction costs, encourages private investment, facilitates technological diffusion, and promotes sustained improvements in economic welfare. Complementing this perspective, Urban Agglomeration Theory suggests that urbanization generates economies of scale, knowledge spill overs, labour market specialization, and improved access to markets, thereby increasing productivity and supporting economic development when accompanied by adequate infrastructure (Henderson, 1974; Fujita, 1989). Drawing on these theoretical foundations and previous empirical studies (Ashakah, 2025; Musa, et al., 2025; Ndalu & Okene, 2024; Mercillinus et al., 2026), this study specifies a multivariate model in which economic development, proxied by the Human Development Index (HDI), is explained by key dimensions of physical infrastructure, social infrastructure, and urbanization. The functional relationship is expressed as:

$$HDI = f(CWSI, PRDI, EPS, GEH, TCI, UPG)$$

The econometric model is therefore specified as:

$$HDI_t = \beta_0 + \beta_1 CWSI_t + \beta_2 PRDI_t + \beta_3 EPS_t + \beta_4 GEH_t + \beta_5 TCI_t + \beta_6 UPG_t + \varepsilon_t$$

where:

HDI_t = Human Development Index (proxy for economic development)
$CWSI_t$ = Clean Water Supply Infrastructure
$PRDI_t$ = Paved Road Infrastructure
EPS_t = Electricity Power Supply
GEH_t = Government Expenditure on Health
TCI_t= Telecommunications Infrastructure
UPG_t = Urban Population Growth
β_0= Intercept
$\beta_1 - \beta_6$ = Parameters to be estimated
ε_t = Stochastic error term

A Priori Expectations

Consistent with Endogenous Growth Theory and previous empirical studies, all explanatory variables are expected to exert positive effects on economic development.

Thus,

$$\beta_1>0, \beta_2>0, \beta_3>0, \beta_4>0, \beta_5>0, \beta_6>0$$

Specifically, improved access to clean water is expected to enhance health outcomes and labour productivity, thereby increasing human development. Investment in paved roads reduces transportation costs, facilitates market integration, and stimulates economic activities. Reliable electricity supply supports industrial production, education, healthcare delivery, and household welfare. Government expenditure on health contributes to human capital development through improved healthcare services. Telecommunications infrastructure enhances digital connectivity, information exchange, innovation, and financial inclusion. Finally, urban population growth is expected to positively influence economic development by generating agglomeration economies, labour specialization, and knowledge spill overs, provided that urban expansion is supported by adequate infrastructure and effective planning.

3.3 **Justification for the ARDL Estimation Technique**

The study employs the Autoregressive Distributed Lag (ARDL) bounds testing approach developed by Pesaran, Shin, and Smith (2001) because it is particularly appropriate for analysing both short-run and long-run relationships among variables integrated of order I(0) and I(1). The Augmented Dickey-Fuller (ADF) unit root results indicate that the variables are integrated at mixed orders, with some stationary at level and others becoming stationary after first differencing. Since none of the variables is integrated of order two [I(2)], the ARDL approach is suitable for this study. Furthermore, the ARDL model performs efficiently with relatively small sample sizes, provides unbiased long-run estimates, simultaneously estimates short-run dynamics through the Error Correction Model (ECM), and effectively captures the speed of adjustment towards long-run equilibrium following short-run shocks. These advantages make the ARDL framework particularly appropriate for investigating the dynamic relationships between infrastructure provision, urbanization, and economic development in Nigeria over the period 1990–2023.

3.4 **Alignment with the Study Objectives**

The empirical model is directly aligned with the objectives of this study, which seek to examine the influence of clean water supply infrastructure, paved road infrastructure, electricity supply, government health expenditure, telecommunications infrastructure, and urban population growth on economic development in Nigeria. By estimating both the short-run and long-run effects of these variables within a unified ARDL framework, the model provides comprehensive evidence on how different dimensions of infrastructure and urbanization jointly influence human development. This integrated approach enables the formulation of more effective infrastructure and urban development policies capable of promoting inclusive and sustainable economic growth.

3.5 **Sources of Data and Method of Estimation**

We look at the human development index, the infrastructure for paved roads, the infrastructure for clean water systems, the provision of electricity, the government's spending on health, the infrastructure for telecommunications, and the expansion of the urban population using secondary time-series data from 1990 to 2023. The CBN Statistical Bulletin, NBS, World Bank's WDI, and ITU data are utilized for reliability and to compare countries. The study employs contemporary econometric techniques for robustness, given its time-series nature. The ADF stationarity tests find the sequence of integration, while the Bounds test looks at long-term relationships. We used the ARDL estimate method to reach the study's goal.

4.0 **Result, Findings and Summary**

4.1 **Data Analysis**

Table 4.1.1 Descriptive Statistics

	HDI	CWSI	PRDI	EPS	GEH	TCI	UPG
Mean	41739227	4.965580	21.38933	47.90553	116.2667	18.86314	39.88143
Median	39995505	5.398824	19.81765	49.96892	81.90937	18.51000	39.94000
Maximum	69799942	5.743439	30.90000	59.30000	388.3671	90.03000	49.50000
Minimum	18494114	3.020501	15.00000	27.30000	0.150161	0.240000	28.84000
Std. Dev.	19226883	0.857127	5.101341	7.895556	115.7255	18.89470	6.945157
Skewness	0.141896	-0.962481	0.894899	-0.622308	0.706756	1.933556	-0.055066
Kurtosis	1.403534	2.527466	2.425916	2.537863	2.376770	7.744573	1.527043
Jarque-Bera	3.834308	5.729454	5.152220	2.570515	3.480210	54.63722	3.181692
Probability	0.147025	0.056999	0.076069	0.276579	0.175502	0.000000	0.203753
Sum	1.46E+09	173.7953	748.6265	1676.694	4069.336	660.2100	1395.850
Sum Sq. Dev.	1.26E+16	24.97864	884.8051	2119.554	455340.9	12138.33	1639.997
Observations	35	35	35	35	35	35	35

The average HDI was 41,739,227 and the median was 39,995,505 based on 35 observations. The gap shows that real GDP is structurally weak. Skewness (0.1419) shows that the data is slightly right-skewed, while standard deviation (19,226,883) shows that the data is very variable. Kurtosis (1.4035) and Jarque–Bera probability (0.1435) indicate a platykurtic distribution with no significant deviation from normalcy. A

mean of 4.9656 and a median of 5.3988 for the clean water system infrastructure (CWSI) show that the data is left-skewed. Low variability (SD = 0.8571). A flat distribution is shown by skewness (–0.9625) and kurtosis (2.5275). The Jarque-Bera probability (0.0570) shows that the data is not normal. The mean and median of paved road infrastructure (PRDI) are 21.3893 and 19.8177, respectively. The values range from 15.00 to 30.90. Low variability (SD = 5.1013). Positively skewed (0.8949) and platykurtic (2.4259). The Jarque–Bera probability (0.0761) indicates no substantial departure from normality. Electric power supply (EPS) averages 47.9055 and medians 49.9689, going up and down between 47% and 50% of what is needed. The distribution is plateykurtic (2.5379), has a negative skewness (–0.6223), and has low variability (SD = 7.8956). The Jarque–Bera probability (0.2766) indicates that things are normal.
The average amount of money the government spends on health care (GEH) is 116.2667, and the median amount is 81.9094. This shows that spending is not evenly distributed and that there are big differences (SD = 115.7255). The kurtosis is platykurtic (2.3768) and the skewness is positive (0.7068). A Jarque–Bera value of 0.1755 shows that something is very wrong with the normal. Telecommunication infrastructure (TCI) has a mean of 18.8631 and a median of 18.5100, and there isn't much difference between the two (SD = 18.8947). A strong right-skewed (1.9336) and leptokurtic (7.7446) distribution. 0.0000 The Jarque–Bera probability test shows that the data is not normal. The average urban population growth (UPG) is 39.8814, while the median is 39.9400. This means that growth is constant at about 40%. SD = 6.9452 shows that there is some fluctuation. The kurtosis (1.5270) and skewness (–0.05) show that the distribution is flat. A Jarque–Bera probability of 0.2038 indicates no significant divergence from normality.

4.2 **Empirical Analysis**

Table 4.2.1 ADF Stationarity Test of the Model:

Variables	Level		1st Difference		Order
	T-Stat.	5% Critical Value	T-Stat.	5% Critical Value	
HDI	-1.070661	-2.954021	-8.980735	-2.954021	I (1)
CWSI	-8.920607	-2.951125	-	-	I (0)
PRD	-2.926737	-2.954021	-6.021107	-2.954021	I (1)
EPS	-3.123555	-2.963972	-	-	I (0)
GEH	-1.074168	-2.951125	-5.218913	-2.954021	I (1)
TCI	-3.242558	-2.954021	-	-	I (0)
UPG	-2.181023	-2.967767	-5.348231	-2.971853	I (1)

Source: Authors Compilation

Table 4.2.1 illustrates the summary of the stationarity test conducted with a unit root approach proposed by Dickey and Fuller in 1979. The summary result of the stationarity test reveals that all the time series data used for the study became stationary after they were subjected to first differences, except clean water system (CWSI), electric power supply (EPS) and telecommunication infrastructure (TCI). As such, we can conclude that all of the time series data were integrated at level (0) or order one (1), thus we conclude to use the autoregressive distributed lag (ARDL) modelling approach.

Table 4.2.2 ARDL Bounds Test of the Model

Null Hypothesis: No long-run relationships exist

Test Statistic	Value	K
F-statistic	7.721365	6

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.12	3.23
5%	2.45	3.61
2.5%	2.75	3.99
1%	3.15	4.43

From the bounds cointegration test above, the f-statistical value of 7.721365 is greater than the upper bound of the critical value of 3.61 at 5 percent. This suggests that there is evidence to reject the null hypotheses of no long-run relationship and accept the alternative hypotheses of the existence of a long-run relationship between the variables being tested. Since there is a long-run association, we then proceed to ascertain their long-run and error-correction regressions.

Table 4.2.3 Long Run result

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
	0.391305	0.068429	5.718455	0.0001
LOG(CWSI)	0.391305	0.068429	5.718455	0.0001
LOG(PRDI)	0.465914	0.328858	-1.416764	0.1784
LOG(EPS)	-1.683198	1.037684	-1.622071	0.1271
LOG(GEH)	0.120241	0.046184	2.603541	0.0208
LOG(TCI)	0.011686	0.041967	0.278450	0.7847
UPG	0.070453	0.016741	4.208331	0.0009
C	21.544054	2.629477	8.193284	0.0000

Table 4.2.3 shows the results of the long-run estimation. The infrastructure for clean water systems (CWSI) has a positive and statistically significant effect on the Human Development Index (HDI). This means that when CWSI grows over time, life expectancy, education, and the standard of living will all increase up by 39%. This finding aligns with prior expectations and underscores the developmental importance of clean water, as effective water systems attract investment, reduce production risks, lower operational costs, and improve workforce health, thereby fostering capital accumulation and encouraging sustained growth. There is a positive but not statistically significant relationship between paved road infrastructure (PRDI) and HDI at the 5% level. This means that improvements to road networks don't have a big long-term effect on economic development. Electric power supply (EPS) has a detrimental impact on HDI, albeit not statistically significant. This indicates that long-term economic growth does not exhibit considerable responsiveness to fluctuations in power supply during the research period. Government health expenditure (GHE) has a considerable and favourable effect on HDI. Theoretical

projections suggest that a 12% increase in HDI correlates with an escalation in government expenditure on health. In fact, spending more on health care produces more employment in the field, boosts people's earnings, and makes them more productive, all of which help the economy thrive over time. Telecommunication infrastructure (TCI) shows a positive but statistically insignificant connection with HDI, indicating that changes in telecom infrastructure did not significantly affect economic development over the study period. Urban population growth (UPG), on the other hand, has a positive and statistically significant long-term effect on HDI. This means that more people relocating to cities makes HDI go up by 7%. This result is unexpected because it goes against what was thought. For instance, there are problems with too many people, too much stress on public services, and government money being wasted. But it does show that living in cities may have made it easier for people to go to services, marketplaces, and job opportunities that help them grow.

Table 4.2.4 Short run result

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(HDI(-1))	0.607142	0.226106	2.685213	0.0178
DLOG(CWSI)	27.098549	11.638092	2.328436	0.0354
DLOG(CWSI(-1))	-27.022564	6.178205	-4.373853	0.0006
DLOG(PRDI)	-0.479538	0.326007	-1.470944	0.1634
DLOG(PRDI(-1))	0.180975	0.062692	2.886738	0.0120
DLOG(EPS)	0.403594	0.065651	6.147559	0.0000
DLOG(EPS(-1))	-0.148687	0.061428	-7.304242	0.0000
DLOG(GEH)	0.231907	0.096203	2.410602	0.0302
DLOG(TCI)	-0.018850	0.046935	-0.401629	0.6940
DLOG(TCI(-1))	-0.071936	0.043610	-1.649517	0.1213
D(UPG)	0.180975	0.062692	2.886738	0.0120
D(UPG(-1))	0.448687	0.061428	7.304242	0.0000
CointEq(-1)	-0.448687	0.061428	-7.304242	0.0000

R-squared	0.863423	Mean dependent var	17.47189
Adjusted R-squared	0.816396	S.D. dependent var	0.485616
S.E. of regression	0.140413	Akaike info criterion	-0.794398
Sum squared resid	0.276020	Schwarz criterion	0.067228
Log likelihood	32.10756	Hannan-Quinn criter.	-0.504487
F-statistic	20.48654	Durbin-Watson stat	2.473444
Prob(F-statistic)	0.000000		

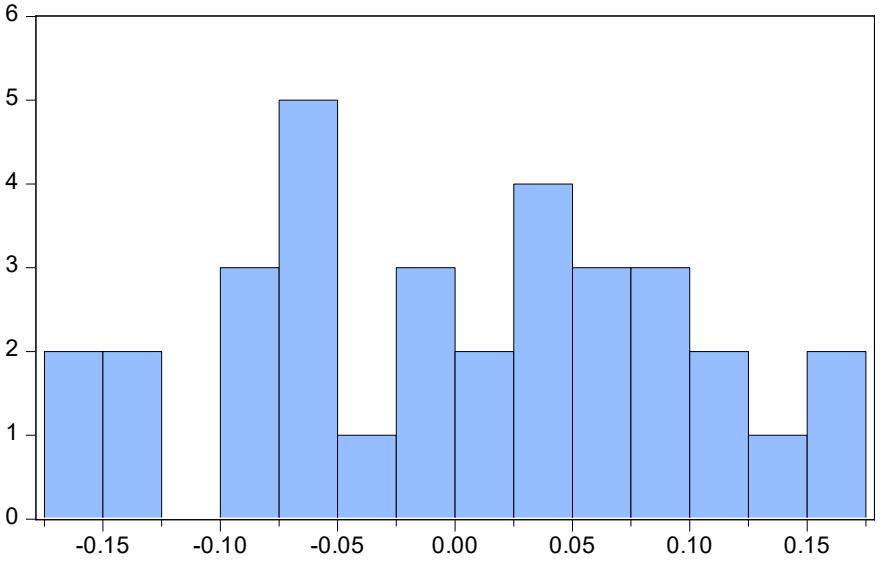
*Note: p-values and any subsequent tests do not account for model selection.

The model fits well for the short run, with an R-square of 0.8634 and an adjusted R-square of 0.8164. This means that the explanatory variables are responsible for about 82% of the changes in the Human Development Index (HDI), while the other 18% are due to other factors. The Durbin-Watson value of 2.47 demonstrates that there isn't a lot of autocorrelations. The error-correction term has the expected negative sign and is significant at the 5% level. This indicates that every year, 45% of the differences from long-run equilibrium are fixed. The lagged HDI coefficient is big and positive, which suggests that improvements in human development in the past elevate the current HDI by 61%. This shows that things are still getting better in the short term. The current clean water system infrastructure (CWSI) has a big

and positive effect on HDI. For instance, if the water supply goes up by 1%, development goes up by 27.10%. But its one-year lag has a big negative coefficient, which suggests that building more water infrastructure in the past slows down short-term growth. This is likely due to short-term adjustment costs, such as the burden of investment, delays in implementation, or inefficiency. At this time, paved road infrastructure (PRDI) has a negative but not very strong effect on HDI, which means it doesn't have an immediate effect. But its lagged value has a big and positive effect; for example, an 18% increase in the current HDI happens when the prior year goes up by 1%. This is what really happens when roads are fixed: Costs of transportation go down, people can move about more easily, and work gets done faster, but these benefits take time to show up. EPS has a substantial and good short-term effect; a 1% boost in EPS leads to a 40% rise in HDI. This is in keeping with the fact that electricity is very crucial for supporting production, healthcare, education, and general well-being. But its one-year lag has a big and negative coefficient: a 1% increase in electricity supply the year before lowers HDI by 14%. This could be due to short-term issues brought on by changes in the power industry, changes in tariffs, or instability during the transition that hurts businesses and families. Government spending on health (GEH) is a good thing and a big deal. This suggests that in the short run, spending more on public health raises HDI by about 23%. Spending more on health care increases productivity, makes it easier for families to pay for medical treatment, and helps enhance welfare. Telecommunication infrastructure (TCI), both historically and currently, has yielded negative and negligible effects, suggesting no significant short-term impact on development. Lastly, the growth of the urban population (UPG) in both periods is good and significant. An 18% and 44% rise in HDI is connected to a 1% rise in UPG. This goes against what was first thought, since rapid urbanization could put a strain on infrastructure. However, it does show that metropolitan areas may have made it easier to find work, go to school, and get services throughout the study period, which helped people flourish in the short term.

4.3 **Post Estimation Test:**

i. Normality of the Residual Test



Series: Residuals	
Sample 1992 2024	
Observations 33	
Mean	1.03e-14
Median	0.013408
Maximum	0.163215
Minimum	-0.174776
Std. Dev.	0.092874
Skewness	-0.052249
Kurtosis	2.165845
Jarque-Bera	0.971759
Probability	0.615156

Given the value of the Jarque-Bera statistic of 0.971759 and its probability value of 0.615156, we assert that the residuals are normally distributed.

ii. Serial Correlation Test:

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.876671	Prob. F(2,12)	0.1954
Obs*R-squared	7.862476	Prob. Chi-Square(2)	0.1196

The F-statistic value of 1.876671 and the observed R-squared value of 7.862476 are statistically insignificant with probability values of 0.1954 and 0.1196, we assert that there is no evidence of serial correlation in the residual of the study, and we conclude that the estimated equation is blue.

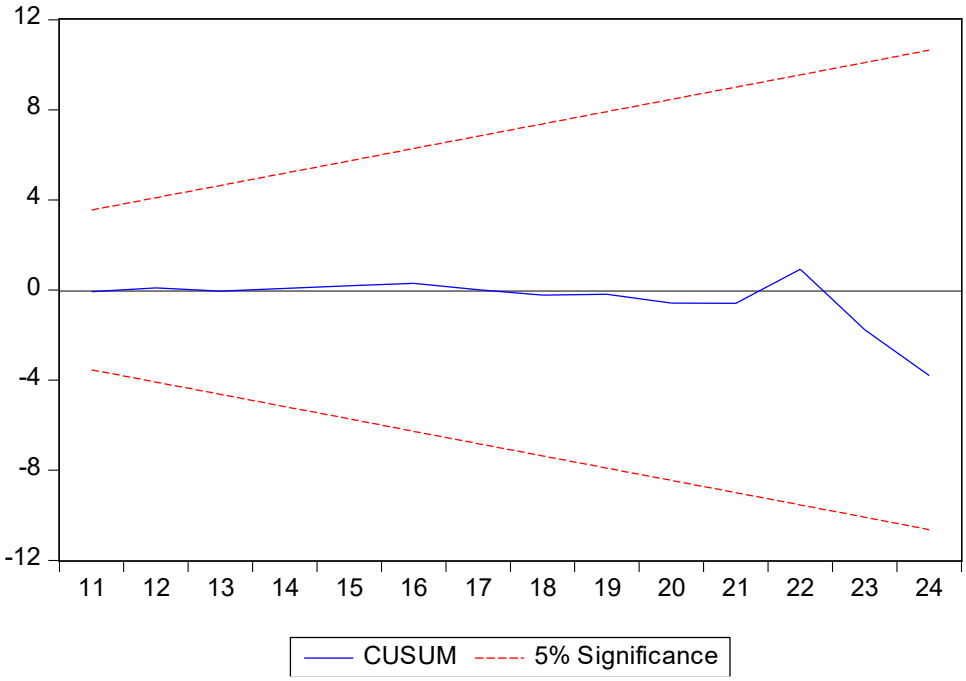
iii. Heteroskedasticity Test:

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	30.639030	Prob. F(18,14)	0.104
Obs*R-squared	30.53939	Prob. Chi-Square(18)	0.0922
Scaled explained SS	3.099136	Prob. Chi-Square(18)	1.0000

This test assess whether there is evidence of unequal variance of the residuals across different levels of the independent variables in regression analysis. Given the fact that the F statistic value of 30.639030, the Obs*R-squared value of 30.53939 and the scaled explained SS value of 3.099136 and their probability values of 0.104, 0.0922, and 1.0000 are greater than the 0.05 threshold, we conclude that there is evidence of homoskedasticity in the residual, and we conclude that the estimated equation is blue.

iv. Model Stability Test:



The cusum test was employed to test the stability of the regression. A critical assessment of the cusum line above shows that the line is within the accepted margin. This implies that the estimate lies within the 95 percent confidence interval.

4.4 **Discussion of Findings**

The expected results show that clean water supply infrastructure (CWSI) has a positive and statistically significant effect on long-term economic growth. CWSI has a significant good effect now, but it had a big bad effect in the past. This means that the short-term effect is not clear. Access to clean water enhances children's health, brain development, and school completion rates, which over time boosts the economy's ability to produce goods and services. Paved road infrastructure (PRDI) has a positive effect on long-term economic growth, although it is not statistically significant. PRDI has a tiny negative effect in the immediate term, but its one-year lag has a substantial positive effect. This means that it takes time for upgraded roads to help the economy thrive. When they're done, roads make it easier to get to marketplaces, cut the cost of transportation, make trading easier, and help businesses thrive. Electric power supply (EPS) has a minor but bad long-term effect on economic growth. The current supply of power has a major effect on economic growth in the short term, while the lagged value has a big effect on growth. Businesses don't have to use pricey generators as much because they can get electricity more easily. This lowers the cost of making things, makes healthcare better, and makes people better off in general. The adverse lagged effect may stem from transient issues arising during electricity sector reforms or tariff adjustments. The theory suggests that government spending on health (GEH) should have a positive and statistically significant effect on economic growth in both the short and long run. Spending more on health care decreases the costs of medical care for families, increases disposable income, makes workers more productive, and helps promote welfare and economic growth. Telecommunication infrastructure (TCI), on the other hand, doesn't seem to have any effect on economic growth in the short or long term. This suggests that even though more people were utilizing telecom services, the industry didn't help the economy grow much throughout the study period. This may be due to the unproductive use of telecom services. Urban population growth (UPG) has a positive and statistically significant effect on economic growth in both the short and long term, which is not what was expected. In developing countries, rapid urbanization often puts a lot of stress on the infrastructure that is already there. But the data reveal that during the time of the study, cities may have made it simpler to travel to jobs, markets, and services that helped the economy flourish. The findings indicate that infrastructural development and urbanization significantly impact Nigeria's economic growth over the research period. But the implications are different for different sectors in the short and long run.

4.5 Summary

This study investigates the relationship between infrastructure provision, urbanization, and economic development in Nigeria, acknowledging that sustainable growth is profoundly affected by the quality of physical and social infrastructure, as well as the patterns of urban population expansion. The research used the Human Development Index (HDI) as a measure of economic advancement, assessing the influence of critical infrastructure components (paved road networks, clean water systems, energy supply, and telecommunication infrastructure) in conjunction with urban population growth.

4.6Findings

i. Long-term infrastructure for clean water supply has a large positive effect on the economy. In the short term, it has a mixed but statistically significant effect.

ii. In the long run, paved roads are excellent for the economy. Its one-year lagged effect considerably enhances economic growth in the short term, which shows that the benefits will come later but will be important.

iii. The availability of electricity has a bad and unimportant long-term influence on economic growth, but it has mixed and statistically significant effects in the short run. In the short and long run, government investment on health has a substantial and positive effect on economic growth.

iv. The telecommunications infrastructure has a positive but not very strong long-term link with economic growth and a negative but not very strong short-term effect. This suggests that it didn't have much of an effect on growth during the study period.

The growth of the urban population has a substantial and positive impact on economic growth in both the short and long term.

5.0 **Conclusion and Recommendations**

5.1 **Conclusion**

This study examined the relationship between infrastructure provision, urbanization, and economic development in Nigeria using annual time-series data spanning 1990–2023 within an Autoregressive Distributed Lag (ARDL) framework. The study contributes to the growing body of literature on infrastructure-led development by adopting the Human Development Index (HDI) as a multidimensional measure of economic development rather than the conventional Gross Domestic Product (GDP). By integrating physical infrastructure (paved roads, electricity supply, and telecommunications), social infrastructure (clean water supply and government health expenditure), and urban population growth into a single empirical framework, the study provides a more comprehensive understanding of how infrastructure and urbanization jointly shape long-term development outcomes in Nigeria. The findings reinforce the propositions of Endogenous Growth Theory and Urban Agglomeration Theory by demonstrating that sustainable economic development depends not only on expanding infrastructure but also on improving its quality, accessibility, and effective integration with the process of urbanization. The study further highlights that the developmental benefits of urbanization are maximized when urban expansion is supported by adequate physical and social infrastructure capable of improving productivity, human capital, and overall welfare. These findings underscore the importance of adopting a holistic approach to infrastructure planning that recognizes the complementary roles of transport, energy, water, health, telecommunications, and urban development in achieving inclusive and sustainable growth. From a policy perspective, the study suggests that infrastructure investment should be viewed as a long-term development strategy rather than merely a means of expanding economic output. Policymakers should therefore prioritize investments that simultaneously enhance human development, reduce regional disparities, strengthen institutional effectiveness, and improve the quality and maintenance of existing infrastructure assets. Integrating infrastructure development with strategic urban planning will enable Nigeria to better accommodate its rapidly growing urban population while promoting greater economic resilience, social inclusion, and sustainable development. Consequently, the study provides empirical evidence capable of informing infrastructure financing, urban development strategies, and public investment policies aimed at accelerating Nigeria's progress toward the Sustainable Development Goals (SDGs).

5.2 **Recommendations**

Based on the findings of this study, the Nigerian government should adopt a comprehensive and integrated approach to infrastructure development by prioritizing sustained investments in both physical and social infrastructure. Particular attention should be given to expanding access to clean water supply, improving road networks, strengthening electricity generation and distribution systems, increasing public expenditure on healthcare, and enhancing telecommunications infrastructure. These investments should be accompanied by regular maintenance, efficient service delivery, and improved infrastructure quality to maximize their contribution to human development and long-term economic growth. Since urbanization continues to exert an important influence on development outcomes, infrastructure planning should be closely integrated with urban development policies to ensure that rapidly growing cities are supported by adequate housing, transportation systems, water and sanitation facilities, healthcare services, and digital connectivity. Such an integrated approach would improve productivity, enhance the quality of life, and promote more balanced regional development. In addition, improving the effectiveness of infrastructure investment requires stronger institutional capacity, greater transparency, and enhanced accountability throughout the planning, procurement, implementation, and maintenance of public infrastructure projects. Government should strengthen regulatory oversight, promote public-private partnerships, and encourage private sector participation to mobilize additional financial resources and improve operational efficiency. Policies that support digital transformation, innovation, and smart urban development should also be expanded to complement traditional infrastructure investments and improve service delivery. Furthermore, urban planning policies should anticipate future population growth by promoting compact, inclusive, and environmentally sustainable cities capable of accommodating increasing demand for public services. Collectively, these policy measures will enhance infrastructure effectiveness, reduce regional disparities, strengthen human development outcomes, and place Nigeria on a more sustainable path toward achieving inclusive economic growth and the Sustainable Development Goals (SDGs).

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Data availability: Data may be available upon request.

References

Adeleye, B. N., Adedoyin, F. F., Nathaniel, S. P., & Bekun, F. V. (2024). Infrastructure development and urbanization in Africa: Evidence from a dynamic panel analysis. *Cities, 153*, 105309. https://doi.org/10.1016/j.cities.2024.105309

Adeniran, A. I. (2017). Urbanization and economic development in Nigeria: Issues and prospects. *Journal of Sustainable Development in Africa, 19*(2), 45–60.

Akinwale, A. A. (2010). The menace of inadequate infrastructure in Nigeria. *African Journal of Science, Technology, Innovation and Development, 2*(3), 207–228.

Alonso, W. (1964). *Location and land use: Toward a general theory of land rent*. Harvard University Press.

Aschauer, D. A. (1989). Is public expenditure productive? *Journal of Monetary Economics, 23*(2), 177–200. https://doi.org/10.1016/0304-3932(89)90047-0

Ashakah, F. O. (2025). Impact of energy consumption on economic growth in Nigeria: An ARDL estimation approach. *Jalingo Journal of Social and Management Sciences, 6*(2), 254–266.

Calderón, C., & Servén, L. (2010). Infrastructure and economic development in sub-Saharan Africa. *Journal of African Economies, 19*(Suppl. 1), i13–i87.

Ebehung, N., & Ogar, O. J. (2025). Foundations of growth: Evaluating the interplay between infrastructure and economic growth in Nigeria. *International Journal of Research and Innovation in Social Science*, 446–460. https://dx.doi.org/10.47772

Estache, A., & Garsous, G. (2012). *The impact of infrastructure on growth in developing countries* (World Bank Policy Research Working Paper No. 6237). World Bank.

Fujita, M. (1989). *Urban economic theory: Land use and city size*. Cambridge University Press.

Gujarati, D. N., & Porter, D. C. (2010). *Essentials of econometrics* (4th ed.). McGraw-Hill.

Henderson, J. V. (1974). The sizes and types of cities. *American Economic Review, 64*(4), 640–656.

Ifoghere, B. E., & Olele, H. E. (2024). Infrastructure development and economic growth nexus: The Nigeria experience. *International Journal of Development and Economic Sustainability, 12*(4), 18–37.

Jemiluyi, O., & Jeke, L. (2024). Revisiting the urbanization–economic growth nexus in Nigeria: The role of human capital. *Scientific African, 26*, e02364. https://doi.org/10.1016/j.sciaf.2024.e02364

Lucas, R. E., Jr. (1988). On the mechanics of economic development. *Journal of Monetary Economics, 22*(1), 3–42.

Mercillinus, N. N., Ikechukwu, O. G., Callistus, O., Joseph, A. O., & Chikaodinaka, E. N. (2026). Effects of public sector investment in transportation infrastructure on economic growth in Nigeria. *Global Journal of Economic and Finance Research, 3*(1), 60–73. https://doi.org/10.55677/GJEFR/07-2026-Vol03E1

Musa, I., Njoku, N. A., & Magaji, S. (2025). Harnessing digital infrastructure to foster innovation and sustainable growth in Nigeria. *International Journal of Innovative Finance and Economics Research, 13*(4), 273–294.

Ndalu, T. C., & Okene, A. J. (2024). Impact of port infrastructure and logistics efficiency on economic growth in Nigeria: The Nigerian Port Authority experience, 2006–2022. *Journal of Interdisciplinary Research in Accounting and Finance, 11*(1), 40–55. https://doi.org/10.5281/zenodo.10814712

Obokoh, L. O., & Goldman, G. (2016). Infrastructure deficiency and the performance of small- and medium-sized enterprises in Nigeria's liberalized economy. *Acta Commercii, 16*(1), 1–10.

Okoye, L. U., Odigbo, B. E., & Ezeh, P. C. (2021). Urbanization, infrastructure and economic development in Nigeria. *International Journal of Economics and Business Research, 22*(4), 351–367.

Olaseni, M., & Alade, W. (2012). Vision 20:2020 and the challenges of infrastructural development in Nigeria. *Journal of Sustainable Development, 5*(2), 63–74.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics, 16*(3), 289–326. https://doi.org/10.1002/jae.616

Romer, P. M. (1986). Increasing returns and long-run growth. *Journal of Political Economy, 94*(5), 1002–1037. https://doi.org/10.1086/261420

UN-Habitat. (2020). *World cities report 2020: The value of sustainable urbanization*. United Nations Human Settlements Programme.

United Nations. (2018). *World urbanization prospects: The 2018 revision*. Department of Economic and Social Affairs.

Utuk, I. O., Ekaetor, E. A., & Bassey, E. E. (2024). Transport infrastructure, institutional quality and agricultural sector performance in Nigeria. *AKSU Journal of Administration and Corporate Governance, 4*(1), 137–150.

World Bank. (2019). *Nigeria infrastructure development report*. World Bank.