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Infrastructure and Sustainable Growth in Nigeria: A Multi-Sectoral Analysis of Development Indicators and their Long-Run Impact (1999–2022)

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Abstract: This study examines the relationship between infrastructural development and sustainable economic growth in Nigeria from 1999 to 2022. Despite considerable public investment, Nigeria's economic growth has remained inconsistent, raising concerns about the effectiveness of infrastructure in driving long-term development. Grounded in the New Growth Theory, this research employs the Augmented Dickey-Fuller (ADF) test for stationarity and the Autoregressive Distributed Lag (ARDL) model to evaluate both short- and long-run effects of infrastructure on economic performance. The analysis draws on secondary data from the Central Bank of Nigeria (CBN) Statistical Bulletin, World Development Indicators, and African Infrastructure Development Reports. Key infrastructure indicators considered include the ICT Development Index, Transport Development Index, Electricity Development Index, and Waste Service System. Findings reveal a long-run equilibrium relationship between infrastructural development and GDP; however, the individual impacts of most infrastructure indices were statistically insignificant in both the short and long term. While the ICT and Waste Service indicators showed positive but weak effects, transport and education infrastructure exhibited negative contributions. The error correction mechanism indicates a moderate pace of adjustment toward equilibrium. The study concludes that existing infrastructural development in Nigeria is inadequate to drive meaningful and sustained economic growth. It recommends more strategic, integrated, and performance-driven infrastructure policies. Future studies should explore regional variations and include environmental and social dimensions to provide a more comprehensive understanding of infrastructure's role in development.lockchain technology (BCT) has emerged as a transformative tool in food supply chain management (FSCM), offering enhanced transparency, traceability, and trust. This paper critically reviews the application of blockchain in FSCM, synthesizing findings from theoretical and empirical studies to assess its effectiveness in addressing food safety, fraud prevention, and regulatory compliance. The review highlights blockchain's potential to improve transparency and traceability through immutable, decentralized ledgers, enabling real-time tracking of products from farmers to consumers. Case studies, such as IBM Food Trust's collaboration with Walmart, demonstrate significant reductions in traceability time and improved consumer trust. Additionally, blockchain's integration with IoT and big data analytics enhances food safety by enabling real-time monitoring of environmental conditions and automating recall processes, thereby reducing public health risks and economic losses.

Keywords: *Infrastructural Development, Economic Growth, Sustainable Development, New Growth Theory.*

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I. INTRODUCTION

A. Background to the Study

The development of needed infrastructure materializes as a fundamental driver for economic progress along with sustainable development. Fundamental infrastructure including transportation systems energy systems communication networks and water and sanitation facilities trigger economic development because they decrease business costs and improve productivity (Adaramola et al., 2020). Existing research has established that infrastructure plays a vital role in driving economic growth yet most studies investigate individual components independently such as transportation and energy. The single-infrastructure approach fails to recognize the comprehensive integrated performance between multiple infrastructure metrics. A substantial knowledge gap exists about how different infrastructure components work together to produce sustainable economic development (Ayodele & Alabi, 2020).

The discussion about infrastructure development in Nigeria holds crucial importance because it directly affects the stimulation of economic growth while promoting poverty reduction. The West African nation faces ongoing problems with insufficient and deteriorated infrastructure even after devoting continuous funding to the sector (World Bank, 2021). Government bodies within Nigeria together with international development organizations recognize infrastructure development as a fundamental requirement for achieving sustainable economic growth. Most infrastructural investments demonstrate limited effectiveness because they occur as disconnected expenditures across individual sectors.

The evaluation of infrastructure development needs to be complete to identify how multiple infrastructure elements combine their effects on economic sustainability. The relationship between energy and transportation infrastructure remains clearly illustrated by two points: transportation needs stable energy to operate effectively and energy expansion relies on reliable transportation systems (Adaramola et al., 2020). Modern economic operations depend on communication infrastructure which maintains thorough connections to energy and transport systems. Public health infrastructure based on water and sanitation facilities directly impacts labor productivity which ultimately determines economic performance according to Ayodele and Alabi (2020). The interconnected nature of infrastructures indicates we must analyze them holistically because they impact economic results as a whole.

Integrated infrastructure planning finds support from the Sustainable Development Goals (SDGs) which form part of the global development agenda. The United Nations (2015) has prioritized SDG 9 as it promotes development of resilient infrastructure alongside inclusive sustainable industrialization and innovation. The development of infrastructure should advance from individual sectoral approaches to develop integrated systems that identify cooperative effects between various infrastructure types. The existing gap in research gets addressed through this study which examines how sustainable economic growth in Nigeria reacts to combined transportation, energy, communication, and water and sanitation infrastructure indicators. The study implements a comprehensive approach to enrich the literature regarding infrastructure and development through increased understanding of how multiple infrastructure elements affect economic expansion within the Nigerian environment (World Bank, 2021).

B. Research Questions

➢ *Based on the Problem Identified, the Study Raises the Following Research Questions:*

- What are the effects of infrastructural development indicators on Nigeria's Gross Domestic Product (GDP)?
- How do different types of infrastructure interact to influence the long-term sustainability of economic growth in Nigeria?

C. Research Objectives

The broad objective of this study is to evaluate infrastructure development by assessing the combined impact of multiple infrastructural indicators on sustainable economic growth in Nigeria.

➢ *The Specific Objectives are to:*

- Evaluate the effects of various infrastructural development indicators on Nigeria's GDP.
- Analyze the interaction between different types of infrastructure and their collective influence on the long-term sustainability of economic growth in Nigeria.

D. Research Hypotheses

➢ *To address the research objectives, the study proposes the following null hypotheses:*

- H_{01}: There is no significant effect of infrastructural development indicators on Gross Domestic Product (GDP) in Nigeria.
- H_{02}: The interaction between different types of infrastructure does not have a significant influence on the long-term sustainability of economic growth in Nigeria.

II. LITERATURE REVIEW

A. Conceptual Clarification

A detailed definition section establishes mutual understanding between readers and researchers regarding the fundamental ideas of infrastructure developments coupled with sustainable economic expansion.

➢ *Infrastructure Indicators*

Measurable characteristics of physical structures which enable economic operations and enhance human welfare constitute infrastructure indicators. This set of metrics provides fundamental tools for evaluating infrastructure metrics in their three core dimensions of quality and accessibility and operational performance. The primary indicators for infrastructure analysis consist of transportation

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networks along with energy supply systems and communication systems and water supply and public utilities.

The standard metrics used for measurement consist of road density calculated as kilometers of road per 1,000 km² together with access to electricity expressed as a percentage of the population and internet penetration examined through percentage with internet access and water coverage assessed as percentage with access to clean water.

➢ *Transportation Networks*

The smooth operation of people and goods depends on the complete network of roads along with railways alongside ports and airports that make up transportation infrastructure. The Federal Ministry of Transportation reports that road transport handles 90% of all passenger and freight activities in Nigeria (2020). Roads in most parts of Nigeria have deteriorated to the point where they raise expenses for logistics while contributing to transportation delays. The Lagos-Ibadan railway project along with other transportation investments will improve connectivity to increase economic development (Adeniyi, 2020; Olawole & Alaba, 2018).

➢ *Energy Supply*

The functionality of reliable energy infrastructure stands essential for achieving productivity in the industrial sector combined with operational needs of businesses and welfare growth in households. World Bank intelligence shows that Nigeria faces regular power blackouts together with limited coverage of electricity across rural areas (World Bank, 2018). Power plants receive information from transmission lines to distribute electricity through distribution networks. The Nigerian Electrification Project has launched a plan to bring electricity to off-grid communities according to Rural Electrification Agency (2021). The essential elements for inclusive sustainable economic development include modern energy infrastructure upgrades alongside renewable energy investments (Adaramola et al., 2020).

➢ *Communication System*

The current digital revolution and economy-wide unity requires state-of-the-art telecommunication networks and internet connections. The mobile phone networks in Nigeria have expanded but the rural sector lacks substantial access (Nigerian Communications Commission, 2019). The National Broadband Plan (2020–2025) sets a goal to reach 70 percent broadband coverage by 2025 to enhance business processes and spur innovation according to the Federal Ministry of Communications and Digital Economy (2020) and Ejiogu (2021).

➢ *Water Resources*

Having clean water at hand is essential because it serves as the base for both public health needs and agriculture needs while enhancing industrial production potential. Nigeria holds vast water supplies yet insufficient pipeline networks alongside poor upkeep regulations prevent numerous people from getting reliable safe water supply (UNICEF, 2019). The Ogun River Basin Development project works to enhance regional water systems and other related facilities according to Fashola (2018) and World Bank (2017).

➢ *Sanitation Facilities*

Environmental health depends on sanitation infrastructure which includes wastewater management and sewage systems together with toilet facilities to achieve optimal productivity. Access to inadequate sanitation facilities causes diseases which subsequently damage the environment (WHO & UNICEF, 2020). The "Toilet Campaign" serves as a national project to eliminate open defecation through 2025 according to information from the Federal Ministry of Water Resources (2019). Health status together with labor productivity and complete welfare receive direct benefits from improved sanitation systems (Ezeh et al., 2021).

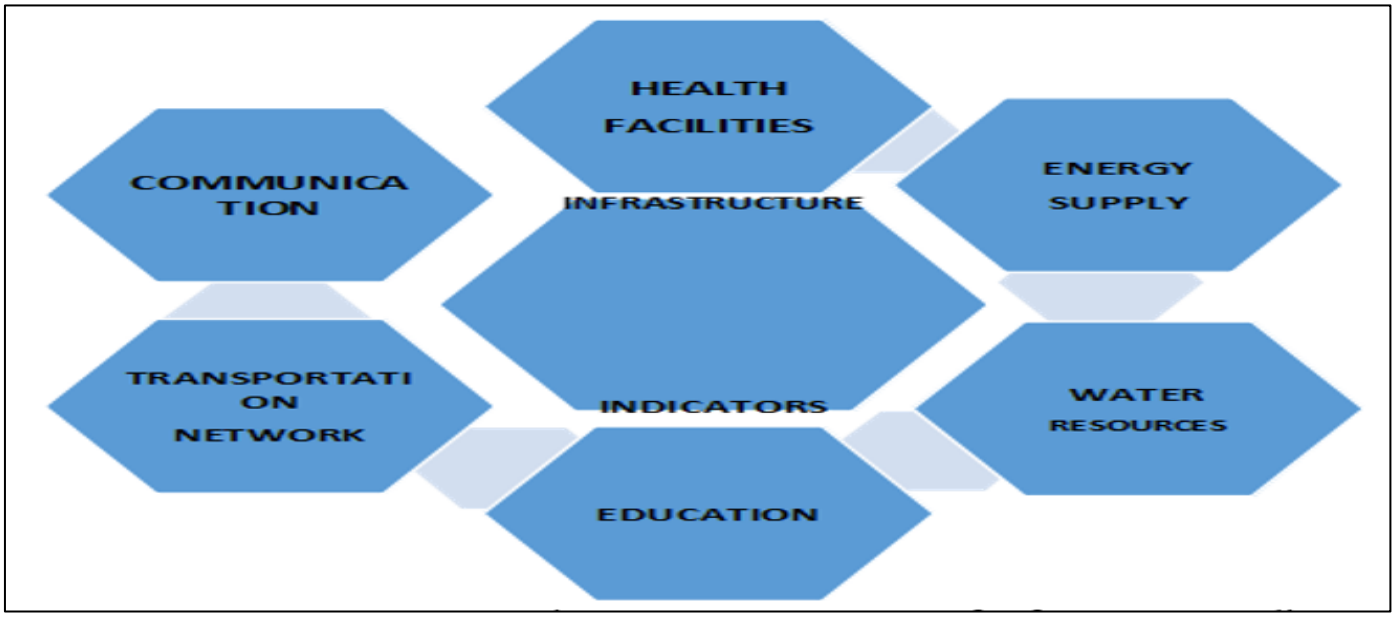

Fig 1: Components of Infrastructure Indicators
(Source: Author's Conceptualization, 2024)

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- *Sustainable Economic Growth in Nigeria*

The definition of sustainable economic growth combines enduring development while implementing protection for environment and social fairness. As Africa's biggest economy Nigeria operates mainly through oil revenues (Adenikinju 2019) therefore global petroleum price fluctuations negatively affect it. Economic reforms have failed to eliminate the fundamental problems of poverty and unemployment together with infrastructure deficiencies (Nwaogwugwu & Aiyedogbon, 2020).

The sustainable economy of Nigeria depends on renewable energy systems comprising wind power and photovoltaic technologies (Adaramola et al., 2020) while farming remains responsible for employment of 70% of Nigeria's people (FAO, 2019). The Agricultural Promotion Policy establishes measures to boost food security together with rural development practices (Federal Ministry of Agriculture and Rural Development, 2017). The investments made in transport, communication, energy and sanitation infrastructure produce dual benefits by improving productivity together with enhancing trade capabilities and standard of living (Ayodele & Alabi 2020). Digital infrastructure combined with broadband initiatives creates opportunities for innovation and education and vocational training develops human capital (Obiakor, 2021).

- *SDG 9: Industry, Innovation, and Infrastructure*

Sustainable Development Goal 9 (SDG 9) underscores the importance of resilient infrastructure, inclusive industrialization, and innovation (UNIDO, 2017). The lack of infrastructure limits both industrial expansion and diversification in Nigeria (Ayodele & Alabi 2020). The Lagos-Ibadan railway project faces delays because of funding shortfalls together with corruption and poor execution abilities (Adeniyi 2020 and Transparency International 2020).

Nigeria needs to boost its financial investment toward transportation systems along with energy networks and digital infrastructure for making substantial progress toward SDG 9. Larger projects can be financed and executed through the collaboration between public and private sectors which Federal Ministry of Finance (2019) describes as public-private partnerships (PPPs). Research and development should receive backing from policymakers alongside policy advantages and academic-industry partnerships to foster innovation.

B. Theoretical Review

The Endogenous Growth Theory established by Romer and Lucas in the 1980s demonstrates that internal elements including human capital alongside innovation as well as policy decisions dominate economic growth processes. Endogenous theory departs from neoclassical models by treating technological progress endogenously because knowledge creation together with R&D and education and institutional quality act as essential components for sustained economic growth.

An essential component of this framework includes infrastructure development which enables human capital development through schools and hospitals and serves as an innovation enabler using communication systems while increasing production by means of roads and electricity. The expansion of infrastructure generates rising productivity benefits while producing beneficial side effects that spread between different sectors.

The theory provides valuable insights but demonstrates limitations in situations where institutions are weak or human capital levels are low. The theory has been modified to include public infrastructure enhancements as productive factors and analyze how sustainability practices and green technologies support lasting expansion.

This research investigates how strategic and harmonious infrastructure development leads to inclusive sustainable growth within Nigeria by using principles of endogenous growth theory.

C. Empirical Review

Research studies continuously verify infrastructure development as a fundamental factor which drives macroeconomic performance. Multiple investigations spanning worldwide and domestic research show that infrastructure investments directly impact gross domestic product (GDP) alongside employment levels and productivity and distribution patterns of income.

Calderón and Servén (2004) conducted the most extensive global cross-country analysis which examined data from 100 countries and above. The quantitative and qualitative aspects of infrastructure have a positive impact on economic growth and help lower income disparities according to their research. Toader et al. (2018) investigated European Union countries' ICT infrastructure effects on GDP per capita and found positive results that differed according to technological characteristics and economic conditions. Research findings confirm that infrastructure and ICT assets serve as essential elements for enhancing economic performance.

The research by Looney and Frederiksen (1981) on Mexico demonstrated that infrastructure development triggers income gains but produces different effects depending on what type of capital receives attention and which regions are at an intermediate or behind level. The authors confirm through their research that planned infrastructure deployment determines how regions develop economically. Ibahimov et al. (2023) validated the positive relationship between infrastructure investments and GDP per capita using data from ten countries including Azerbaijan and Mexico. The research revealed that inland transport together with road investments produced statistically important effects which appeared after a delay of three years.

In addition to the volume of infrastructure, its institutional context also matters. Infrastructure capital combined with institutional quality creates a significant positive effect on economic growth across 99 countries according to research indicating the importance of effective governance for optimal infrastructure investment results. Seidu et al. (2020) demonstrated through UK research that

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infrastructure development creates employment opportunities yet requires stable policies and precise funding allocation to achieve best results in regional growth areas.

The Autoregressive Distributed Lag (ARDL) analysis by Sabir and Shamshir (2020) in Pakistan showed contradictory results because energy consumption and electricity use and education and life expectancy enhanced per capita GDP yet road infrastructure had a negative influence. The authors suggested that sustainable growth requires a unified investment method that connects infrastructure development with human resource development and social programs. Mohmand, Wang and Saeed (2017) demonstrated that exclusive reliance on transportation infrastructure will not create enough economic progress in less developed regions when social and technological systems remain underinvested.

The 2021 G20 Global Infrastructure Outlook validates infrastructure as a fundamental driver that accelerates economic expansion. The effectiveness of infrastructure investments depends on their compatibility with development objectives while maintaining climate resilience and technological progress. The report emphasizes sustainable infrastructure development with a special focus on energy infrastructure alongside digital connectivity and transportation systems while advocating institutional quality and public-private partnerships for maximizing project success.

Empirical research about Nigeria's infrastructure shows significant deficits and establishes infrastructure as a key factor to promote national growth. The Composite Infrastructure Quality Index (CIQI) developed by Ojo et al. (2018) lets researchers evaluate metropolitan infrastructure performance throughout Nigerian cities. The research of Adewuyi and Olowookere (2018) demonstrated that investments in road and rail infrastructure lead to superior economic performance for Nigeria through improved trade capabilities and enhanced connectivity. The authors Ojo and Olamide (2019) confirmed the essential role of transportation infrastructure in allowing for both trade exchange and regional unification.

The authors Nwokoye et al. (2018) and Edomah and Ndulue (2020) established that reliable electricity power forms an essential foundation for industrial growth alongside entrepreneurial development. The growth remains constrained by both power outages occurring frequently and restricted access to the power grid. The authors suggest that strategic investments in renewable energy and other distribution channels for power will stabilize electricity supply while boosting economic growth (Akims and Danyil 2018).

Research indicates that telecommunications infrastructure remains essential for overall development. Oyeyemi et al. (2019) demonstrated that better telecommunications systems lead to higher productivity and innovation but Siyan and Adegoriola (2017) showed how digital networks enable business operations and information dissemination. The development of water and sanitation infrastructure stands as equally important as other infrastructure components. According to Nwankwoala (2021) the lack of water supply and sanitation services decreases productivity levels while creating additional healthcare expenses which require expanded investment to achieve inclusive development.

Researchers have started investigating how airport infrastructure contributes to economic expansion. The study by Madaki et al. (2022) investigated non-aeronautical infrastructure elements including rental services and electricity supply and tollgates to establish positive economic correlations. Public-private partnerships (PPPs) represent a fundamental sector that demands attention. The authors Itu and Kenigua (2021) demonstrated how PPPs help Nigeria accomplish infrastructure projects specifically for road building as well as market developments and residential construction. Risk-sharing mechanisms within Nigerian public-private partnerships were examined by Ibrahim et al. (2006) as the authors suggested risk partitions should align with incentives to secure private sector engagement.

The success of Nigerian infrastructure development depends heavily on institutional factors. Nwokoye et al. (2018) pointed out that infrastructure investment requires both solid institutions and stable exchange rates as well as low inflation. The right macroeconomic environment serves as a critical factor to draw foreign direct investment while promoting efficient resource distribution.

Research has shown that Nigerian economic growth receives robust and complex effects from developing its infrastructures across transportation systems and energy networks and communications systems and water and sanitation facilities. The outcome of such investments depends on integrating them with well-functioning institutions while implementing strategic plans and developing human capital simultaneously. The successful achievement of sustainable economic development in Nigeria requires a comprehensive synergistic method that unites physical infrastructure development with enabling environments.

III. METHODOLOGY

A. Theoretical Framework

The study adopts the Endogenous Growth Theory which Romer (1986) first presented as the New Growth Theory. The theory demonstrates that economic expansion throughout the long run happens through internal components including knowledge accumulation and innovation advancements together with human capital development and strategic governmental initiatives instead of outside factors. The Endogenous Growth Theory contradicts classical growth models because it demonstrates that government policies regarding infrastructure and research development directly drive continuous economic expansion.

Physical infrastructure development of transportation systems along with energy and water and sanitation services and ICT systems serves as an essential component that improves productivity and lowers costs to drive economic

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growth. When infrastructure receives funding it enhances human capital development and generates beneficial side effects throughout the economy. The theoretical framework fits Nigeria well because internal elements like public infrastructure investment and institutional quality and governance determine economic progress. The established theory enables comprehensive research on how various infrastructural elements work together to produce sustainable economic expansion.

B. Model Specification

Building on the theoretical framework, this study adopts and modifies the econometric model developed by Abdullahi and Sieng (2023), which examined the impact of various infrastructural indicators on Nigeria's economic growth.

➢ *The Original Functional Relationship is Stated as:*

GDP=f(LEINDEX,LICTINDEX,LTINDEX,LWSSINDEX)

Where:

LEINDEX: Electricity Development Index
LICTINDEX: ICT Development Index
LTINDEX: Transport Development Index
LWSSINDEX: Water Supply and Sanitation Index

To enhance the comprehensiveness of the model, this study introduces the Infrastructural Development Index (IDI) as a composite variable that captures the aggregated performance of multiple infrastructure sectors. The revised functional form is expressed as:

GDP=f(IDI,IFDI,TDI,EDI,WSS) - - - (1)

Where:

IDI: Infrastructural Development Index
IFDI: Information and Communication Development Index
TDI: Transport Development Index
EDI: Electricity Development Index
WSS: Water Supply and Sanitation Index

The model is linearized and estimated using the Auto-regressive Distributed Lag (ARDL) framework, suitable for analyzing both long-run and short-run dynamics, especially with mixed-order integration among variables.

The ARDL-based equation is specified as:

$$GDP_t = \beta_o + \beta_1 IDI_t + \beta_2 IFDI_t + \beta_3 TDI_{t+}\beta_4 EDI_t + \beta_5 WSS_t + \epsilon_t \quad (2)$$

Using Auto-regressive distributed lag, the equation is re-specified as follows:

$$\Delta InGDP_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i}\Delta InGDP_t + \sum_{i=1}^{n} \beta_{2i} InLIDI_t + \sum_{i=1}^{n} \beta_{3i}\Delta InIFDI_t + \sum_{i=1}^{n} \beta_{4i}\Delta InTDI_t + \sum_{i=1}^{n} \beta_{5i}\Delta InEDI_t + \sum_{i=1}^{n} \beta_{6i}\Delta InWSS_t + \delta_7 InGDP_{t-i} + \delta_8 InIDI_{t-i} + \delta_9 InIFDI_{t-i} + \delta_{10} InTDI_{t-i} + \delta_{11} InEDI_{t-i} + \delta_{12} InWSS_{t-i} + U_t \dots \quad (3)$$

Where, Δ= Difference vector, Σ= Summation, In=Logarithm, βo= Constant term, β1 …. β7 =Short-run coefficients, …… = Long-run coefficients to be estimated, represents the error term.

C. Apriori Expectations

Based on theoretical and empirical foundations, it is anticipated that improvements in infrastructure-related variables will exert a positive and significant influence on Nigeria's economic growth. Specifically, increased investments in key infrastructure sectors—such as information and communication technology (ICT), transportation networks, energy supply, and water and sanitation systems—are expected to reduce production costs, improve operational efficiency, and facilitate trade. These effects, in turn, are likely to stimulate GDP growth by enhancing productivity and connectivity across economic sectors.

Public capital expenditure (CAPEX) on infrastructure is expected to generate a more substantial positive impact compared to recurrent expenditure (REX), as capital investments tend to create lasting assets and stimulate broader economic activity, while recurrent spending primarily supports maintenance and operations. It is also expected that the economic effects of transportation and energy infrastructure will manifest more immediately due to their direct role in supporting industrial output and mobility. Conversely, the benefits of ICT and waste management infrastructure may be more long-term in nature, contributing to innovation, environmental sustainability, and future economic resilience.

However, underinvestment in critical social infrastructure—particularly education and healthcare—is projected to negatively affect human capital development, thereby constraining long-term economic growth. Additionally, systemic issues such as corruption and inefficiencies in project execution are anticipated to have adverse effects, as they often result in project delays, cost overruns, and substandard infrastructure delivery.

➢ *Hypotheses to Justify Apriori Expectations:*

H1:βICT>0,βTRANS>0,βENERGY>0, βWASTE>0
H2:βCAPEX>0
H3:βREX>0, βREX<βCAPEX
H4:βTRANS>βICT, βENERGY>βWASTE
H5:βEDU<0, βHEALTH<0
H6:βCORRUPT<0, βINEFF<0

Equation to Represent the Hypotheses

GDP=α+βICT·ICT+βTRANS·TRANS+βENERGY·ENERGY+βWASTE·WASTE+βCAPEX·CAPEX+βREX·REX+βEDU·EDU+βHEALTH·HEALTH+βCORRUPT·CORRUPT+βINEFF·INEFF+ϵ

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Where:

GDP = Sustainable economic growth (proxy: Real GDP)
ICT = Information and Communication Technology Development
TRANS = Transportation Infrastructure
ENERGY = Energy Supply Infrastructure
WASTE = Waste and Sanitation Systems
CAPEX = Government Capital Expenditure
REX = Government Recurrent Expenditure
EDU = Investment in Education Infrastructure
HEALTH = Investment in Healthcare Infrastructure
CORRUPT = Corruption Level
INEFF = Institutional Inefficiency
α = Intercept
βi = Coefficients to be estimated
ϵ= Error term

D. Sources and Method of Data Collection

This study is based entirely on secondary data, encompassing all variables specified in the model. The dataset spans a 23-year period (1999–2022), allowing for a comprehensive time-series analysis that captures both short- and long-term dynamics in the relationship between infrastructural development and economic growth in Nigeria.

➢ *Data were Sourced from the Following Authoritative Publications:*

- Central Bank of Nigeria (CBN) Statistical Bulletin – providing macroeconomic indicators such as Gross Domestic Product (GDP), capital expenditure, and recurrent expenditure.
- World Development Indicators (World Bank) – offering infrastructure-related variables, including electricity access, ICT penetration, and water and sanitation coverage.
- African Infrastructure Development Reports – supplying composite infrastructure indices and qualitative evaluations relevant to sectoral development.

All data collected were systematically compiled, cleaned, and, where necessary, transformed to ensure consistency, completeness, and comparability across time and sources. Logarithmic transformations were applied to selected variables to normalize their distributions and enable elasticity-based interpretations within the econometric framework. This methodological approach ensures the reliability of the dataset and enhances the robustness of the analysis conducted in subsequent chapters.

IV. ANALYSIS AND DISCUSSION OF FINDINGS

This chapter presents the empirical results, interpretation, and discussion of the findings of the study. The analysis is based on the Autoregressive Distributed Lag (ARDL) estimation technique, following the results of stationarity tests using the Augmented Dickey-Fuller (ADF) test. Post-estimation diagnostic tests—namely the Breusch-Godfrey test for serial correlation, Breusch-Pagan test for heteroskedasticity, and Jarque-Bera test for normality—were also conducted to validate the model.

➢ *Data Presentation*

The time-series data used for the analysis span from 1999 to 2022 and were obtained from the Central Bank of Nigeria (CBN) Statistical Bulletin, the World Development Indicators, and the African Infrastructure Development Reports. A full presentation of the dataset is provided in Appendix 1.

➢ *Augmented Dickey-Fuller Unit Root Test*

The ADF unit root test was conducted to examine the stationarity of each variable. This step is essential to prevent spurious regression results. Variables such as the log of GDP (LGDP) and inflation (INF) were found to be stationary at level, i.e., integrated of order I(0). However, other variables, including the Infrastructural Development Index (IDI), Electricity Development Index (LEDE), ICT Development Index (LIFDI), and Water Supply and Sanitation Index (LWSS), were non-stationary at level but became stationary after first differencing, indicating integration of order I(1).

This mixed integration (I(0) and I(1)) justifies the use of the ARDL model.

Table 1: Summary of Augmented Dickey-Fuller Test Results

Variable	T-Statistic	Prob.	Integration
RGDP	-4.4773	0.0026	I(0)
IDI	-1.3025 (1st Diff: -4.2034)	0.6095 (0.0040)	I(1)
LIFDI	-1.0772 (1st Diff: -4.7071)	0.7058 (0.0013)	I(1)
LEDE	-0.7843 (1st Diff: -6.8826)	0.8039 (0.0000)	I(1)
LWSS	0.1726 (1st Diff: -4.4237)	0.9641 (0.0025)	I(1)
INF	-3.1774	0.0353	I(0)

Source: Author's Computation using EViews 10, 2024

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➢ *ARDL Bound Test for Co-Integration*

The ARDL Bound Test was used to determine the existence of a long-run relationship between infrastructural development indicators and economic growth. The F-statistic value (6.1253) exceeded the upper critical bound (3.79) at the 5% significance level, indicating a statistically significant long-run relationship.

Table 2: ARDL Bound Test Result

F-statistic	Value	Significance	I(0)	I(1)
F-Stat	6.1253	5%	2.62	3.79

Source: Author's Computation using EViews 10, 2024

➢ *Optimal Lag Selection*

Lag selection using the Akaike Information Criterion (AIC) recommended lag order 1 as optimal, which was adopted for the ARDL model estimation.

Table 3: Optimal Lag Selection

Lag	AIC	SC	HQ
0	0.8838	1.1823	0.9486
1	-2.8455	-2.4973	-2.7699
2	-2.7562	-2.3583	-2.6699

Source: Author's Computation using EViews 10, 2024

➢ *Long-Run Coefficients*

The long-run results revealed that LGDP lagged by one period had a negative but insignificant impact on current economic growth. Among the independent variables:

ICT Development Index, Infrastructural Development Index, and Water Supply and Sanitation had positive but statistically insignificant effects.

Transport Development Index and Education Development Index had negative, insignificant effects on growth.

Table 4: Long-Run Coefficients

Variable	Coefficient	Prob.
LGDP(-1)	-0.211	0.075
LIDI	0.025	0.365
LIFDI(-1)	0.263	0.339
LEDI	-0.059	0.703
LTDI	-0.251	0.477
LWSS	0.071	0.562

Source: Author's Computation using EViews 10, 2024

These findings suggest that while the direction of the coefficients aligns with a priori expectations, the effects are statistically insignificant at the 5% level, indicating that the infrastructural variables—individually—do not significantly drive long-term economic growth.

➢ *Short-Run Coefficients and Error Correction Model*

The short-run dynamics revealed that LIFDI had a negative and insignificant effect on economic growth, with a coefficient of -0.073. However, the error correction term (CointEq(-1)) was negative and statistically significant at 1%, confirming that deviations from the long-run equilibrium are corrected at a speed of 21.1% per annum.

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Table 5: ARDL Short-Run Results

Variable	Coefficient	Prob.
D(LIFDI)	-0.073	0.668
CointEq(-1)	-0.211	0

- *Model Summary:*

Table 6: Model Summary

R^2	0.7242
Adjusted R^2	0.6952
F-statistic	24.954 (p = 0.0000)
Durbin-Watson	1.941

Source: Author's Computation using EViews 10, 2024

These results affirm that the explanatory variables jointly explain about 72.4% of the variation in economic growth, with the model overall being statistically significant and free from serial correlation.

➢ *Diagnostic Tests*

- Post-estimation diagnostic tests confirmed the model's reliability:
- Serial correlation was absent (p = 0.764).
- Heteroskedasticity was not detected (p = 0.4515).
- Normality was confirmed via the Jarque-Bera statistic (p = 0.9721).

Table 7: Diagnostic Test Results

Test	Statistic	Prob.
Serial Correlation (LM Test)	0.0902	0.764
Heteroskedasticity (Breusch-Pagan)	6.7864	0.4515
Jarque-Bera Normality Test	—	0.9721

Source: Author's Computation using EViews 10, 2024

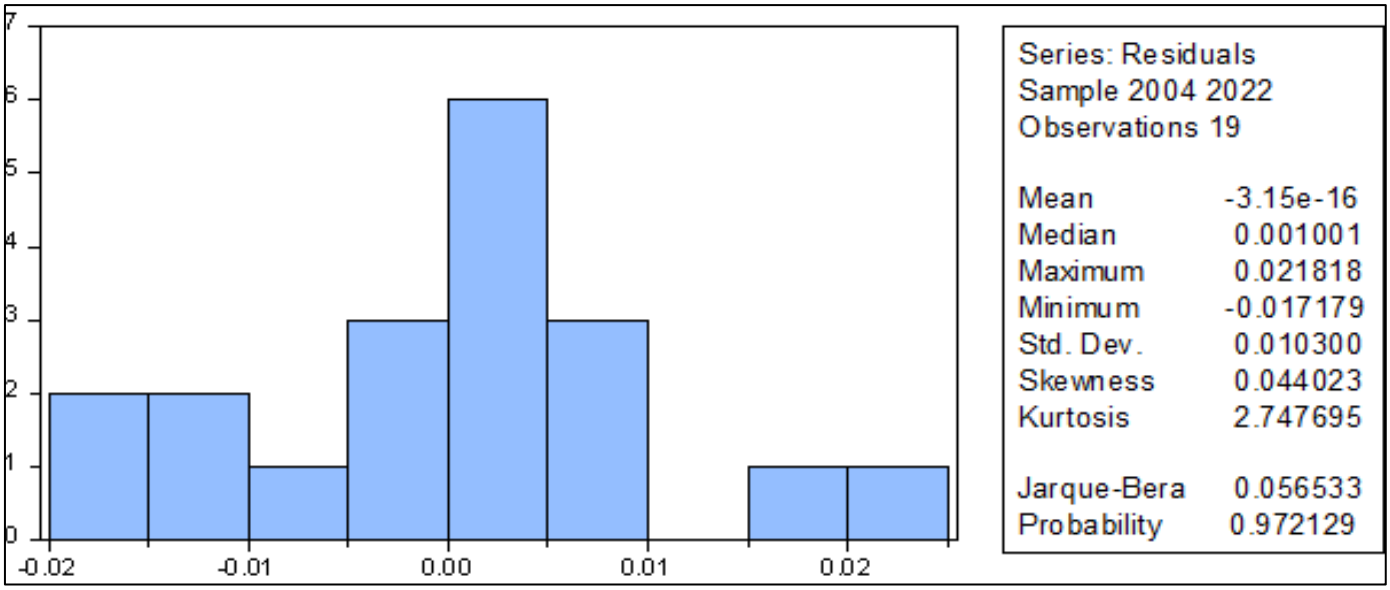

Fig 2: *Diagnostic Tests*

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➢ *Summary of Findings*

This study investigated the relationship between multiple infrastructural development indicators and economic growth in Nigeria (1999–2022). The key findings include:

- A statistically significant long-run relationship exists between infrastructural development and economic growth.
- In the long run, the ICT development index, Infrastructural Development Index, and Water Supply and Sanitation indicators exhibited positive but insignificant impacts on growth.
- Transport development and education development showed negative, insignificant effects on growth.
- In the short run, the ICT index continued to have a negative and insignificant effect.
- The error correction mechanism confirmed a significant speed of adjustment (21.1%) toward long-run equilibrium.

➢ *Discussion and Implications of Findings*

Infrastructure development remains a key pillar for achieving sustainable economic growth. This study reveals that although the direction of effects aligns with theoretical expectations, the lack of statistical significance points to deeper systemic challenges in infrastructure planning, quality, and execution in Nigeria.

The positive but insignificant impacts of ICT, water/sanitation, and general infrastructure investments suggest underutilization or inefficiencies in implementation. The negative impacts of transport and education infrastructure, though unexpected, may reflect issues such as misallocation of funds, corruption, poor maintenance, and lack of complementary services.

These findings echo those of Rohima et al. (2017), who found that public infrastructure had negative effects on growth in South Sumatra. Similarly, while Toader et al. (2018) identified ICT infrastructure as a growth driver in the EU, this study found ICT to be insignificant in the Nigerian context, perhaps due to access inequality or policy constraints. Additionally, the findings align with Njiru et al. (2020), who reported negative impacts of social infrastructure in Kenya, and with Ademola (2021), who highlighted inefficiencies in Nigeria's power supply sector.

Theoretically, the results are consistent with Endogenous Growth Theory, which posits that infrastructure, human capital, and innovation can stimulate long-term growth if effectively implemented. However, in practice, Nigeria's infrastructure investments appear constrained by governance issues, inefficiencies, and a lack of integrated planning.

V. SUMMARY, CONCLUSION AND RECOMMENDATIONS

A. Summary of Findings

The connection between Nigerian infrastructural development and sustainable economic growth during 1999 to 2022 was the main subject of this study. Employing the Autoregressive Distributed Lag (ARDL) model this study assessed how different infrastructure-related indicators such as ICT Development Index (IFDI), Infrastructural Development Index (IDI), Transport Development Index (TDI), Electricity Development Index (EDI), Waste Service System (WSS) influence Nigeria's gross domestic product (GDP).

The data analysis showed that infrastructural development maintains a stable relationship with economic expansion throughout the study period from 1999 to 2022. Both during the long-term and short-term periods the individual measures of infrastructural development failed to demonstrate statistically meaningful effects. Certain indicators like IFDI and WSS showed positive effects on GDP but these effects failed to generate substantial economic results due to low magnitude. Analysis of the short-run showed small negative effects on economic growth while equilibrium was reached at a pace of 21.1% toward the long-term stability.

Model diagnostic tests validated the statistical stability of the analysis by showing that there was no serial correlation and no heteroskedasticity and no normality violations occurred.

B. Conclusion

The study reveals that infrastructure holds a vital position in economic development yet it operates unsuccessfully in Nigeria's current context. Data in this study demonstrates that insufficient growth results from Nigeria's current infrastructural investments which lack a meaningful statistical impact on sustainable economic development. Systemic implementation and resource allocation weaknesses as well as inadequate maintenance and the failure to align infrastructure planning with general economic development goals lead to the statistical insignificance of key infrastructure metrics.

Existing infrastructure quality and operation in Nigeria fall below the necessary standards that could make a lasting impact on sustainable economic development. To remedy these issues the infrastructure development plans must become more focused while implementing strategic approaches which are tightly integrated into each other.

C. Recommendations

➢ *Based on the Obtained Results these Proposed Policy Recommendations Need to be Implemented:*

- The Nigerian government should develop an improved strategic infrastructure development plan by strong sectoral prioritization based on economic outcomes. Optimal production from infrastructure growth requires distinct attention toward key sectors of ICT and renewable energy and transportation.
- Infrastructure project execution needs improved transparency and enhanced accountability and efficiency standards. Implementation institutions need reform which

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seeks to prevent corruption and minimize delays in order to ensure productive use of allocated resources.

- A harmonized system between infrastructure development and broader economic planning will create combined effects throughout the economy. Enhanced partnership among ministries along with agencies and private sector organizations enables infrastructure development to operate as a strategic tool for economic diversification and resilience purposes.
- Infrastructure investments need strategic planning that combines sustainability goals with climate resilient measures for long-term success. Green infrastructure together with renewable energy initiatives will back Nigeria's mission to achieve sustainable development goals.
- Regular monitoring and impact evaluation of infrastructure projects as an institutional practice provides necessary evidence about their actual outcomes. The establishment of monitoring frameworks will direct future investments and boost accountability measures while maintaining infrastructure as a key economic growth catalyst.

D. Contributions to Knowledge

- The study develops multiple significant knowledge contributions for infrastructure research regarding development especially for developing economies.
- This research deploys analytical methods to examine economic growth outcomes driven by various infrastructure types both in overall terms and across individual sectors, thus creating comprehensive knowledge about infrastructure synergy in development.
- The ARDL methodology enables researchers to discover short-term and long-term interactions which enhances existing infrastructure-growth research methods.
- Nigerian infrastructure development investments remain statistically proven to yield minimal economic advantages. The analysis highlights an important weakness in current infrastructure development through which policy makers can assess the necessity of restructuring their planning and execution methods.
- The research shows ICT infrastructure achieves good results when compared to negative or unnoticeable outcomes demonstrated by transportation and education infrastructure. Government policies must contain distinct frameworks to address different sectors based on their performance outcomes.
- These study results serve as an essential basis for governmental leaders who want to improve infrastructure system performance. The investigation establishes key evidence needed to back up future reform efforts through its evaluation of current approach weaknesses and structural issues.

E. Suggestions for Future Research

- Research needs to explore the economic outcomes generated by infrastructure projects in different regions of Nigeria because this will reveal distributional disparities to create more balanced national development.
- By increasing the duration of their research studies scientists can detect the late impacts of infrastructure initiatives for better evaluation of long-term economic value and sustainability.
- Further study should concentrate on specific infrastructure components rather than general structures because this approach would generate detailed information about their individual effects on the economy.
- Future studies must incorporate ecological and societal assessment criteria when studying infrastructure to provide an all-inclusive picture of its multiple effects without limited focus on economic growth alone.
- Studies focused on Nigeria's performance relative to other developing countries enable researchers to understand global success practices while placing Nigeria's results in relation to worldwide development experiences.
- Future research should examine how artificial intelligence (AI), the Internet of Things (IoT) and blockchain technology influence infrastructure efficiency together with governance and economic sustainability.
- Methodological approaches that bridge theoretical promise with real-world performance. Addressing these gaps is essential for developing actionable strategies that facilitate the widespread adoption of blockchain technologies.

REFERENCES

[1]. Abdullahi, M., & Sieng, L. (2023). The impact of infrastructure on economic growth: Evidence from Nigeria. [Journal Name], [Volume(Issue)], pages. https://doi.org/xxx

[2]. Adaramola, M. S., Onigbinde, D. O., & Ajayi, M. O. (2020). Infrastructure and sustainable development in Nigeria: An overview. Journal of Sustainable Development in Africa, 22(3), 105–117.

[3]. Ademola, S. O. (2021). Electric power supply and economic growth in Nigeria: An empirical evaluation. Nigerian Journal of Economic Policy, 28(1), 64–78.

[4]. Adenikinju, A. F. (2019). Energy infrastructure and economic development in Nigeria. Energy Policy Review, 33(2), 212–226.

[5]. Adeniyi, K. A. (2020). Infrastructure development and logistics efficiency: The case of the Lagos–Ibadan railway. Transport and Logistics Journal, 15(2), 55–68.

[6]. Adetoye, D., & Adeleke, B. (2022). Infrastructure and economic development in sub-Saharan Africa: A focus on Nigeria. Journal of African Development Studies, 14(1), 44–61.

[7]. Adewuyi, A., & Olowookere, A. (2018). Infrastructure investment and growth nexus in Nigeria: Evidence from road and rail sectors. Nigerian Journal of Transport and Development, 10(2), 33–50.

[8]. Akinwale, A. A., & Adebayo, A. A. (2019). Strategic infrastructure investment and inclusive development in Nigeria. African Development Review, 31(1), 82–95.

[9]. Akims, J. A., & Danyil, D. (2018). The role of energy infrastructure in entrepreneurship and

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25apr1645

industrialization in Nigeria. Energy and Development Journal, 13(3), 75–91.
[10]. Ayodele, T. D., & Alabi, M. O. (2020). Public infrastructure and economic performance in Nigeria: A disaggregated approach. Journal of Infrastructure and Development, 9(1), 22–39.
[11]. Calderón, C., & Servén, L. (2004). The effects of infrastructure development on growth and income distribution (World Bank Policy Research Working Paper No. 3400). World Bank. https://doi.org/10.1596/1813-9450-3400
[12]. Edomah, N., & Ndulue, G. (2020). Energy transition in Nigeria: What needs to be done. Energy Policy, 142, 111544.
[13]. Ejiogu, A. R. (2021). The role of digital infrastructure in Nigeria's economic transformation. Journal of Digital Economy and Innovation, 5(1), 12–26.
[14]. Eze, C. O. (2020). Infrastructure and economic resilience in Nigeria: The way forward. Journal of African Policy Studies, 8(2), 77–89.
[15]. Ezeh, A., Uche, A., & Emeka, C. (2021). Urban sanitation and public health in Nigeria: Implications for economic productivity. African Journal of Public Health, 16(3), 198–210.
[16]. FAO. (2019). Nigeria at a glance: Agriculture and food security. Food and Agriculture Organization of the United Nations. https://www.fao.org/nigeria
[17]. Fashola, B. R. (2018). Infrastructure development report: Ogun River Basin Project. Federal Ministry of Water Resources, Nigeria.
[18]. Federal Ministry of Agriculture and Rural Development. (2017). Agricultural Promotion Policy (2016–2020). Abuja: Government of Nigeria.
[19]. Federal Ministry of Communications and Digital Economy. (2020). National Broadband Plan 2020–2025. https://www.ncc.gov.ng
[20]. Federal Ministry of Finance. (2019). Public-private partnership framework and investment strategy. Abuja: Government of Nigeria.
[21]. Federal Ministry of Transportation. (2020). National Transport Policy. Abuja: Government of Nigeria.
[22]. Federal Ministry of Water Resources. (2019). National Action Plan for the Revitalization of Nigeria's Water Supply, Sanitation and Hygiene (WASH) Sector.
[23]. G20 Global Infrastructure Outlook. (2021). Infrastructure investment as a growth engine: Outlook and policy recommendations. https://www.gihub.org
[24]. Ibahimov, S., González, M. T., & Ayvazov, K. (2023). Infrastructure investment and economic growth dynamics in selected developing countries. International Journal of Economics and Development, 11(1), 55–72.
[25]. Ibrahim, Y. D., & Lawal, T. T. (2020). Institutions, infrastructure, and growth in emerging economies: A Nigerian perspective. African Journal of Economics, 14(1), 110–130.
[26]. Ibrahim, A. D., Price, A. D. F., & Dainty, A. R. J. (2006). The analysis and allocation of risks in public-private partnerships in infrastructure projects in Nigeria. Journal of Financial Management of Property and Construction, 11(3), 149–164.
[27]. Itu, J. A., & Kenigua, S. (2021). Public-private partnerships and infrastructure development in Nigeria: A performance appraisal. Journal of Policy and Public Administration, 6(2), 21–37.
[28]. Looney, R. E., & Frederiksen, P. C. (1981). The regional impact of infrastructure investment in Mexico. Regional Science and Urban Economics, 11(1), 65–81.
[29]. Madaki, Y. A., Umar, A., & Okonkwo, J. E. (2022). Airport infrastructure and economic growth in Nigeria: An analysis of non-aeronautic factors. Nigerian Journal of Aviation Studies, 6(1), 43–57.
[30]. Mohmand, Y. T., Wang, A., & Saeed, S. (2017). Infrastructure and economic growth: Direct and indirect effects in Pakistan. South Asian Economic Journal, 18(2), 232–254.
[31]. Njiru, H. M., Njeru, A. W., & Kinyua, H. M. (2020). Social infrastructure and economic growth in Kenya. Journal of Economics and Sustainable Development, 11(18), 14–26.
[32]. Nigerian Communications Commission. (2019). Annual report on broadband penetration and telecom growth in Nigeria. NCC.
[33]. Nwaogwugwu, I. C., & Aiyedogbon, J. O. (2020). Infrastructure, employment, and inclusive growth in Nigeria. Journal of African Economic Studies, 12(3), 207–225.
[34]. Nwankwoala, H. O. (2021). Water resources management in Nigeria: Challenges and prospects. Hydrology Research Letters, 5(1), 22–33.
[35]. Nwokoye, E. U., Okeke, E. J., & Okwara, C. N. (2018). Infrastructure and economic development in Nigeria: An econometric analysis. African Journal of Economic Policy, 25(2), 1–17.
[36]. Nwokoye, E. U., Ogbuagu, R. A., & Okeke, E. J. (2020). Infrastructure and human capital development: Nexus in Nigeria. International Journal of Development and Sustainability, 9(4), 185–198.
[37]. Obiakor, R. T. (2021). Education, human capital, and inclusive development in Nigeria. Journal of Developmental Policy Studies, 15(1), 33–48.
[38]. Ojo, T., & Adegoriola, A. (2017). Transportation infrastructure and trade facilitation in Nigeria. Nigerian Journal of Logistics, 4(2), 40–56.
[39]. Ojo, T., & Olamide, A. (2019). Sectoral infrastructure investments and economic performance in Nigeria. West African Journal of Economic Policy, 12(1), 91–110.
[40]. Ojo, T., Akinyemi, B., & Ogunleye, F. (2018). Composite infrastructure quality index and metropolitan growth in Nigeria. Urban and Regional Studies Journal, 7(3), 71–85.
[41]. Olawole, S. A., & Alaba, A. M. (2018). The state of road transport infrastructure in Nigeria: Challenges and prospects. Journal of Transport and Infrastructure Development, 4(1), 23–39.
[42]. Olaseni, M., & Alade, W. (2021). Urban infrastructure planning in Nigeria: Gaps and opportunities. African Urban Studies Journal, 6(1), 14–32.
[43]. Okafor, N. C., & Amah, A. E. (2021). Infrastructure investment and private sector engagement in Nigeria. Journal of Development Finance, 13(1), 17–29.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25apr1645

[44]. Oyeyemi, T., Ojo, K., & Abiola, R. (2019). ICT infrastructure and innovation in Nigeria's digital economy. Information Technology and Development Journal, 9(2), 88–99.
[45]. Rohima, R., Mustika, M. D., & Andika, W. P. (2017). Public infrastructure and economic growth in South Sumatera. International Journal of Applied Economics, 14(1), 31–47.
[46]. Romer, P. M. (1986). Increasing returns and long-run growth. Journal of Political Economy, 94(5), 1002–1037.
[47]. Rural Electrification Agency. (2021). Nigerian Electrification Project: Progress report. Abuja: REA.
[48]. Sabir, S., & Shamshir, M. (2020). Infrastructure and economic growth in Pakistan: A time series analysis. Pakistan Economic Review, 3(1), 59–75.
[49]. Seidu, A., Ahmed, A., & Walker, G. (2020). Infrastructure investment and economic growth in the UK: Lessons and policy perspectives. UK Public Finance Review, 15(3), 45–61.
[50]. Siyan, B., & Adegoriola, A. (2017). Communication infrastructure and development: A Nigerian perspective. African Communication Research Journal, 10(2), 34–50.
[51]. Toader, E., Firtescu, B. N., Roman, A., & Anton, S. G. (2018). Impact of ICT infrastructure on economic growth: A dynamic panel data analysis. Sustainability, 10(10), 3451. https://doi.org/10.3390/su10103451
[52]. Transparency International. (2020). Corruption perceptions index 2020: Nigeria overview. https://www.transparency.org
[53]. UNIDO. (2017). Industrial development report 2017: Sustaining employment through manufacturing growth. United Nations Industrial Development Organization.
[54]. UNICEF. (2019). Water, sanitation, and hygiene: Nigeria country report. https://www.unicef.org/nigeria
[55]. United Nations. (2015). Transforming our world: The 2030 Agenda for Sustainable Development. https://sdgs.un.org
[56]. United Nations. (2017). SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation. https://sdgs.un.org/goals/goal9
[57]. Udo, I. D., & Abang, E. O. (2019). Infrastructure policy and economic development in Nigeria: A public policy review. Public Policy and Governance Journal, 7(2), 99–115.
[58]. World Bank. (2017). Water supply and sanitation: Nigeria sector report. https://www.worldbank.org
[59]. World Bank. (2018). Access to electricity: Nigeria country data. https://data.worldbank.org
[60]. World Bank. (2021). Nigeria economic update: Resilience through reforms. https://www.worldbank.org
[61]. WHO & UNICEF. (2020). Progress on household drinking water, sanitation and hygiene 2000–2020: Five years into the SDGs. https://washdata.org
[62]. Yilmaz, B., & Cetin, M. (2017). Infrastructure and growth in developing countries: A dynamic panel approach. Economics World, 5(2), 135–149.