Socioeconomic Infrastructures Development: Pathways for Spurring Inclusive Growth in Nigeria

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ABSTRACT

Following the Infrastructure-Led Development theoretical taught path that, provision of suitable infrastructures are catalysts for inclusive growth through enhanced real economic activities; thus, associated with the profound problem of infrastructure conditions and inclusive growth in Nigeria, this study examines the impacts of Nigeria's education, health, road & construction, transport & communication, and energy infrastructure investments as socio-economic infrastructures on gross domestic product per person employed as inclusive growth indicator. Yearly secondary data from 1988 to 2023 were gathered from the 2023 Statistical Bulletin of the 'Central Bank of Nigeria, the National Bureau of Statistics, and the Development Indicators of the World Bank'. Applying the 'Autoregressive Distributed Lag (ARDL)' processes, the produced evidence showed palpably that, except investment in transport & communication infrastructures which exerted short-run positively insignificant impact, and long-run directly significant impact on inclusive growth, investments in education, health, road & construction, and energy infrastructures exhibited positively significant short-run and long-run impacts on Nigeria's aggregate domestic output per person employed over the sampled period. This, necessitated the conclusive highlight that socio-economic infrastructures development are pivotal pathways for driving real economic activities to enhance inclusive growth in Nigeria. Therefore, the study emphasized that to prop up inclusive growth in Nigeria, public sector expansionary allocative policy for improved education, health, road and construction, transport & communication, and energy infrastructures should be given purposeful consideration.

Keywords: Socioeconomic Infrastructures, Development, Inclusive Growth, Nigeria, Autoregressive Distributed Lag

JEL Classification: H54, O45

INTRODUCTION

Infrastructure development forms the foundation of productive economic activities in any nation. It plays a pivotal role in strengthening economic progress and promoting inclusive growth by enhancing productivity, reducing income inequality, and improving the overall quality of life. Inclusive economic growth is an aggregated index that integrates overall economic expansion with equitable income distribution. This underscores the fact that infrastructure development is an indispensable pathway for fostering inclusive growth. With genuine and supportive investment policies targeted toward developing educational, health, energy, information and communication, transportation, and housing facilities, inclusive growth becomes an attainable outcome for an economy.

This argument is based on the understanding that high-quality infrastructure is essential for job creation, expanding shared economic opportunities, enabling equitable income generation, and reducing poverty. According to Challoumis (2024), economic and social infrastructures are key drivers of development, especially in developing countries. Quality infrastructure substantially boosts a nation's productivity and economic growth; thus, it is central to any meaningful economic advancement. Infrastructure spending encourages industrial investment, which fuels sustainably shared economic growth and helps generate a cycle of prosperity. The World Bank's Infrastructure for Development Report (1994) similarly observed that social and economic infrastructure supports socio-economic development, reaffirming the widely recognized notion that adequate infrastructural facilities drive productivity and shared growth.

Thess critical factors, however, are gravely insufficient in Nigeria, hindering economic growth and severely obstructing sustainable development. Nigeria's long-standing pursuit of sustainable progress has been significantly undermined by a visible shortage of infrastructural provision. The country's limited socio-economic advancement can be partly attributed to inadequate energy supply since the 1980s, and efforts to address this challenge have proven extremely difficult. For instance, Nigeria currently generates only about 4,500 MW of electricity daily, while nearly 50 percent of households remain unconnected to the national grid. Self-generation through diesel and petrol generators is estimated at approximately 6,000 MW. Similar shortcomings are evident across other sectors due to inadequate and deteriorating infrastructure; an unfortunate reality for a nation aspiring to rank among the world's 20 largest economies (Salisu, 2016).

In light of the foregoing, this study is broadly designed to empirically assess the impact of public sector investment in infrastructure development on inclusive economic growth in Nigeria. Specifically, the study seeks to determine the effects of education infrastructure, health infrastructure, road and construction infrastructure, transport and communication infrastructure, and energy infrastructure investments on total domestic output per person employed, which serves as the indicator of inclusive growth. In alignment with these objectives, five null hypotheses are formulated: **$H0_i$:** There is no significant impact of education infrastructure, health infrastructure, road and construction infrastructure, transport and communication infrastructure, and energy infrastructure investments on the indicator of inclusive growth, where *i* represents hypotheses 1 to 5 corresponding to the five explanatory variables.

RELATED LITERATURE REVIEW

Conceptual Clarification

Infrastructure comprises essential economic, social, and institutional facilities that support the effective functioning of a society, enabling improved outcomes and enhancing people's well-being. Shortage of such vital infrastructure inevitably leads to weak economic and social performance (Srivastava, Mujoo, Singh & Singh, 2023), underscoring the necessity for continuous infrastructure development. Technically, infrastructure development refers to deliberate investments aimed at creating and upgrading support systems that drive both economic and social progress. These investments include economic infrastructures such as roads, electricity networks, transport and communication systems, water supply facilities, and digital technology as well as social infrastructures like schools, healthcare centers, affordable housing, public libraries, and recreational parks (World Bank, 1994).

Accordingly, in this study, socio-economic infrastructure development is defined as investment efforts that expand and improve the support systems for both social and economic activities, thereby fostering overall societal progress. Economic infrastructure such as road networks, construction works, transportation and communication systems, and energy supply facilities create the needed enabling environment for productive activities to flourish. Social infrastructure which includes educational institutions, healthcare facilities, and community service amenities directly strengthens the education and health sectors, enhancing human capital and improving the general well-being of the population (Kumari *et al*., 2017). Together, these forms of infrastructure work to advance inclusive economic growth, raise living standards, and build a more equitable and sustainable society. Economic and social infrastructures function most effectively when developed simultaneously because they reinforce each other. For instance, improved transportation networks allow people

easier access to schools and hospitals, while better education and healthcare systems help develop a skilled and healthy workforce that can actively contribute to inclusive economic performance.

Furthermore, inclusive growth is a development paradigm that ensures the benefits of economic progress are distributed across all individuals and regions of society. It seeks to reduce economic deprivation, poverty, and inequality by emphasizing broad access to education, healthcare, and employment opportunities (Djokoto, 2022), thereby improving living conditions, particularly for vulnerable groups. Unlike traditional growth models that focus solely on aggregate economic output, inclusive growth emphasizes participation; ensuring that all individuals have the opportunity to contribute to and benefit from economic advancement (Zhang & Zong, 2019).

Theoretical Review

The theory of Infrastructure-Led Development originates from classical economic thought and development economics. Early economists such as Adam Smith and David Ricardo emphasized the significance of infrastructure, such as roads and canals in facilitating trade and stimulating economic expansion. The theory, however, gained substantial prominence in the mid-20th century and later through the contributions of Professor Pierre-Richard Agenor, particularly in discussions surrounding economic development in post-colonial nations seeking modernization and industrialization. Agenor formally articulated the theory in 2006 in an economic discussion paper published by the Centre for Growth and Business Cycle Research at the University of Manchester. The central premise of the theory is that infrastructure constitutes a key determinant of socio-economic transformation, promoting sustainable growth and supporting the shift of economies from basic to more advanced stages. The theory posits that investments in social and economic infrastructure such as education, transportation systems, energy, telecommunications, and water supply boost productivity and improve living standards. One of its notable implications is its catalytic role in promoting regional convergence, thereby reinforcing its relevance in the policy frameworks of both developed and emerging economies. In a subsequent version of the theory published in February 2010, Agenor further emphasized public infrastructure as a fundamental driver of long-term development (Agenor, 2010). He argued that the persistent infrastructure deficits widely observed in low-income countries significantly constrain economic progress and deepen structural inefficiencies.

Empirical Review

In examining the influence of infrastructure development on inclusive economic growth in Mataram City, Putri and Salmah (2025) evaluated the individual and combined effects of road, water, and educational infrastructure from 2017 to 2022. Their findings revealed that educational infrastructure had a significant positive effect when considered independently. However, road, clean water, and educational expenditures collectively exhibited no significant influence on inclusive economic growth during the study period.

Regarding infrastructure investments, Aluko and Ngubane (2024) identified water and sanitation facilities and household electrification as essential infrastructures that positively affect the Human Development Index (HDI) and inclusive growth in emerging economies such as Brazil, South Africa, Turkey, Mexico, and Vietnam. Similarly, Ifoghere and Olele (2024) reported that only transport service infrastructure exerted a positive and significant effect on Nigeria's real GDP, while investments in road, water, and telecommunication infrastructure had negative and insignificant effects. Their study concluded that these variables had no long-run influence on economic growth in Nigeria.

In their assessment of infrastructure and socio-economic development across districts in Uttar Pradesh, India, Srivastava *et al*. (2023) found a strong link between economic infrastructure, such as roads, electricity, as well as markets and overall socio-economic advancement. However, no such relationship was identified for social infrastructure including schools, health clinics, and recreational parks. Wasurum and Kpagih (2023), using per capita income as a proxy for standard of living, established that telecommunications and electricity infrastructure positively and significantly improved living standards in Nigeria, whereas investments in health and education infrastructure had adverse effects.

Salisu (2016) highlighted the substantial infrastructural deficit in Nigeria, noting that the country's infrastructure provision remains far below the level required to support national development. This concern aligns with Mohanty *et al.* (2016), who emphasized the essential role of infrastructure in enhancing human well-being. Ghosh (2017) further demonstrated that infrastructure investment fosters economic growth through enhanced productivity, and that public investments in education and health significantly benefit human welfare. Research by Das and Borah (2021), Zhang and Zong (2019), and Hlotywa and Ndaguba (2017) affirmed that infrastructure such as potable water in hospitals, electricity in schools, and accessible road networks promotes inclusive growth.

Kuada (2013) asserted that inadequate infrastructure investment often stemming from governance failures and corruption has contributed to Sub-Saharan Africa's persistent low people-centered growth (Doumbia, 2019). Owolabi-Merus (2015) found that Gross Fixed Capital Formation significantly and positively influenced Nigeria's GDP between 1983 and 2013, though the causal relationship was weak. Palei (2015) emphasized that quality infrastructure, including roads, rail networks, air transport, and electricity, is vital for national competitiveness. Ogbaro and Omotoso (2017) similarly reported that air transport networks, communication infrastructure, electricity supply, and rail line expansion significantly enhanced Nigeria's economic growth. Saheed and Obianuju (2021), focusing on rural Kaduna State, showed that socio-economic infrastructure positively contributed to improvements in the local economy.

Empirical Gap

An assessment of recent empirical studies reveals that while scholars such as Ifoghere and Olele (2024), Aluko and Ngubane (2024), Wasurum and Kpagih (2023), Ghosh (2017), and Owolabi-Merus (2015) investigated the effects of infrastructure development on dependent variables such as real GDP, HDI, standard of living, and economic growth, only a limited number such as Putri and Salmah (2025) and Zhang and Zong (2019) explored its effect on inclusive economic growth, and predominantly in countries outside Nigeria. Building on these observations, the present study departs from previous compositions by examining whether socio-economic infrastructure development constitutes critical pathway for advancing inclusive economic growth in Nigeria between 1988 and 2023. It does so by evaluating investments in education, health, road and construction, transport and communication, and energy infrastructure, using gross domestic product per person employed as the chosen indicator of inclusive growth.

METHODOLOGY

In conducting this study, annual data spanning the period 1988 to 2023 were analyzed. The primary data sources include the Central Bank of Nigeria's *2023 Statistical Bulletin*, publications of the National Bureau of Statistics (2023), and the World Bank's *World Development Indicators* (2023).

Study Model

This study is theoretically anchored in the Infrastructure-Led Development theory, which asserts that infrastructure investments provide the foundation for economic activity, enhance productivity, and improve individuals' quality of life. Building on this theoretical premise, the model employed in this research is adapted from Ogbaro and Omotoso (2017), who examined the combined effects of air transport, telecommunications, electricity, and rail line development on Nigeria's economic growth. For the purposes of this study, their model is modified to align with the specific objectives of the current research. Accordingly, the functional form of the model, as adapted from Ogbaro and Omotoso (2017), is specified as follows:

$$GDPPPE = f(EDI^{\beta 1}, HTI^{\beta 2}, RCI^{\beta 3}, TCI^{\beta 4}, EGI^{\beta 5}) \quad (3.1)$$

Model (3.1) is transformed to an econometric form aa stated below:

$$GDPPPE_t = \beta_0 + \beta_1 EDI_t + \beta_2 HTI_t + \beta_3 RCI_t + \beta_4 TCI_t + \beta_5 EGI_t + U_t \quad (3.2)$$

Transforming equation (3.2) into log-log model is expressed below:

$InGDPPPE = \beta_0 + \beta_1 InEDI_t + \beta_2 HTI_t + \beta_3 InRCI_t + \beta_4 InTCI_t + \beta_5 InEGI_t + U_t$ (3.3) Where:

DPPPE = Gross domestic product per person employed, EDI = Education infrastructure investment, HTI = Health infrastructure investment, RCI = Road & construction infrastructure investment, TCI = Transport & communication infrastructure investment, EGI = Energy infrastructure investment, β_0 = Constant term, β_1 - β_5 = Slope parameters of the regressors (proxies of socioeconomic infrastructure development), U = Error term

Theoretical Expectations: Following the reasoning set out before the analysis began, the way the different variables in this study should interact can be shown in the equation below: $\beta_1 > 0$; $\beta_2 > 0$; $\beta_3 > 0$; $\beta_4 > 0$; $\beta_5 > 0$.

Variables Description

The dependent and the independent variable are described here.

Gross Domestic Product Per Person Employed (GDPPPE): This is employed as the dependent variable. It is adopted as the measure for inclusive growth in this study. TGDP per person employed is a measure of labour productivity, estimated by dividing the total Gross Domestic Product of a country by the number of employed persons. In the Nigerian context, it reflects the average economic output contributed by each employed individual within a given year.

The independent variable in this study is socio-economic infrastructure development, which is represented through the following components:

Education Infrastructure Investment (EDI): This refers to public expenditure directed toward constructing, renovating, and equipping physical and technological facilities within the education sector. In Nigeria, such investments include building classrooms, laboratories, libraries, ICT centers, and teacher training facilities, as well as providing educational materials and digital learning platforms to enhance access, quality, and equity in educational services delivery.

Health Infrastructure Investment (HTI): This encompasses funding allocated to the development and maintenance of physical health facilities and systems required for effective healthcare delivery. In Nigeria, this includes the construction and upgrading of hospitals, clinics, laboratories, and health centers, along with strengthening supply chains for medical equipment and pharmaceuticals. It also covers investments in sanitation systems, health information systems, and training facilities for healthcare workers.

Road & Construction Infrastructure Investment (RCI): This captures expenditure aimed at developing and maintaining road networks, bridges, interchanges, and other rural and urban infrastructure. In Nigeria, such investments promote national integration, enhance rural–urban connectivity, and improve market accessibility through the development of federal highways, state roads, and rural feeder roads.

Transport & Communication Infrastructure Investment (TCI): It consists of investments in systems that support the movement of people and goods, as well as the flow of information. In Nigeria, this includes airports, seaports, railway systems, public mass transit infrastructure, broadband internet, mobile communication networks, and postal services. These investments help reduce logistics costs, promote digital inclusion, and strengthen economic competitiveness.

Energy Infrastructure Investment (EGI): it is factor that represents funding directed at developing facilities and systems for power generation, transmission, and distribution. In Nigeria, such investments include hydro, gas, solar, and wind power plants; electricity grids; transmission lines; and rural electrification initiatives. It also encompasses renewable and alternative energy solutions aimed at reducing energy poverty and supporting industrial and economic development.

Data Analysis Techniques

The primary analytical method adopted in this study is the Autoregressive Distributed Lag (ARDL) technique. This method was chosen because the unit root test conducted using the Augmented Dickey–Fuller (ADF)

approach indicated that the study variables are integrated at different levels, some at I(0) and others at I(1). The ARDL technique is suitable for such situations, as it does not require all variables to be stationary at the same order of integration. Its flexibility makes it an ideal approach for models with mixed integration levels. The ARDL model specified as adapted from Equation (3.3) is presented below:

$$\begin{aligned}\Delta\ln(GDPPPE_t) &= \beta_0 + \beta_{1i}\Delta\ln(GDPPPE_{t-1}) + \beta_{2i}\Delta\ln(EDI_{t-1}) + \beta_{3i}\Delta\ln(HTI_{t-1}) + \beta_{4i}\Delta\ln(RCI_{t-1}) \\ &+ \beta_{5i}\Delta\ln(TCI_{t-1}) + \beta_{6i}\Delta\ln(EGI_{t-1}) + \sum_{t=1}^{q}\alpha_{1i}\Delta In(GDPPPE_{t-1}) + \sum_{t=1}^{q}\alpha_{2i}\Delta In(EDI_{t-1}) \\ &+ \sum_{t=1}^{q}\alpha_{3i}\Delta In(HTI_{t-1}) + \sum_{t=1}^{q}\alpha_{4i}\Delta In(RCI_{t-1}) \sum_{t=1}^{q}\alpha_{5i}\Delta In(TCI_{t-1}) + \sum_{t=1}^{q}\alpha_{6i}\Delta In(EGI_{t-1}) \\ &+ \varepsilon_{1i} \qquad (3.4)\end{aligned}$$

In furtherance, short-run dynamic parameters come from running an error-correction model that is tied to the long-run estimates, shown in the equation below:

$$\begin{aligned}\Delta\ln(GDPPPE_t) &= \alpha_0 + \sum_{t=1}^{q}\alpha_{1i}\Delta In(GDPPPE_{t-1}) + \sum_{t=1}^{q}\alpha_{2i}\Delta In(EDI_{t-1}) + \sum_{t=1}^{q}\alpha_{3i}\Delta In(HTI_{t-1}) \\ &+ \sum_{t=1}^{q}\alpha_{4i}\Delta In(RCI_{t-1}) + \sum_{t=1}^{q}\alpha_{5i}\Delta In(TCI_{t-1}) + \sum_{t=1}^{q}\alpha_{6i}\Delta In(EGI_{t-1}) + \delta ECT_{t-1} \\ &+ \varepsilon_{2i} \qquad (3.5)\end{aligned}$$

In = Natural log; Δ = Difference operator; *t-1* = Time lag; β_0, α_0 = Constant terms; $\beta_1 - \beta_6$ = Long-run dynamic slope coefficients; $\alpha_1 - \alpha_6$ = Short-run dynamic slope indicators; ε_{1i} and ε_{2i} = stochastic terms.

ANALYSES RESULTS AND DISCUSSION

Trend Analyses

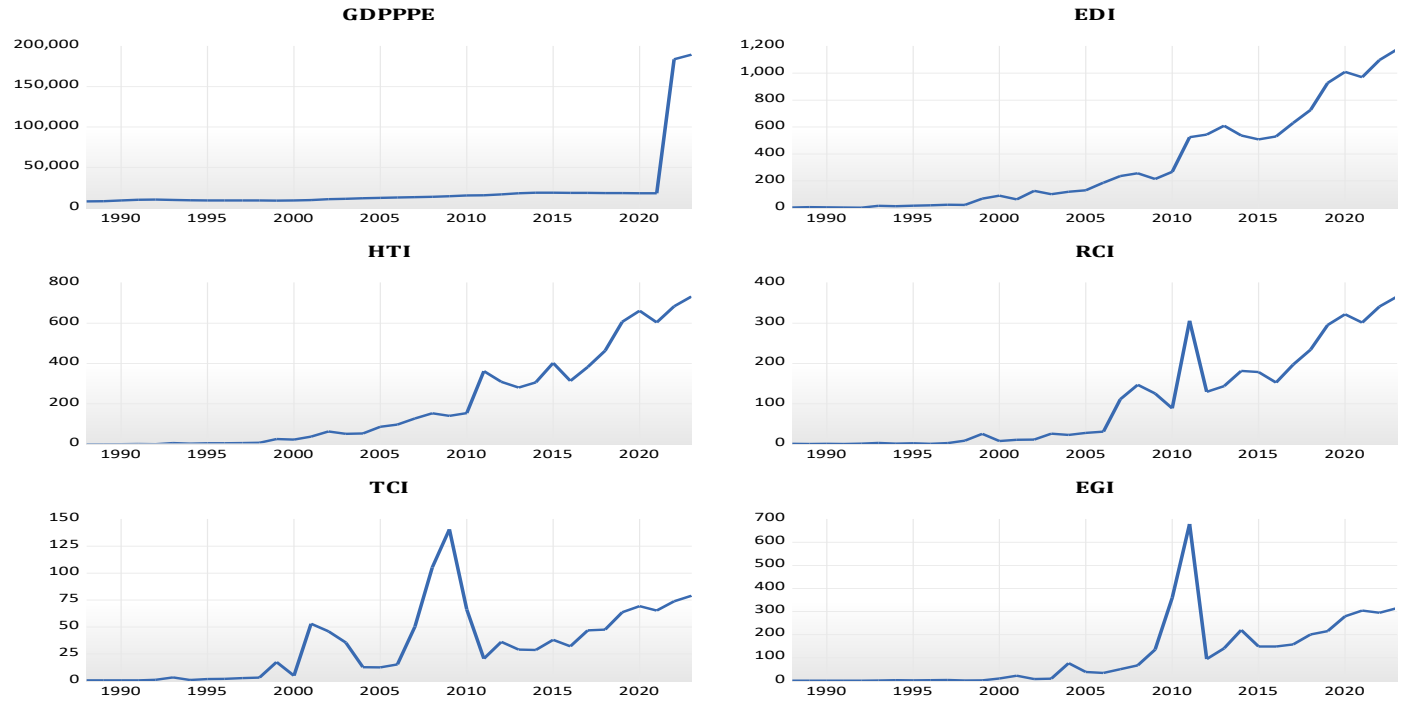

Figure 4.1: The Research Variables' Trend Graphs

Figure 4.1 above shows that unlike gross domestic product per person employed (GDPPPE) that followed a fairly consistent upward movements, education infrastructure investment (EDI), health infrastructure investment (HTI), road & construction infrastructure investment (RCI), transport & communication infrastructure investment (TCI) and energy infrastructure investment (EGI) in Nigeria mostly showed inconsistencies in their trend behaviours, moving cyclically throughout the 1988 to 2023 period sampled.

Descriptive Analysis

The results showing the descriptive statistics features of the study's variables: gross domestic product per person employed (GDPPPE), education infrastructure investment (EDI), health infrastructure investment (HTI), road & construction infrastructure investment (RCI), transport & communication infrastructure investment (TCI) and energy infrastructure investment (EGI) in Nigeria for the thirty-six years sampled data period from 1988 to 2023 are scheduled below in Table 4.1.

Table 4.1: Test Outcomes of Descriptive Statistics

	GDPPPE	**EDI**	**HTI**	**RCI**	**TCI**	**EGI**
Mean	22577.99	326.7144	198.9158	105.9975	33.45250	111.8650
Median	12461.74	157.5950	92.10500	29.64500	28.74500	44.15000
Maximum	189466.9	1175.980	731.9100	365.4700	140.6100	679.4300
Minimum	7941.040	0.450000	0.230000	0.640000	0.360000	0.090000
Std. Dev.	40534.36	362.8496	231.8184	119.8445	33.66380	147.8418
Skewness	3.825259	0.963820	1.001864	0.830530	1.141844	1.850613
Kurtosis	15.80015	2.665091	2.695090	2.313002	4.194714	7.082680
Jarque-Bera	333.5612	5.741936	6.161850	4.846630	9.963860	45.55103
Probability	0.000000	0.056644	0.045917	0.088627	0.006861	0.000000
Sum	812807.8	11761.72	7160.970	3815.910	1204.290	4027.140
Sum Sq. Dev.	5.75E+10	4608095.	1880891.	502694.5	39663.81	765001.5
Observations	**36**	**36**	**36**	**36**	**36**	**36**

Source: *Authors' 2025 Computation.*

As shown in the table above, gross domestic product per person employed recorded a mean of ₦22,577.99 billion with a maximum value of ₦189,466.9 billion and minimum value of ₦7,941.04 billion while its standard deviation of ₦40,534.36 billion indicates high dispersion from the mean. In addition, education infrastructure investment, averaged N326.71bn, stretching from a peak of N1,175.98bn down to a bare minimum of N0.45bn. Its standard deviation, often the measure of volatility, sits at N362.85bn, suggesting that yearly outlays do not tend to stray far from the average. Similarly, health infrastructure investment recorded an average of N198.92bn, with a high of N731.91bn and a low of N0.23bn. The corresponding standard deviation is N231.8bn, indicating that most observations cluster reasonably close to the mean value. Road-and-construction funding posted a mean of N105.998bn, peaking at N365.47bn and dropping to lowest of N0.64bn; here, the standard deviation of N119.84bn also points to narrow dispersion around the average. Transport-and-communication outlay flowed at an average of N33.45bn, reaching N140.61bn and falling to N0.36bn, and its standard deviation matches the mean at N33.66bn, so variation is minimal. Energy infrastructure investment

averaged N111.87bn, reached N679.43bn, dropped to N0.09bn, and finished with a standard deviation of N147.84bn, again signaling that most annual budgets hover near the central figure.

Pre-estimation Tests

Multicollinearity Test

In this study, pairwise correlation is adopted to detect the presence or absence of multicollinearity problem. The test result reported in Table 4.2 below indicates that all correlation coefficients of the independent series (education infrastructure investment, health infrastructure investment, road & construction infrastructure investment, transport & communication infrastructure investment and energy infrastructure investment) in the result setting are evidentially below a 0.6 threshold.

Table 4.2: Correlation Matrix

	$\mathbf{InGDPPPE_t}$	$\mathbf{InEDI_t}$	$\mathbf{InHTI_t}$	$\mathbf{InRCI_t}$	$\mathbf{InTCI_t}$	$\mathbf{InEGI_t}$
$InGDPPPE_t$	1					
$InEDI_t$	0.102337	1				
$InHTI_t$	0.310171	0.193567	1			
$InRCI_t$	0.032276	0.245454	0.063487	1		
$InTCI_t$	0.227227	0.105767	0.527172	0.314589	1	
$InEGI_t$	0.408086	0.133429	0.448933	0.537582	0.376825	1

Source: *Authors' 2025 Computation.*

This outcome implies that all the independent variables have weak relationships with gross domestic product per person employed (GDPPPE). It is also indicative that the causal variables are of weak pairwise connections among them over the study years. This pattern tells us that multicollinearity is not a concern here and gives us the impetus to move forward with other analyses.

Unit Root Test

The data series gathered for each variable in this study was subjected to test of stationarity by analyzing for the presence or absence of unit root using Augmented Dickey-Fuller (ADF). Table 4.3 summarized results below.

Table 4.3: Augmented Dickey-Fuller (ADF) Test Results

	At Levels		**At First Difference**			
Variables	**ADF Test Statistics**	**Mackinnon Critical Value @ 5%**	**ADF Test Statistics**	**Mackinnon Critical Value @ 5%**	**Stationarity Remark**	**Order of Integration**
$InGDPPPE_t$	0.522190	-2.948404	-5.840689	-2.951125	at 1st Diff.	I(1)
$InEDI_t$	-4.631868	-2.963972	-	-	at Level	I(0)
$InHTI_t$	-2.477482	-2.971853	-3.852883	-2.981038	at 1st Diff.	I(1)

$InRCI_t$	-1.765799	-2.957110	-3.966146	-2.960411	at 1st Diff.	I(1)
$InTCI_t$	-1.858427	-2.948404	-7.943486	-2.951125	at 1st Diff.	I(1)
$InEGI_t$	-1.745375	-2.954021	-7.796879	-2.954021	at 1st Diff.	I(1)

Source: *Authors' 2025 Computation.*

The estimated outcomes of the ADF unit root tests presented in Table 4.3 indicate that, at the 5 percent significance level, the test statistic for education infrastructure investment (EDI) is, in absolute terms, greater than its corresponding critical value. This result implies that EDI is stationary at level, or integrated of order zero [I(0)]. Conversely, gross domestic product per person employed (GDPPPE), health infrastructure investment (HTI), road & construction infrastructure investment (RCI), transport & communication infrastructure investment (TCI), and energy infrastructure investment (EGI) became stationary only after first differencing, indicating that they are integrated of order one [I(1)]. With the variables demonstrating stationarity at both level and first difference, the next appropriate step is to conduct the ARDL bounds test to determine whether a stable long-run cointegrating relationship exists among them.

Cointegration Estimate Result

Table 4.4 presents the ARDL bounds test results. The calculated F-statistic of 5.846411 exceeds the upper critical bound value of 3.38 at the 5 percent significance level. This finding provides clear evidence of a long-run association among gross domestic product per person employed (GDPPPE), education infrastructure investment (EDI), health infrastructure investment (HTI), road & construction infrastructure investment (RCI), transport & communication infrastructure investment (TCI), and energy infrastructure investment (EGI).

Table 4.4: Cointegration Estimate

'Null Hypothesis: No Long-Run Relationships Exist'			Bounds' Critical Values	
T-statistic	Value	Significance	I(0)	I(1)
F-statistic	5.846411	10%	2.08	3
K	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

Source: *Authors' 2025 Computation.*

Therefore, consequent upon the clear long-run association and the I(0) and I(1) mixed orders of integrations, the ARDL model of the order 3, 4, 4, 4, 2, 3 is estimated to ascertain the short-run and long-run outputs for this study.

The Autoregressive Distributive Lag Model Estimates

Table 4.5 below summarizes the findings from the both dynamic short-run and long-run ARDL models. The evidence shows that spending for educational infrastructure had strong, positive influence on Nigeria's real gross domestic product per worker, whether measured over the short term or the long term. In technical terms, its coefficients are statistically positive, the p-values fall below 0.05, and the t-statistics exceed the 1.96 threshold cited in standard tables. As a result, boosting investment in education sector's facilities appears to encourage more inclusive growth, lifting output per employed person in both horizons. A similar pattern emerges for health-related infrastructure; the relevant coefficients also carry positive signs, are highly significant at p-values under 0.05, and the corresponding t-statistics again cross the 1.96 line. Therefore, larger

budgets for hospitals, clinics, and sanitation systems are equally important for advancing output per worker over both short and long periods. Moreover, spending on roads and other building projects showed strong and positive relationship with GDP per employed person in Nigeria, both in the short run and over time. The evidence comes from the high, positive coefficients, p-values below 0.05, and t-statistics above 1.96. Thus, the implication is that expansionary road & construction infrastructure investment is important for improving gross domestic product per person employed in the short-run and the long-run.

Table 4.5: Short-Run and Long-Run ARDL Estimates

	Regressand = D$\mathrm{InGDPPPE_t}$			
Variables	**Coefficients**	**Std. Errors**	**t-Statistics**	**Probs.***
$\mathrm{DIn(GDPPPE_{t-1})}$	4.239489	0.682570	6.211064	0.0008
$\mathrm{DIn(GDPPPE_{t-2})}$	35.72501	6.048304	5.906617	0.0010
$\mathrm{DIn(EDI_t)}$	12.03319	1.909766	6.300871	0.0007
$\mathrm{DIn(EDI_{t-1})}$	9.147539	1.509419	6.060306	0.0009
$\mathrm{DIn(EDI_{t-2})}$	4.275471	0.760527	5.621725	0.0014
$\mathrm{DIn(HTI_t)}$	13.04205	2.069116	6.303202	0.0007
$\mathrm{DIn(HTI_{t-1})}$	10.49708	1.708720	6.143244	0.0009
$\mathrm{DIn(HTI_{t-2})}$	-5.403364	0.937497	-5.763608	0.0012
$\mathrm{DIn(RCI_t)}$	2.773459	0.438957	6.318293	0.0007
$\mathrm{DIn(RCI_{t-1})}$	-4.969647	0.812395	-6.117276	0.0009
$\mathrm{DIn(RCI_{t-2})}$	-3.004215	0.546238	-5.499825	0.0015
$\mathrm{DIn(TCI_t)}$	0.968171	3.240203	0.298800	0.7672
$\mathrm{DIn(TCI_{t-1})}$	-0.366090	2.071610	-0.176718	0.8609
$\mathrm{DIn(EGI_t)}$	1.579594	0.288354	5.477971	0.0015
$\mathrm{DIn(EGI_{t-1})}$	4.148119	0.664045	6.246746	0.0008
$\mathrm{DIn(EGI_{t-2})}$	2.673354	0.437626	6.108765	0.0009
CointEqM(-1)*	-0.253302	0.039905	-6.347613	0.0001
Adjusted R-squared = 0.613934; Durbin-Watson stat = 2.398077				
Regressand = $\mathrm{InGDPPPE_t}$				
Variables	**Coefficients**	**Std. Errors**	**t-Statistics**	**Probs.***
$\mathrm{InEDI_t}$	0.843706	0.122250	6.901473	0.0001

$InHTI_t$	1.126435	0.037811	29.79128	0.0000
$InRCI_t$	0.258743	0.038020	6.805518	0.0001
$InTCI_t$	0.077628	0.063419	1.224056	0.2668
$InEGI_t$	0.137325	0.032236	4.259933	0.0021
C	8.169198	1.059695	7.709005	0.0002
EC = In(GDPPPE) - (0.8437*In(EDI) + 1.1264*In(HTI) + 0.2587*In(RCI) + 0.0776*In(TCI) + 0.1373*In(EGI) + 8.1692)				

Source: *Authors' 2025 Computation.*

Conversely, transport and communication infrastructure investment exhibited a positive but statistically insignificant effect on real economic growth per person employed during the study period. This conclusion is supported by the coefficient values, which, although positively signed, have p-values greater than 0.05 and t-statistics below the 1.96 threshold. This implies that increased investment in transport and communication infrastructure is still required to meaningfully enhance gross domestic product per person employed in both the short and long run.

Furthermore, investment in energy infrastructure demonstrated a positive and statistically significant impact on the short- and long-run levels of real gross domestic product per person employed. This result is validated by the positive coefficient estimates accompanied by p-values below 0.05 and t-statistics exceeding the critical value of 1.96. This suggests that greater investment in energy infrastructure is essential for improving gross domestic product per person employed over the period under review.

Additionally, the Adjusted R-squared (Adj. R^2) value of 0.613934 indicates that 61 percent of the systematic variation in gross domestic product per person employed during the study period is explained by the independent variables in the short run, while the remaining 39 percent is accounted for by the error term; representing factors not included in the model.

Finally, the coefficient of the error correction term, reported in Table 4.5 as CointEq(-1)* and valued at –0.253302, shows that the adjustment speed toward long-run equilibrium is 25 percent annually. This means that gross domestic product per person employed adjusts relatively slowly to deviations caused by changes in education, health, road and construction, transport and communication, and energy infrastructure investments.

Post-Estimation Tests

The results of the post-diagnostic tests are presented in Table 4.6. The model successfully passed the Jarque–Bera normality test, Lagrange Multiplier test for serial correlation, heteroskedasticity test, and Ramsey RESET specification test. These outcomes indicate that the model residuals are normally distributed, free from serial correlation issue, homoscedastic, and correctly specified. The CUSUM plot in Figure 4.2 further evaluates the stability of both short- and long-run coefficients over the samples period. Since the CUSUM line remains within the 5 percent significance boundaries throughout, it is concluded that the long-run effects of the explanatory variables on inclusive growth in Nigeria are stable.

Table 4.6: Post-Diagnostic Estimates

Tests' Methods	**Statistics**	**P-Values**	**Null Hypotheses**	**Decisions**
A. Normality	2.035982	0.3613	**H_0:** Normally Distributed	H_0 not Rejected
B. Serial Correlation	1.785778	0.2362	**H_0:** No Serial Correlation	H_0 not Rejected

C. Heteroskedasticity	2.622793	0.0683	**H_0:** Homoscedasticity	H_0 not Rejected
D. Functional Form	0.309260	0.5933	**H_0:** Specified Correctly	H_0 not Rejected

Source: *Authors' 2025 Computation.*

NB: The methods applied are- Test A Jarque-Bera; Test B Lagrange multiplier; Test C squared errors relate to the squared predicted values; and Test D utilized the Ramsey RESET.

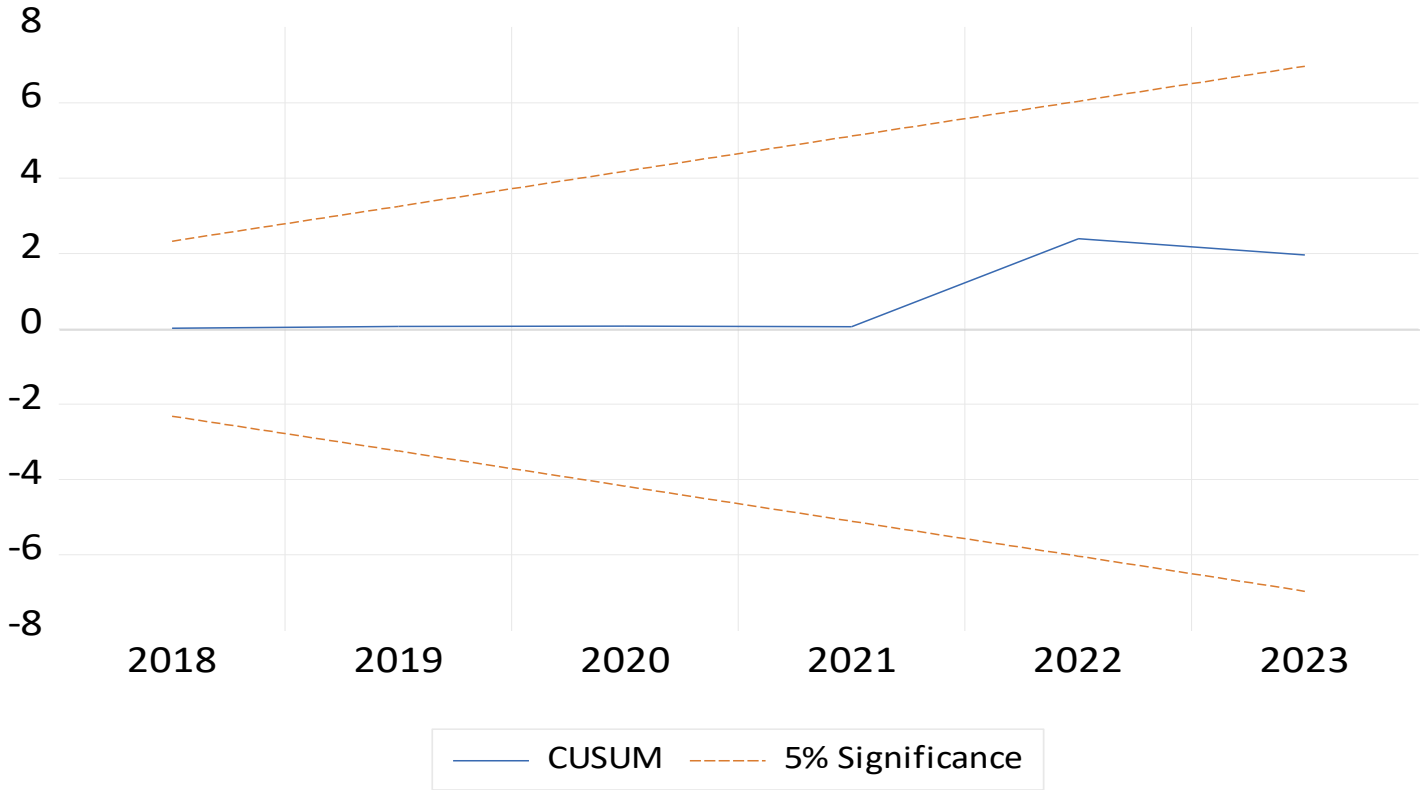

Figure 4.2: CUSUM Stability Test

DISCUSSION OF FINDINGS

The findings of the study reveal that investment in education infrastructure exerted a positive and statistically significant influence on the economy's gross domestic product per person employed during the period under review. This result aligns with the study by Putri and Salmah (2025), which examined the effects of infrastructure development on inclusive economic growth in Mataram City and found educational infrastructure to have a significant positive impact on the dependent variable. It is also consistent with Ghosh (2017). However, Wasurum and Kpagih (2023) reported a contrary outcome regarding the influence of educational infrastructure investment on Nigeria's standard of living. Similarly, investment in health infrastructure was found to have a positive and significant effect on Nigeria's gross domestic product per person employed in both the short and long run. This finding supports Ghosh (2017), who emphasized that public investment in health infrastructure greatly enhances human well-being. Nonetheless, Wasurum and Kpagih (2023) again documented a conflicting result concerning its effect on the standard of living in Nigeria. In addition, the study showed that road and construction infrastructure investment had a positive and significant effect on the country's short- and long-run gross domestic product per person employed. This result is consistent with Putri and Salmah (2025), who noted that road infrastructure development facilitates inclusive growth. Conversely, Ifoghere and Olele (2024) reported that road infrastructure development had a negative and insignificant impact on real GDP. Furthermore, investment in transport and communication infrastructure demonstrated a positive and substantial impact on real gross domestic product per person employed in the long run, although its initial effect appeared positive but statistically insignificant. This finding corresponds with empirical evidence provided by Wasurum and Kpagih (2023) and Ogbaro and Omotoso (2017), both of whom

found positive and significant impacts from investments in transport and telecommunications infrastructure in Nigeria. In contrast, Ifoghere and Olele (2024) acknowledged the positive role of transport services infrastructure but reported that telecommunications infrastructure did not contribute to real GDP growth. Finally, investment in energy infrastructure was also shown to have a positive and significant effect on real domestic output per person employed in both the short and long run. This result is supported by studies from Aluko and Ngubane (2024), Ogbaro and Omotoso (2017), and Palei (2015), all of which highlight the critical role of electrification, power, and electricity supply infrastructure in enhancing economic performance. Overall, the findings imply that, ceteris paribus, fiscal expansion targeted toward increased investment in the identified socio-economic infrastructure sectors is essential for strengthening economic activities and fostering inclusive growth in Nigeria.

CONCLUDING REMARK AND POLICY RECOMMENDATIONS

Concluding Remark

This study conducted an empirical investigation to determine how the development of socio-economic infrastructure influences inclusive growth in Nigeria, using time-series data spanning from 1988 to 2023. The empirical findings revealed that five key socio-economic infrastructure indicators: education infrastructure investment, health infrastructure investment, road and construction infrastructure investment, transport and communication infrastructure investment, and energy infrastructure investment collectively contributed positively to Nigeria's gross domestic product per person employed. The study therefore concludes that development of socio-economic infrastructure constitutes vital pathway for significantly enhancing inclusive economic growth in Nigeria.

Policy Recommendations

Based on the study's findings and conclusion, the following recommendations are proposed to advance inclusive economic growth in Nigeria:

i. In light of the positive and significant effects of education infrastructure investment on gross domestic product per person employed, the government should allocate adequate funding to improve education sector infrastructure, with particular consideration for regional disparities and underserved communities, complemented by improvements in human resource quality. Such measures will broaden access to quality education, reduce inequality, enhance human capital development across different social groups, and ultimately promote inclusive economic growth over time.

ii. Given the positive and significant impact of healthcare infrastructure investment on gross domestic product per person employed, the government should increase capital expenditure in the health sector to expand and maintain community-based health facilities, such as primary health centers and mobile clinics; aligned with local government development strategies and supported by skilled personnel and digital health systems. These efforts will reinforce human capital and contribute more effectively to inclusive growth.

iii. Similarly, since the empirical results established long-run beneficial effects of road and construction, energy, and transport and communication infrastructure investments on gross domestic product per person employed, an expansionary public spending policy is recommended to maintain existing facilities and develop new ones in these sectors. Such investments should strengthen rural–urban connectivity, improve mobility and communication, and enhance general energy access. Collectively, these actions will boost participation in economic activities, thereby steadily improving economic inclusiveness in Nigeria.

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