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Integrating product portfolio and supply chain design for sustainable construction

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ABSTRACT

This study examined the relationship between public infrastructure expenditure on information technology, electricity and economic growth using real gross domestic products as proxy. The methods of data analysis and estimation technique are Ordinary Least Square (OLS) method, Augmented Dickey Fuller (ADF) method, Unit Root Test, Johansen Co-integration Test and Error Correction Model. Data on these variables from 1981 to 2021 were sourced from the Central Bank of Nigeria Statistical Bulletin (CBN, 2021) and World Development indicators. The evidence from the long-run coefficient of public expenditure on infrastructural development has significantly impacted on economic growth, therefore infrastructure development expenditure is seen to constitute significant determinant of economic growth particularly for developing countries. The study suggested analysis of the elasticity of growth towards public expenditure on economic services and government need to take proactive and concerted effort to significantly enhance economic growth through fiscal policy targeted on sustainable economic service provision.

Keywords: Public Infrastructural, ICT, Electricity, Transportation, Economic Growth.

1. INTRODUCTION

Infrastructure play a great role in the value and quality of lifecycle by providing services such as energy, transportation, communication that provide macroeconomic stability of the nation. In the sub-Saharan space, the traffic bottleneck, power outages in the urban centres, poor quality of road constructions, insufficient telecommunication and lack of portable water supply. All these stood out concerning the derisory infrastructure services in the countries. The schools are not left out with poorly equipped common infrastructure that ought to improve human capital development (Moses, *et al*, 2016; Ogunjimi, & Amune, 2017; Onyekwelu, 2017).

Infrastructure is defined as an unpaid factor of production that enhances the productivity of other factors while also serving as an intermediate input in the production process (Akinyosoye, 2010; Gaal & Afrah, 2017, Ufua, *et al*, 2022). They further argued that the output produced as a result of sustainable infrastructure base will result in an increase cumulative output. Though, the overall perspective is that public investment or expenditure, whether capital or recurrent, particularly in economic and social infrastructure, can be a catalyst for growth. However, the manner in which such expenditures are funded may impact growth either positively or negatively. Investments aimed at providing essential infrastructure services—such as transportation, electricity, telecommunications, waste management, healthcare, and sanitation—can either stimulate or hinder economic growth, depending on their efficiency and sustainability.

Infrastructure is broadly categorized into two main types: economic and social infrastructure. Economic infrastructure includes public utilities such as power supply, water distribution, postal services, sanitation and sewage systems, telecommunications, and solid waste management. These facilities are essential for enhancing productivity, improving quality of life, and fostering economic development. While public works are construction of roads, canals, dams, drainage and irrigation and transportation entails urban mass transportation, airport, railways, eater way. Social infrastructure refers to education and healthcare delivery (Ibikunle, Ojo, & Kuyebi 2021, Ufua, *et al*, 2023). Over the years infrastructure has renewed our hope. According to Asher and Novosad (2020) and Donaldson (2018), the renewed focus on infrastructure development can be attributed to global transformations over the past three decades. In the first phase, which began in the mid-1980s and continued through the 1990s, many developing countries witnessed a shift away from government-led infrastructure provision toward increased private sector participation. This transition marked a significant departure from the traditional public sector dominance in infrastructure development.

Globally, there has been a growing reliance on market-driven approaches and private sector involvement in the provision of public utilities. This shift has also led to the expansion of public-private partnerships (PPPs), which have become a key mechanism for financing and managing infrastructure projects. The rise of these collaborative models reflects an effort to leverage private sector efficiency, innovation, and investment to address infrastructure deficits and drive sustainable economic growth. These initiatives at the beginning gained traction in developed counties, predominantly the United Kingdom. This has grown in emerging economies, especially Latin America and sub-Saharan Africa countries. Infrastructure contributes to provision of quality life (transport, energy, and communication services). However, in sub-Saharan Africa, Nigeria in particular, traffic congestion, poor quality of roads, power outages, inadequate telecommunication services, shortage of drinking water, basic amenities in schools, access to capital market contribute to the insufficient existing infrastructure facilities (Deinne, 2021; Oyoko, Peter, & Jegede, 2023).

Provision of infrastructures in rural areas help as an encouragement to attract industrial activities, with electricity value chain in process of primary commodities will be sustained. According to Agundu and Umor (2016), the acknowledgement is built on the thoughts such as cost efficiency, allocation efficiency, equity consideration, and fiscal prudence. The government have found out the importance of developing, maintaining and sustaining a suitable and well-organized infrastructure development and the consequences of failing to provide these services. Many a times serious fiscal constraints are faced by most countries because of past neglect in the private sector resources. In the past two to three decades, many countries

have embraced the Public-Private Partnership (PPP) model as a strategic approach to bridging infrastructure development gaps and enhancing citizens' welfare. While developed nations such as the United States, the United Kingdom, Germany, and France have long integrated PPPs into their economic frameworks, emerging economies like Singapore, Malaysia, Qatar, and India have also adopted this model. These countries leverage PPPs not only to develop critical infrastructure but also to stimulate economic growth, improve service delivery, and foster innovation in key sectors, but also accelerate the growth of their economies (Ogbari et *al*, 2022; Opara, 2023).

From the World Bank report, since 1984, eight-six (86) industrialized and developing countries have shifted away from public sector financing leading to the privatization of five hundred and forty-seven (547) infrastructure in developing countries. On the light of these countries like Nigeria began to review hitherto government-controlled production, gave way to private for value addition to infrastructure provision and provide respite to already overstrained budget. Infrastructural development is value adding to economic growth by increasing effectiveness of facilities which improve the value of life expectancy. To improve these limitations to growth and poverty alleviations, many observers have suggested a large increase in public infrastructural development in line with the Big Push (Valerie *et al*, 2022; Ejima, Ikpefan, & Itai ,2024). The primary rationale for providing infrastructure goods and services is to stimulate robust economic growth by reducing production costs. Investments in infrastructure and productive activities are expected to have a positive impact on economic growth, whereas government consumption is often considered growth-retarding (Maku, 2014; Aregbe, Taoheed, & Ekpung, 2015). This has led to a significant increase in infrastructure services, including water supply, electricity, transportation, telecommunications, and irrigation. However, in developing countries like Nigeria, the provision of adequate infrastructure to meet the demands of households, businesses, and other users remains one of the major challenges of economic development. The administration of Olusegun Obasanjo (1999-2007) took proactive steps to reduce the debt profile of Nigeria only for the debt to pile up/increase during the administration of YarAdua/Goodluck Jonathan (2007-2015) and subsequent administration. Despite the huge fund expended on infrastructure financing in electricity and ICT between 1999-2015 there exists a gap between standard and actual in public infrastructural development in Nigeria.

Sanusi (2010) reported that Nigeria's investment in infrastructure accounts for 7% of GDP, slightly above the average for sub-Saharan African countries. His report emphasized the need to scale up this investment to at least 12% of GDP to drive sustainable economic growth. Infrastructure is not merely a factor of production but a fundamental prerequisite for accelerating economic development. According to endogenous growth models, infrastructure plays a crucial role in fostering economic growth, while Wagner's Law suggests that GDP growth serves as a key determinant of public infrastructural investment.

Economic growth is typically measured using Gross Domestic Product (GDP), Gross National Product (GNP), or Gross National Income (GNI), which estimate a country's total income within a given year. In developing economies like Nigeria, domestic savings are often insufficient to finance necessary investments for economic development. Since investment relies on savings, external financing becomes essential for infrastructure development. Studies indicate that returns on transport infrastructure investment are higher in developing countries than in developed nations. However, Nigeria's current infrastructure development remains in a deficit position, highlighting the urgent need for increased investment (Popov, 2018; Bhattacharya, Gupta, & Sikdar, 2020; Ashakah & Ogbebor, 2022).

Nigeria's goal of becoming one of the world's top 20 economies is hindered by poor road infrastructure, widespread power outages affecting over 60% of the population, and a struggling railway system. Despite spending over $13 billion annually on generators, the country lacks a stable power supply. The National Bureau of Statistics (NBS) reported that infrastructure expenditure contributed 19% to GDP annually over the past decade, while KPMG recommended increased investment. Sanusi (2010) noted that Nigeria's infrastructure investment stands at 7% of GDP, slightly above the sub-Saharan average but below the recommended 12%. Given the mixed findings in existing literature on the impact of public infrastructure spending, this study examines the effect of ICT and electricity investment on Nigeria's economic growth.

This study aims to examine the relationship between public infrastructure expenditure on information technology, electricity and economic growth, using real gross domestic product (GDP) as a proxy. The

key research question explores the nature of this relationship in Nigeria. The study tests the hypothesis that no significant relationship exists between public infrastructure expenditure on information technology, electricity, and economic growth. Covering a 40-year period (1981–2021), the study accounts for approximately 67% of Nigeria's post-independence history, providing a comprehensive analysis of long-term trends.

2. LITERATURE REVIEW

The nexus between the spending of government and economic growth has continued to elicit public discuss amongst researchers. The roles of government can be clarified into two – provision of security and that of public goods and services. The security function entails the creation of rules and enforcement of rights of property ownership. The risk of wrongdoing is curtailed, while also delivery securing life and property, and protect the nation from external aggression. On the other hand, the delivery of public goods and services such as roads, health, education, power, etc. Some researchers argued that a rise in government investment on physical infrastructure and social-economic activities will hearten economic growth, that is, investment on health, education, will increase the productivity of labour and subsequently growth in national output. This also implies to investment in infrastructure like power, roads, communication, etc. The outcome will lower the cost of production, increase private sector investment in viable and profitable businesses, thus encouraging economic growth. (Robinson, Eravwoke & Ukavwe 2014, World Bank, 2020).

Empirical findings indicate a positive correlation between economic growth and public investment in infrastructure facilities (Ram, 1986; Devarajan *et al.,* 1993; Niyoy et al., 2003; Mohanty & Bhanumurthy, 2019). Inadequate infrastructure remains a major hindrance to growth and development in less-developed countries. In Sub-Saharan Africa, only about 16 percent of roads are paved, and in five African countries, less than 1 percent of the population has access to electricity (World Bank & IEA, 2015). Studies have shown that the quality of public infrastructure can be measured by the average number of days per year that firms experience electricity outages (Yashino, 2008). For instance, in Rwanda, farmers receive only 20 percent of the export price of coffee, while the remaining 80 percent is lost due to high transportation costs resulting from poor road networks between Rwanda and the Port of Mombasa in Kenya. To address these structural limitations and promote economic growth and poverty alleviation, researchers have advocated for increased public investment in infrastructure, aligning with the "Big Push" theory proposed by Rosenstein-Rodan (1943). Chude and Chude (2013) examined the impact of public expenditure on education and its effect on Nigeria's economic growth between 1977 and 2012, focusing on disaggregated and sectoral expenditure analysis. In line with this, the present study adopts an ex-post facto research design and applies time-series econometric techniques to investigate the short- and long-run effects of public expenditure on Nigeria's economic growth. (Owolabi, *et al*, 2023).

Mutiu and Olusijibomi (2013), examined the relationship between public expenditure and economic growth in Nigeria. One study analyzed data from 1970 to 2009 using the Gregory-Hansen structural breaks cointegration technique. The findings supported Wagner's law in two models over the long run, revealing a structural break in 1993 due to political instability. The study also showed that economic growth and development, particularly infrastructure and human capital investment within social and community services, are key priorities of government expenditure. Edame (2014) analyzed public infrastructure expenditure trends in Nigeria from 1970 to 2012 using the Chow test. The results indicated that public expenditure consistently influenced various factors, including urbanization, population density, government revenue, external reserves, and governance structure. Okoro (2013) examined the impact of government spending on economic growth in Nigeria using time series data from 1980 to 2011. Employing the ordinary least squares (OLS) multiple regression model, with Real Gross Domestic Product (RGDP) as the dependent variable and government expenditure (GREXP) as the independent variable, the study applied the Johansen Cointegration Test, Granger Causality, and the Error Correction Mechanism. The findings confirmed a long-run equilibrium relationship between government spending and economic growth. Abu and Abdullahi (2010) observed that, despite rising government expenditure, Nigeria

continues to rank among the world's poorer nations. Their study, using a disaggregated analysis, found that total government expenditure, recurrent expenditure, and education spending negatively impacted economic growth. However, increased government spending on transportation, communication, and healthcare contributed positively to economic growth.

Results of the study revealed that national competitiveness is influenced by the level of institutional development and key infrastructural factors, including the quality of roads, air transport, railroad infrastructure, and electricity supply. Tatyana (2014) examined the extent to which infrastructure impacts national attractiveness. According to World Bank reports several factors account for economy growth and national competitiveness, these include infrastructure, health and primary education, institutions, macroeconomic, environment, technology availability, the size of the market, etc. There are various variables, analytical tools, and models that can be used to establish the fundamental relationship between key infrastructure and national attractiveness. These findings demonstrate major factors that determine economic growth that provide policy makers and owners of business, a well-structured policy framework for infrastructure investment in projects such as electricity, roads, airports, and telecommunications forms the foundation of modern economies. These infrastructures have a significant multiplier effect, often yielding results greater than two. For instance, an investment in a power plant not only generates direct employment through its construction and operation but also stimulates industrial growth in its surrounding areas, further boosting economic development. These industries will produce entrepreneurs and employment of additional labour. The employees purchasing power for goods and services will rise in the market demand, creating a virtuous cycle. When roads are built in rural areas, the citizens are close to employment options, better healthcare and market. Infrastructure therefore, is the key to eradicating poverty.

Availability of electricity in rural areas that enhances the production of commodities, with no access roads to carry the produce to market limits the production efforts of the program designed to increase access to energy. It is well noted that electricity and roads are not mutually exclusive, rather they are complimentary components of infrastructure development, that is, its availability in operations will generate efficiency and positive externalities. In developed countries, Government use economic stabilization to stimulate investment activities, public expenditure rate of growth, in less developed countries, public infrastructure expenditure plays a crucial role in reducing regional disparities by investing in social services and developing economic growth infrastructure, such as transportation, telecommunication, education and training, provision of enabling environment for key industries (Bhatia, 2002). Development of cities and new ones infers greater capital expenditure on public facilities. It requires a significantly larger supply of related goods and services, such as those associated with education, road traffic flow, and healthcare. The execution of a unique economic plan often necessitates an increase in government spending. For example, the implementation of the Structural Adjustment Programme (SAP) in 1986 led to a sharp rise in public expenditure in Nigeria

There is extensive literature on public infrastructure expenditure and economic growth in Nigeria. However, to the best of the researcher's knowledge, no study has specifically examined the relationship between public infrastructure expenditure, electricity, ICT, and economic growth in Nigeria. This is a study that should be investigated as it will assist the government and the financial regulatory authorities in narrowing the deficit in public infrastructural financing in the Nigerian economy and also recommend policies that will assist in closing the gap in public infrastructure spending so as to heighten development in economic growth in Nigeria.

3. METHODOLOGY

For the purpose of this study, a time series data is sourced for the period of 40 years from Central Bank of Nigeria (CBN) statistical bulletin, annual report and World Development Indicator (WDI) from 1981 to 2021. The choice of the sample period, 1981 to 2021, is driven by the need to capture a comprehensive and long-term perspective on the relationship between public infrastructural expenditure and economic growth. The study considers key variables (Public Infrastructural Expenditure, Economic Growth (GDP

Growth Rate), Control Variables) that are essential to understanding the relationship between public infrastructural expenditure and economic growth. A combination of advanced econometric techniques is employed to ensure a rigorous and reliable analysis.

3.1. Research Variables - Independent Variable

$$RGDP = f(GEES, GESS, GREICT, ELEC, AIRT) \quad (1)$$

Where;
RGDP measures the real growth rate domestic gross product,
GEES is public expenditure on economic services,
GESS is public expenditure on social services,
GREICT is public expenditure on information and communication technology, electricity consumption and;
AIRT is air transport infrastructure.
Data on these variables 1981 to 2021 are sourced from the Central Bank of Nigeria statistical bulletin (CBN, 2021).

3.2. Dependent Variable

Economic Growth proxied by Real Gross Domestic Product (RGDP)
These hypotheses consist of Ho which is the null hypothesis and 'H_1' which is the alternate hypothesis and they represented in Null form as follows:

3.3. Hypothesis

H_0/H_1 There exists no significant relationship between public infrastructure investment on information technology, electricity and economic growth in Nigeria.
The methods of data analysis used in this study and estimation technique are Ordinary Least Square (OLS) method, Augmented Dickey Fuller (ADF) method, Unit Root Test, Johnson Co-Integration Test and Error Correction Model. These procedures are the Unit Root Test by
Augmented Dickey-fuller test, Johnson Co-Integration Technique and the Vector Error Correction Model (VCM)
The vector error correction model could be generally specified as

$$\Delta y_t = \Pi y_{t-k} + \eta_1 \Delta y_{t-1} + \eta_2 \Delta y_{t-2} + \ldots + \eta_{k-1} \Delta y_{t-(k-1)} + \varepsilon_t \quad (2)$$

Where;

$\Pi = (\sum_{i=1}^{k} \beta i)_{t-i}$ are the long run co efficient of y_s and
$\eta_i = (\sum_{j=1}^{i} \beta j)_{t-i}$ represents short run estimates.

The VECM is a case of unrestricted VAR, thus it is required that the same number of lags of all the variables is used in all the equations.

3.4. Specified Model

It was observed by various scholars that there was lack of relationship between long run growth and available policy instruments in the neoclassical model. This lack of relationship between the two led to the development of the new growth model which had different variants, such as that of Lucas (1988) and Romer (1989). This new growth theory is referred as Endogenous growth model. This model offers the possibilities of transforming the temporary growth effects of infrastructure spending and other fiscal policy into permanent ones. Here, the actions of the government are very important. This theory places more emphasis on the role of public expenditure towards economic growth particularly in less developed and developing economies such Nigeria. The study will now go on to provide a basic model based on the endogenous growth theory as follows;

$$RGDP = f(GEES, GESS, GREICT, ELEC, AIRT) \quad (3)$$

Where;

RGDP measures the real growth rate domestic gross product, GEES is public expenditure on economic services, GESS is public expenditure on social services, GEICT is public expenditure on information and communication technology, electricity consumption and AIRT is air transport infrastructure. The data on these variables from 1981 to 2021 were sourced from Central Bank of Nigeria statistical bulletin (CBN, 2021).

Equation (1) may be estimated in its econometric form which is *written* as:

$$RGDP_t = \alpha_0 + \alpha_1 GEES_t + \alpha_2 GEICT_t + \alpha_3 ELEC_t + \alpha_4 AIRT_t + \varepsilon_t \quad (4)$$

α_0 is the intercept term

α_i are the slope coefficient representing the parameters for estimation.

μ_t is the disturbance term assumed to purely random and distributed with zero mean and constant variance while the subscript t denotes the variables at time period t.

The study apriori expectation, the various theoretical expectations are:

$\alpha_1, \alpha_2, \alpha_3 \alpha_4$ and $\alpha_5 > 0$

The long run relationship in equation 2 above is estimated using Johansenand Juselius (1992) co integration technique based on auto regression models.

4. DISCUSSION AND FINDINGS

As stated in the previous section, the time series of the variables were examined, and the results are presented in Table 1. At their levels, none of the series were stationary, indicating that the unit root null hypothesis could not be rejected. To achieve stationarity, all variables were differenced once, attaining stationarity at the first difference, using a 5% significance level. Therefore, the use of first difference in the model. We achieved the policy implication as a result of stationarity of the variables used in the models.

Table 1. Unit Root Result

Variable	ADF Test @Levels (5 % significance level	ADF Test @ First Difference	Remark
LRGDP	-0.950480(-2. 941145)	-3.979343(-2.938987) ***	Integrated to order 1
LGEES	-0.732501(-2. 936942)	-6.758429(-2.938987) * **	Integrated to order 1
LGEICT	-1.579555(-2. 936942)	-8.427243(-2.938987) * **	Integrated to order 1
LELEC	-2.479256(-2. 936942)	-8.787504(-2.938987) * **	Integrated to order 1
LAIRT	-0.873397(-2. 936942)	-5.873327(-2.938987) * **	Integrated to order 1

*Source: Computer Printout Analysis – E-Views 10. Note: The critical t-values are in brackets, while the ADF test statistics are outside the brackets. ***, **, and * indicate stationarity at the 1% significance level.*

From the indication, stationarity for two or more sequence with different order of integration comprising of 1 (0) and one 1(1), To confirm the long-run relationship among the series, a linear combination of two or more series should result in a co integrated series of a higher order, I(1). Therefore, the study employed the Johansen-Juselius (1992) multivariate co integration procedure to determine whether a long-run relationship exists among the model's variables, as presented in Table 2.

Table 2. Co integration Analysis

Hypothesized No. of CE(s)	Eigen Value	Trace Statistics	0.05 Critical Value	Prob.**	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.771380	127.0999	88.80380	0.0000	54.60075	38.33101	0.0003

Hypothesized No. of CE(s)	Eigen Value	Trace Statistics	0.05 Critical Value	Prob.**	Max-Eigen Statistic	0.05 Critical Value	Prob.**
At most 1 *	0.640875	72.49918	63.87610	0.0079	37.89111	32.11832	0.0088
At most 2	0.444367	34.60807	42.91525	0.2615	21.74295	25.82321	0.1580
At most 3	0.233831	12.86512	25.87211	0.7486	9.855063	19.38704	0.6344
At most 4	0.078132	3.010060	12.51798	0.8753	3.010060	12.51798	0.8753

Source: Computer Print Out Analysis – E-view 10

The results of the statistical test, including the trace and maximum eigenvalue statistics, indicate the presence of at most two co integrating relationships among the variables considered in the study. This suggests the existence of a long-run equilibrium relationship among the series, which includes real gross domestic product (GDP), government expenditure on economic services, and other relevant factors, on ICT, registered air transport carrier departure and electricity consumption that measures energy infrastructure.

Table 3. WAR Lag Oder Selection Criteria

Endogenous variables: DRGDP DGEES DGETCOM DELEC DAIRT						
Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	-1251.925	NA	3700.000	66.15397	66.36945*	66.23064*
1	-1225.899	43.83465*	3550.000*	66.09993*	67.39276	66.55991
2	-1205.757	28.62171	4930.000	66.35566	68.72585	67.19895

Source: Computer Print Out Analysis – E-view 10

It is essential to ascertain the relevant lag periods in estimating the vector error correction model and its required tests. This study employed the vector autoregressive lag length criteria in carrying out this procedure. The statistical criteria used comprises of loglikelihood (LogL), sequential modified Likelihood Ratio (LR) test statistic, Final Prediction Error (FPE), Akaike Information Criterion (AIC); Schwarz Information Creteria (SIC), and Hanna-Quinn Information Criteria (HQ). From the result in Table 4, it is obvious that lag period 1 is the most suitable lag order as selected by LR test statistic and the Akaike Information Criteria (AIC) for the estimation. Each test was conducted at 5 percent level.

Table 4. Normalized Cointegrating Series

1 cointegrating Equation(s):		**Log likelihood**	**-1157.818**	
Normalized cointegrating coefficients (standard error in parentheses)				
DRGDP	DGEES	DGEICT	DELEC	DAIRT
1.000000	16.04940	-115.4646	-103.8238	-0.238830
	(3.48874)	(21.2427)	(34.9216)	(0.03486)
T-Statistics	[4.6003]	[5.4355]	[2.9730]	[6.8502]

Source: Computer Print Out Analysis – E-view 10. T-statistics are the values in square brackets represents the while the standard errors are in brackets.

The outcome of the normalized long run relationship between government expenditure on economic services, information communication technology, energy infrastructure, air transport infrastructure and RGDP. Given the normalized cointegrating results, the signed coefficients are interpreted in reverse order. Thus, government expenditure on economic services shows significant retarded impact on real economic growth while ICT, electricity and air transport infrastructural spending exhibited a direct effect on growth. Specifically, a percentage change in ICT, electricity and air transport spending leads to a corresponding 115.46, 103.82 and 0.24 percentage increase in growth respectively while a percentage change in economic

services spending result to 16.05 percentage in retardation in growth. It is seen that all the infrastructural components of government expenditure exert significant impact on real growth. With the exception of economic service expenditure all the infrastructural spending determinants had a positive influence on growth.

Table 5. Long run coefficient

Variable Co integrating Eq:	Coefficient CointEq1	Std. Error	T-Statistic	
C	293.0141			
GEES(-1)	-16.04940	3.48874	[4.60034]	
GEICT(-1)	115.4646	21.2427	[-5.43551]	
ELEC(-1)	103.8238	34.9216	[-2.97305]	
AIRT(-1)	41.93319	16.1199	[-2.60132]	
Diagnostic tests				**P-value**
R-squared	0.621249			
Adj. R-squared	0.454599			
Serial Correlation LM Tests	0.762878			0.7697
Heteroskedasticity Tests	348.1824			0.2355

Source: Computer Print Out Analysis – E-view 10.

The analysis of the results in Table 5 confirms the existence of a long-run relationship between economic growth and public expenditure on infrastructural development, as represented by government expenditure on economic services, social services, ICT, electricity consumption, and air transport infrastructure, proxied by registered air transport carriers. The R-squared value indicates that over 62% of the total variations in economic growth are jointly and significantly explained by variations in public expenditure on infrastructural development, including expenditures on economic services, social services, information and communication technology (ICT), electricity consumption, and air transport infrastructure. This reflects a high goodness of fit for the model, demonstrating its strong explanatory power in capturing the relationship between public infrastructure investment and economic growth.

All the variables were estimated at a lag length of 1. Specifically, a 1% change in public expenditure on economic goods and services results in a 16.05% change in economic growth, assuming other variables remain constant. This indicates that a proportional change in government expenditure on economic services leads to a more than proportional and significant impact on economic growth. Evidence from the estimated long-run coefficient for government expenditure on social services in Table 4 suggests that economic growth is highly responsive to changes in government spending on social services, demonstrating an elastic relationship.

Analysis of the estimated result for public expenditure on ICT infrastructure has a significant relationship with economic growth. The estimated lag coefficient indicates that a 1% change in ICT infrastructure expenditure leads to a 115.46% change in real economic growth. This suggests that government expenditure on ICT infrastructure has a substantial impact on economic growth within the study period. Similarly, electricity consumption shows a positive and significant relationship with economic growth. A 1% increase in electricity consumption results in a 103.82% increase in economic growth at a 5% significance level. This implies that changes in electricity consumption led to a more than proportionate impact on economic growth, demonstrating a high degree of responsiveness. The variation in electricity consumption exhibits elasticity greater than one, indicating that economic growth is highly sensitive to changes in electricity usage. Furthermore, the estimated coefficient for registered air transport carriers reveals a significant relationship with economic growth at a 5% significance level, emphasizing the role of air transport in supporting economic expansion. A percentage change in air transport infrastructure indicates a 41.93 percentage change in growth all things being equal.

A detailed analysis of the parameter estimates for the economic growth model shows that public expenditure on information communication technology, electricity consumption and air transport infrastructure reveal a significant positive effect on economic growth. The result further shows that in

terms of signs and magnitude, changes in public expenditure on economic services, electricity consumption and air transport infrastructure results to a significant direct relationship with economic growth and therefore could be considered to have significantly enhanced growth in the economy.

The evidence from the long-run coefficient confirms that public expenditure on infrastructural development has a significant impact on economic development. Therefore, infrastructure development expenditure is considered a key determinant of real economic growth, particularly for developing countries like Nigeria. However, a detailed analysis of the elasticity of growth in response to public expenditure on economic infrastructure is necessary to understand its long-term effects and policy implications. services suggest the need for a concerted effort to significantly enhance economic growth through economic service oriented fiscal policy targeted on promoting real growth through sustainable and inclusive economic service delivery.

Table 6. Error Correction Estimates

Error Correction:	D(DRGDP)	D(DGEES)	D(DGETCOM)	D(DELEC)	D(DAIRT)
CointEq1	-0.570541	-0.032882	0.001998	-0.000930	1.005955
	(0.15081)	(0.01748)	(0.00251)	(0.00133)	(1.65148)
	[-3.78326]	[-1.88102]	[0.79554]	[-0.69842]	[0.60912]

Source: Computer Print Out Analysis – E-view 10.

Given the long-run relationship between public infrastructural expenditure and economic growth, as previously discussed, this study further estimates the error correction model using the vector error correction approach (Table 6). The error correction model allows for the assessment of short-run dynamics in adjusting toward long-run equilibrium. The error correction term is correctly signed, falls within the expected range of 0 and 1 in absolute terms, and is statistically significant at the 5 percent level. This indicates that approximately 57.05 percent of the disequilibrium in the system, caused by external shocks, is corrected in each period. Hence there is opportunity for the system to be fully restored back to normal in less than two fiscal periods in the advent of external shocks. In the same vain, the system has the ability to adjust back to its equilibrium condition when external forces are acted upon with a relatively high speed of convergence.

4.1. Findings

The empirical findings were obtained through a series of econometric tests. The Augmented Dickey-Fuller (ADF) unit root test was conducted to assess the stationarity of the variables, ensuring the appropriateness of further analysis. Following this, the Johansen co-integration test was applied to determine the existence of a long-run relationship between public expenditure on infrastructure and economic growth in Nigeria. Additionally, the Vector Error Correction Model (VECM) was employed to examine the short-run dynamics and adjustment process of public infrastructural expenditure in relation to real economic growth in Nigeria.

In this study, the basic line model is specified to capture the hypothesized relationship among the essential variables. In the literature of finance, various scholars observed that there was lack of relationship between long run growth and available policy instruments in the neoclassical model. This lack of relationship between the two led to the development of the new growth model which had different variants, such as that of Lucas (1988) and Romer (1989). This new growth theory is referred as Endogenous growth model. This theory highlights the significance of public expenditure towards economic growth particularly in less developed and developing economies such as Nigeria.

The empirical findings from the data analysis are presented in the previous section (Tables 1–6). The results of the Augmented Dickey-Fuller (ADF) unit root test indicate that all variables in the study are stationary at first difference, justifying the application of the Johansen co-integration test. The Johansen co-integration test results (Tables 2 and 3) confirm the presence of a long-run relationship among the variables, establishing that real economic growth and public expenditure on infrastructure—including

economic services, ICT, electricity, and air transport facilities (Table 6)—are co-integrated. This reinforces the existence of a long-run equilibrium relationship between public infrastructure investment and economic growth in Nigeria.

The hypothesized number of co-integration equations and the error correction mechanism are presented in Tables 2 and 5. As shown in Table 4, a proportional increase in government expenditure on economic services results in a more than proportional increase in economic growth. The estimated long-run coefficient for government spending on economic services confirms that real economic growth responds significantly and elastically to changes in infrastructural investment. Additionally, a 1% increase in government expenditure on social services leads to a more than proportional and statistically significant impact on economic growth. The analysis further reveals a strong and positive relationship between public expenditure on ICT infrastructure and economic growth, reinforcing the notion that investment in social service infrastructure plays a crucial role in driving economic expansion in Nigeria as a developing economy.

The estimated lag coefficient results indicate that a 1% increase in ICT infrastructure expenditure leads to a 115.46% change in real economic growth, highlighting the substantial impact of government investment in ICT on economic expansion during the study period. Similarly, electricity consumption demonstrates a strong and significant relationship with economic growth, as a 1% increase in electricity consumption results in a 103.82% increase in economic growth at a 5% significance level. This suggests that economic growth responds more than proportionately to variations in electricity consumption, emphasizing its highly elastic and significant effect. Furthermore, the estimated coefficient for registered air transport carriers confirms a significant relationship with economic growth at the 5% significance level. A percentage change in air transport infrastructure indicate 41.93 percentage change in growth all things being equal.

It is seen from the study findings that the estimated lag coefficient result of the parameter estimates for the real growth model shows that public expenditure on economic services, electricity consumption and air transport infrastructure reveal a significant long run effect on economic growth. The results further reveal that, in terms of both direction and magnitude, changes in public expenditure on economic services, electricity consumption, and air transport infrastructure exhibit a significant positive relationship with economic growth, except for public spending on economic services, which deviates from this pattern. Hence, public infrastructural spending could be considered to have significantly enhanced growth in the Nigerian economy. Hence, public financing on economic services, utility and infrastructure plays out to have significant contribution towards economic growth as evidenced from the present study.

5. CONCLUSIONS

Evidence from the long-run coefficient indicates that public expenditure on infrastructural development has a significant impact on real economic growth, making it a key driver of economic progress, particularly in developing countries. However, a detailed analysis of growth elasticity in relation to public expenditure on economic services highlights the need for a strategic and coordinated approach. This calls for fiscal policies aimed at fostering sustainable and inclusive economic service delivery to maximize growth potential. The study therefore concludes that public expenditure infrastructure is crucial for real economic growth. The study shows that public spending could be both good and detrimental to the economy. Public expenditure infrastructure is good where it enhances economic activities and detrimental where there is misappropriation of funds. Therefore, a balance has to be put in place between the two for maximum efficiency.

The study provides empirical evidence that expansionary fiscal policies directed toward economic and social services—such as power supply, transportation, aviation, power generation, and information and communication technology—can significantly enhance real economic growth. These investments not only improve the quality of life and overall welfare of citizens but also create opportunities for investment and employment in key sectors, ultimately driving sustainable economic expansion. However, fiscal policies on the provision of economic services seemed not to have yielded expected result owing to administrative

and institutional deficiencies. For instance, between 1999-2021, the Nigeria government borrowed so much but there are no visible signs or impact on real economic growth as expected. This may be due to massive corruption witnessed during the period mentioned above. The borrowed funds were channeled to less productive projects such as addressing of security challenges posed by terrorism It is therefore pertinent for a proper review and appraisal of the fiscal policy formulation and implementation in this regard in order to enhance contribution to the growth of the Nigeria economy.

The study highlights the importance of analysing the elasticity of economic growth in relation to public expenditure on economic services. It emphasises the need for the government to adopt a proactive and strategic approach to fiscal policy, ensuring that public spending effectively drives sustainable economic growth. Based on the findings, the study recommends that the government exercise prudence in public expenditure, infrastructure development, and economic growth initiatives to maximise their impact on Nigeria's economy. Public expenditure infrastructure should be under taken only when necessary and should be used for the purpose for which it was taken.

Ethical approval

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

Informed consent statement

Not applicable.

Authors' contributions

Itai Muktar conceptualized the study, developed the analytical framework, and supervised the overall research process. Ikpefan Ailemen contributed to the literature review, theoretical development, and data analysis. Okorie Uchechukwu was responsible for data collection, model implementation, and interpretation of findings. Olubuyi Timilehin assisted in methodological design, drafting, and refining the manuscript for publication. All authors reviewed and approved the final version of the manuscript.

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No potential conflict of interest was reported by the author(s).

Data availability statement

The data presented in this study are available on request from the corresponding author due to privacy reasons.

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