Innovations

Electricity Consumption and Human Capital Development in Nigeria;An Implication for the Sustainable Development Goal (SDG 7)

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Absract:*Managing energy consumption and human beings for the sustainace of economic prosperity in Nigeia have neccesitaed the deliberate efforts to explore healthier and sustainable energy sources. As a result of this, the nexus between electricity consumption and human capital development in Nigeria requires urgent attention because human capital plays a pivotal function in motivating economic development, and consumption of electricity is an impetus for the output growth. Against this backdrop, this study examined the influence of electricity consumption on human capital development in Nigeria from 1990 to 2019 within the techniques of econometrics. The summary of findings in this study are presented as follows; electricity consumption had a positive and significant relationship with the human development index in Nigeria. Furthermore, there was a unidirectional causal relationship flowing from government capital expenditure (GEC) to electricity consumption (ELC) in Nigeria. As a result of the above findings, this study makes the following recommendation for the policymakers as thus, whenever the development of human capital is the priority of the Nigerian government, the investment in capital projects that will catalyse the improvement in generation of electricity should be embarked in the country. Similarly, in achieveing the SDG goal seven in Nigeria the policymakers in the country shouldexplore more of energy from electricity in driving human development in the country.*

Keywords: 1.*Electricity Consumption, 2.Human Capital Development, (SDG 7)*

1. Introduction

In the recent times, the impact of energy consumption and its aftamath effects on macroeconomic variables such as human capital, industrial outputs and economic growth have increasingly become one of the critical subject of debates among scholars in Nigeria (Aderemi *et al.*, 2022; Olaoye *et al.*, 2020; Aderemi *et al.,* 2021; Zhange *et al.,* 2017; Osabohien *et al.*, 2021). Meanwhile, the need to expand economic prosperity and urbanization to cater for the spoardical growth in developing countries has put the persistent pressure on the global usage of energy such as electricity (Nain *et al.,* 2017; Suganthi and Samuel, 2012; Raza et al., 2016). Over the times, the rise in the use of energy like electricity has been attributed to the accumulation of greenhouse gases in the atmosphere, of which its effects on human health have been submitted to be devastating (Matthew *et al.,* 2018; Alege *et al.,* 2017). Despite this, every country`s economic prosperity is a function of high power consumption which is a principal variable for the advancement of human capital (Fang and Chang, 2016).

However, In recent years, managing energy consumption and human beings for the sustainace of economic prosperity in countries of the world have neccesitaed the deliberate efforts toexplore healthier and sustainable energy sources. As a result of this, the United Nations provided the global platform to achive to achieve through the institutionised of the agenda 2030 otherwise known as the Sustainable Development Goals (SDGs) (United Nations 2015).

Consquently, studies regarding nexus between electricity consumption and human capital development in Nigeria require urgent attention because human capital plays a pivotal function in motivating economic development in one hand(Mankiw *et al*., 1992; Lucas, 1988), and consumption of electricity is an impetus for the output growth on the other hand (Ejemeyovwi *et al.*, 2018; Todaro and Smith, 2003). But, it has been observed that human capital development is very critical in Nigeria due to the fact that the country is extremely ranked low in terms of human development in the world(UNDP, 2019). In the same vein, electricity as a source of energy is a critical infrastructure in which its linkage with the development of human capability cannot be ignored (Jahan, 2000). Against this backdrop, this study examined the influence of electricity on human capital development in Nigeria. This study was built on the argument that there have not been adequate research done in the impact of electricity consumption in human capital development especially in Nigeria. Therefore, this study exists to fill the existing gap in the literature.

2. Theoretical Review

2.1 Human Capital Theory

Human capital theory could be associated with the revolutionary works of Schultz (1961) and Becker (1964). The basic argument underlining this theory is that investment in human capacity through education increases the cognitive skills and efficiency of workers which metamorphose into higher productivity in the firm. Investment in human capacity brings about a rise in the stock of human capabilities, and such investment include the following education and educational oriented conferences, health, nutrition and on-the-job training. It is important to stress that, according to the theory, the stock of human capital could only rise in a period the moment the gross investment supersedes depreciation as time goes, with intense use or lack of use. Meanwhile, education in this context is regarded as a strategic investment in human resource in which human capital theorist considers as important as physical capital or even more worthwhile than the investment in physical capital. It has been established by human capital theorists that basic literacy catalyzes the productivity of workers engaging working in low skilled professions. Consequently, the marginal productivity of workers engaging in high skilled profession and positions increases in response to the demand for logical and analytical reasoning which requires technical and specialized information. Therefore, the submission of the theory is that the society that makes room for greater the provision of schooling, such the society will eventually witness the greater rise in aggregate productivity. Hence, the relevance of this theory to the subject matter of the study.

2.2 Literature Review

From 1981 to 2016, Matthew et al. (2018) investigated the multiplier effect of human capital development via the use of electricity power for maximum productivity to boost economic growth in Nigeria. The method of analysis used in the study was fully modified ordinary least squares (FMOLS). The study's findings revealed that the consumption of electricity is significantly related to the rise of the economy, whereas human capital development is insignificantly related to economic growth. According to the study, the government should promote human capital development by improving the country's health and educational infrastructures.

Ugwoke et al. (2016) used a double-log linear formulation to analyze data from 1980 to 2014 on the connection between electricity consumption with outputs from industrial scene in Nigeria. According to the findings, electricity supply and trade openness had a relatively insignificant negative impact on industrial production. It was suggested that the government provide tax breaks for privately generated power used in industrial output.

Prince et al. (2021) used a multivariate framework to examine the causal relationship between energy consumption and economic growth in Nigeria from 2000Q1 to 2018Q4. The Autoregressive Distributed Lag (ARDL) bounds test approach and the Error Correction Model (ECM) were used to analyze the data for the study. The findings revealed a bidirectional co-integration relationship between petroleum consumption, liquefied natural gas consumption, and electricity consumption. Increased energy consumption stimulates economic growth by increasing the value of goods and services. A unit reduction in electricity consumption raises petroleum consumption while lowering economic growth. The non-causal relationship can be attributed to the energy demand-supply gap. The study recommends, among other things, a review of the billing system, pricing framework, and policies to support and ensure efficient and responsive energy distribution and maintenance in order to promote value addition and economic growth.

Okoligwe and okezie (2014) investigated the relationship between electricity consumption and economic growth from 1971-2012. Error Correction Mechanism (ECM) and Granger Causality test were used to analyze the data. During the study year, the Granger causality was found to be non-existent between electricity consumption and real GDP, as well as between GDP and electricity consumption.. As a result, policymakers in Nigeria should prioritize building capacity expansion and infrastructure development during the early stages of reconstruction.

Chinedu *et al.* (2019) assessed the impact of energy consumption on economic growth over a period of 1980 to 2017. The method of analysis used was error correction model. The empirical findings revealed that petroleum oil and liquefied natural gas had a positive significant impact on real GDP, whereas electricity had a positive insignificant impact on real GDP. As a result, the study suggests that oil refining and transportation companies increase petroleum supply throughout the country by connecting major towns with petroleum pipelines.

Keji (2021) empirically examines the nexus between human capital and economic growth in Nigeria between 1981 and 2017. According to the findings, the estimated human capital coefficients have a long-run significant impact on Nigeria's economic growth. Moving forward, the study suggests that Nigeria sustain its economy by increasing budgetary allocations to the education and health sectors in order to boost human capital skills required to drive a knowledge-based economy.

Abubakar *et al.* (2020) examined the effect of human capital development on the economic growth of Nigeria.

The Auto-regressive and Distributive Lag (ARDL) model was applied to annual series spanning the years 1983 to 2018. The findings of the study revealed the a long-run association between the study variables was present. Furthermore, both components of human capital development were discovered to have a positive effect on economic growth in both the short and long run, with education having a larger effect. In order to stimulate Nigeria's economic growth, policymakers must improve access to and the quality of health care and education, according to the study.

3. Methodology

3.1 Theoretical Framework

This work is anchored on the endogenous growth theory. This theory was developed in reaction to the shortcomings of the neoclassical (exogenous) growth model which was championed by Solow. Endogenous growth theory as developed by Lucas (1988) represents an extension of the Solow (1956) neoclassical growth model incorporating positive externalities related to the accumulation of human capital through knowledge. The basic argument of the endogenous model is that human capital is an indispensable input in the production function. Therefore, sustainable growth is facilitated by endogenizing technical progress. In the recent version of the model, economic growth was driven by innovation which was domiciled in investment in human and technical improvement (Lucas, 1988).

Different scholars have designed different conceptual frameworks that incorporate human capital as one of the determinant factors of economic growth. The justification for the inclusion of human capital in the model is the fact of non-homogeneity of labour in the production process either within a nation or across different economies due to their possession of different levels of education and skills. This modification facilitates the suitability and hence, the adaptation of this model for the Nigerian context. The basic assumption in this approach is that increase in workers' quality through improved education, improves output Mankiw *et al.* (1992) explain the relationship in a Cobb-Douglas production function with constant returns to scale. The general form of the human capital augmented Cobb-Douglas production is shown below:

$$Yt=AKt^{\alpha}Ht^{\beta}\,Lt^{1-\alpha-\beta} \qquad \alpha+\beta<1 \qquad (1)$$

Econometrically, the model is specified as follows:

$$Yt=AKt^{\alpha}Ht^{\beta}\,Lt^{1-\alpha-\beta}\,U \qquad \alpha+\beta<1 \qquad (2)$$

Where: Yt = output at time t

A = level of technology

Kt = physical capital at time t

Ht = human capital at time t

Lt = labour at time t

α = elasticity of physical capital with respect to output

β = elasticity of human capital with respect to output

U = error term

When transformed into a log-linear form, it becomes:

$$logYt=\alpha_0+\alpha logKt+\beta logHt+\theta logLt+V \qquad (3)$$

Where: $\theta=1-\alpha-\beta$; α_0 = logA and V = logU

3.1 Model Specification

Emanating from endogenous theory, the importance of investment in education and health cannot be ignored in facilitating human capital development (Lucas, 1988). Meanwhile, electricity generation is one of the strategic spillovers of education and technology in which its inputs for production are essential in driving development in an economy (Lee and Chang, 2008; Stern, 2011; Alaali *et al*., 2015).
In the light of the above, this study utilized an input-output analysis in the forms of the Cobb Douglas production function as follows;

$$HDI = F(ELC^{\alpha 1}\, GEC^{\alpha 2}\, GFCF^{\alpha 3} FDI^{\alpha 4} \quad (4)$$

If the independent variables in model 1are subjected to logarithm, this cause the linearization of the modelascfollows;

$$HDI_t = \alpha_0 + \alpha_1 \log ELC_t + \alpha_2 \log GEC_t + \alpha_3 \log GFCF_t + \alpha_4 \log FDI_t + u_t \quad (5)$$

In the models 3-5, the direction of causality was examined in this study as follows:

$$HDI_t = \beta_0 + \sum_{i=0}^{p} \beta_1 HDI_{t-1} + \sum_{i=0}^{p} \beta_2 ELC_{t-1} + \sum_{i=0}^{p} \beta_3 GEC_{t-1} + \varepsilon_{1t} \quad (6)$$

$$ELC_t = \gamma_0 + \sum_{i=0}^{p} \gamma_1 ELC_{t-1} + \sum_{i=0}^{p} \gamma_2 GEC_{t-1} + \sum_{i=0}^{p} \gamma_3 HDI_{t-1} + \varepsilon_{2t} \quad (7)$$

$$GEC_t = \alpha_0 + \sum_{i=0}^{p} \alpha_1 GEC_{t-1} + \sum_{i=0}^{p} \alpha_2 HDI_{t-1} + \sum_{i=0}^{p} \alpha_3 ELC_{t-1} + \varepsilon_{3t} \quad (8)$$

Table 1: Data Description and Measurement

Abbreviation	Description	Unit of Measurement	Source
HDI	Human Development Index HDI which the UNDP has operationally defined in the form of a composite index conceptualisihing human development in terms of health, knowledge, and standard of living. However, the technical calculation of HDI could be explored from the technical note of the Human Development Reports.	Percentage	World Development Indicators of World Bank
ELC	Electricity Consumption and supply of electricity production from hydroelectric sources was used to proxy it	Kilo-watt	World Development Indicators of World Bank
FDI	FDI inflows as a percentage of GDP is used in this study	Percentage	United Nations Conference on Trade and Development
GEE	Government Expenditure on Capital Project as percentage of GDP	Percentage	Central Bank of Nigeria Stastical Bulletin
GFCF	Gross fixed capital formation	Percentage	World Development Indicators of World Bank
α_0 is the intercept, and α_1 toα_4 have the expected of sign >0			

Source: Authors` Compilation (2022)

3.2 Estimation of Analysis

The study employed Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) unit roots test to check for the stationarity of the data series and Johansen Cointegration test was used to check the long run equilibrium among the variables. If the data set variables possess unit root, this means they only have a short run relationship hence the need for the cointegration test to check for the long run relationship. The study also made use of Fully Modified Ordinary Least Square (FMOLS) to check the impact of electricity consumption on human capital development. The study also checked for the causal relationship among the key variables in the data set using the Pairwise Granger Causality.

4 Results and Discussion

Table 2: Descriptive Statistics

	HDI	ELC	GEC	GFCF	FDI
Mean	0.468000	116.0728	2.947931	27.75531	1.728000
Median	0.465000	120.6351	2.250000	26.06325	1.608284
Maximum	0.539000	156.7972	9.080000	53.12219	5.790847
Minimum	0.400000	74.49062	0.640000	14.16873	0.195183
Std. Dev.	0.043616	27.79852	1.988977	11.77122	1.219247
Skewness	0.172046	-0.107967	1.177469	0.513524	1.766123
Kurtosis	1.717716	1.488655	4.190925	2.059042	6.461956
Jarque-Bera	2.129869	2.816374	8.414875	2.344444	29.55813
Probability	0.344750	0.244586	0.014884	0.309678	0.000000
Sum	13.57200	3366.112	85.49000	804.9040	50.11200
Sum Sq. Dev.	0.053266	21637.22	110.7689	3879.725	41.62378
Observations	29	29	29	29	29

Source: Authors` Computation (2022)

The table above displays the descriptive statistics for the estimated data set. Descriptive statistics are required to determine whether or not the data set corresponds to the normal distribution assumption. According to the table above, the highest value is for electricity consumption (ELC), while the lowest is for FDI. Furthermore, the mean value of electricity consumption (ELC) is the highest, while the mean value of foreign direct investment is the lowest. Furthermore, the median value of electricity consumption (ELC) is the highest, while the median value of FDI is the lowest. The means of all variables are greater than their standard deviations. Because the standard deviation is smaller than the mean, the data is fairly dispersed from its mean. Furthermore, the skewness values in the data set are positive, with the exception of electricity consumption (ELC), which is negatively skewed.

Kurtosis, on the other hand, shows that certain variables are platykurtic in nature because their values are less than 3, while others are leptokurtic because their values are greater than 3, meaning that they are highly peaked with a very high tail. The JarqueBera test is used to determine the distribution of a variable's normalcy.

Table 3: Augmented Dickey-fuller Test and Phillips PerronTest

Variables	Augmented Dickey-Fuller Test				
	Level	Probability	1st Diff	Probability	Remark
HDI	-2.976263	0.7717	-2.986225	0.0000	I (1)
ELC	-2.967767	0.7478	-2.971853	0.0000	I (1)
GEC	-2.971853	0.6739	-2.971853	0.0000	I (1)
GFCF	-2.967767	0.0980	-2.971853	0.0143	I (1)
FDI	-2.967767	0.0462			I (0)
Variables	Phillips Perron Test				
	Level	Probability	1st Diff	Probability	Remark
HDI	-2.976263	0.8496	-2.986225	0.0001	I (1)
ELC	-2.986225	0.7748	-2.971853	0.0000	I (1)
GEC	-2.967767	0.3453	-2.971853	0.0000	I (1)
GFCF	-2.967767	0.0980	-2.971853	0.0147	I (1)
FDI	-2.967767	0.0462			I (0)

Source: Authors` Computation (2022)

The estimated results of the unit roots tests utilizing the Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) tests are shown in Table 2. The results demonstrate that, with the exception of one variable

that was stationary at level, all variables in the data set were stationary at first differencing. This indicates that all of the data in this study are a combination of I(0) and I(1).

Table 4: Johansen Cointegration Test

Hypothesized No. Of Ce(S)	Eigenvalue	Trace Statistic	Prob.**	Max-Eigen Statistic	Prob.**
None *	0.918723	122.4688	0.0000	62.74727	0.0000
At most 1 *	0.673132	59.72151	0.0026	27.95499	0.0448
At most 2 *	0.518866	31.76652	0.0293	18.29022	0.1194
At most 3	0.384768	13.47631	0.0985	12.14389	0.1053
At most 4	0.051901	1.332416	0.2484	1.332416	0.2484

Source: Authors` Computation (2022)

The table above displays the projected long-run equilibrium link between electricity consumption and human capital development in Nigeria using the Johansen Cointegration Test. As a result of the given table, it was possible to determine that at least four (4) cointegration vectors existed among the variables.

Table 5: Electricity Consumption and Human Capital Development in Nigeria

Method: FMOLS

Independent Variables	Coefficient	T-Statistic	Prob.
ELC	0.001060	4.324373	0.0003
GEC	-0.000980	0.349164	0.7301
GFCF	-0.000653	1.154924	0.2600
FDI	-0.007767	3.112902	0.0049
C	0.383207	9.064364	0.0000
R-squared	0.838691		

Source: Authors` Computation (2022)

The following table presents estimates of the long-run link between electricity consumption and human capital development using the Fully Modified Ordinary Least Squares approach. It should be stressed that it is only electricity consumption shows the anticipated sign. The R-Squared value of 0.83 indicates that ELC,GEC, GFCF, and FDI together explained around 83 percent of the systematic fluctuations in the human development index (HDI). This signifies that the model performed rather well in the analysis. Furthermore, in Nigeria, electricity consumption in log form shows a direct and substantial relationship with the human development index. This shows that electricity consumption motivated a significant development of human capital in Nigeria. However, government expenditure on captal project, gross fixed capital formation, and FDI have a negative influence on human capital development in the country, although only FDI has a significant impact on HDI, while GEC and GFCF have an insignificant impact on HDI. A unit increase in electricity consumption results in a 0.001 percent increase in the country's human development index. Similarly, a unit change in government capital expenditure, gross fixed capital formation, and foreign direct investment results in a 0.0009 %, 0.0006 %, and 0.007 % fall in the human development index, respectively. It should be noted that the negative influence of the control variables on HDI could be as a result of low investment of human development aspects of these variables in Nigeria over the years.

Table 6: Pairwise Granger Causality Test

Null hypothesis	F-Stat	Prob.	Decision	Causality
ELC does not Granger Cause HDI	2.74655	0.0883	Accept	
HDI does not Granger Cause ELC	1.90163	0.1754	Accept	
GEC does not Granger Cause HDI	0.61109	0.5526	Accept	
HDI does not Granger Cause GEC	2.78863	0.0855	Accept	
GEC does not Granger Cause ELC	4.78757	0.0183	Reject	Unidirectional
ELC does not Granger Cause GEC	1.11671	0.3445	Accept	

Source: Authors' Computation (2022)

The table above displays the estimated outcome of the pairwise granger causality test, which was used to examine the causal link between electricity consumption and human capital development in Nigeria. The findings established that there is a causal flow from government capital expenditure (GEC) to electricity consumption (ELC), but no causal flow from electricity consumption (ELC) to government capital expenditure (GEC). This means that GEC and ELC have unidirectional causation.

1. Conclusion and Policy Recommendation

The contribution of electricity consumption to the development of human capital in Nigeria from 1990 to 2019 has been examined within the techniques of econometrics like Fully Modified Ordinary Least Squares (FMOLS) and Pairwise Granger Causality Test. The summary of findings in this study are presented as follows; electricity consumption had a direct and ssubstantial relationship with the human development index in Nigeria. Consquently, government expenditure on captal project, gross fixed capital formation, and foreign direct investment had a negative influence on human capital development in the country, although only FDI has a significant impact on HDI, while GEC and GFCF have an insignificant impact on HDI. Moreover,there was a unidirectional causal relationship flowing from government capital expenditure (GEC) to electricity consumption (ELC) in Nigeria. As a result of the above findings, this study makes the following recommendation for the policymakers as thus, whenever the advancement of human capital is the priority of the Nigerian government, the investment in capital projects that will catalyse the improvement in generation of electricity should be embarked in the country.Similarly, in achieveing the SDG goal seven in Nigeria the policymakers in the country shouldexplore moreof energy from electricity in driving human development in the country.

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