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Impact of ICT on Human Capital Development in Nigeria: A Dynamic Error Correction Model Approach

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Abstract: The paper investigates the impact of ICT on human capital development, in terms of its potential to drive educational outcomes, improve the acquisition of critical skills, health capacity and the productivity of the workforce for the period 1981-2023. Cointegration and dynamic error correction modeling techniques were utilized in the analysis. The empirical findings show that ICT infrastructure and population growth drives human capital development in Nigeria. Investment in research and development (R&D) and Institutional quality variable are both positively related to human capital development but not significant due to weak investment in R&D and poor institutional environment in Nigeria. In the light of the findings, it is suggested that there be increased investments in ICT infrastructure and R&D to drive human capital development in Nigeria. Good and supportive institutional framework, including cautious and well-targeted population growth policy are also important in this direction.

JEL Classification: J24, 015, 031, 033

Keywords: ICT, Technology, Innovation, Human capital development, Spillover effects

1. INTRODUCTION

The advent of Information and Communication Technology (ICT) has significantly transformed the way individuals, organizations, and societies operate. By enabling unprecedented access to information and knowledge, and skills, ICT has revolutionized the human capital development landscape. Technology plays a critical role in simplifying and facilitating complex human work process, and in so doing, accelerating greater degree of knowledge diffusion and dispersal. The dynamic interplay between ICT and human capital development, no doubt has a significant place in modern in any modern economy. Human capital development (HCD), a crucial driver of economic

growth and competitiveness, refers to the process of stimulating individuals' innovative capacities and productivity through education, training, and quality health. Technology, is enhancing the capabilities, processes, structures, as well as innovative approaches of doing things in a more efficient and result-oriented manner (Ozekhome, 2023).

As a result of the increasing pressure from competition in knowledge and skills across the globe, the utilization of new technologies has become imperative. Without doubt, the advent of technology has brought about the development of innovative, state-of-the-art and new methods of production techniques that have increased productivity. For instance, businesses can expeditiously and economically manage their operations, grow their markets, and coordinate value chains across borders by utilizing ICTs like the internet. Embracing Information Communication Technologies (ICTs) will greatly speed up economies of scale in new and expanded markets, reduce coordination and transaction costs (Goyal et al., 2019). ICT as a key driver of human capital development (HCD) enhances the creation of wealth, innate capabilities, job opportunity and management of epidemics. Enhanced ICT policies and strategies are expert-driven skills to increase productivity and impact the development of an informed society (see Ejemeyovwi, 2018, Qamruzzaman, 2020; Hianin, 2021).

Human capital development as crucial driver of sustainable and transformative growth, as well as competitiveness and welfare requires infrastructure development to play its onerous role. Infrastructure plays a critical role by providing the very foundation for individuals to the needed skills, knowledge, and health. Efficient infrastructure enables access to education, healthcare, employment opportunities, and information, thereby enhancing the development of human capital. However, human capital development faces significant challenges such as skills gaps, and unequal access to education, creating country and regional disparity in human capital development (Ozekhome, 2018).

Statement of Problem

Despite having the potential to accelerate human capital development, inadequate infrastructure, particularly ICT has become a bane to rapid accumulation of human capital. Infrastructure constraints hinder human capital development, exacerbating inequality, reducing productivity and economic growth (see OECD, 2019). Adaptation to the yearning demands of a dynamic, competitive and ever-changing environment is complex in the face of structural and infrastructural challenges. To be fully into the global environment of

growing productivity, spurred by enhanced information, knowledge, and skills; ICT should be enhanced (OECD, 2019; World Bank, 2020..The pressures of globalization and the need to enhance efficiency and productivity, with the opportunities and challenges in a dynamic environment imply the upskilling of information, knowledge, experience, skills and talents, which human capital development entails.

Available evidence points to a poor ICT performance, measured by the global ICT Development Index (IDI in West African region, which includes Nigeria, with a score of 2.44, ranked globally 143rd place, compared to an average of 8.44, 8.15 and 7.33 for North America, Western Europe, Germany, and East Asia. The evidence also points a poor global technological and innovation index in Nigeria and the region. Infrastructure and human capital development are key determinant factors in the level of technological advancement. On the other hand, infrastructure development and technological know-how and innovation are key determinants of the human capital development, making ICT, technology and human capital concentric in relationship and mutually reinforcing (Ozekhome & Adesokan, 2022).

While some studies (e.g OECD, 2019; Ozekhome, 2023) have examined the impact of ICT on business, SMES or the economy in general, there is however, very scanty empirical evidence, to the best of the researcher's knowledge on the impact of ICT on human capital development in Nigeria. This study, therefore, undertakes to investigate the impact of ICT on the development of human capital in Nigeria. Studying is therefore different from past studies in in several ways. Firstly, unlike previous studies, that were conceptual or that utilized primary data using structured questionnaire, this study is experimental/empirical and utilizes secondary data approach by means of multiple regression modeling to capture the relationship in Nigeria. Secondly, while the majority of previous studies utilized traditional measure of ICT, this study considers an alternative measure of ICT index from the Africa Infrastructure Development Index database developed by the African Development Bank. Thirdly, unlike previous studies, the current study introduces an array of other important control or intervening variables that may influence the impact of ICT on human capital development nexus in Nigeria. These variables could potential influence the effectiveness of ICT on human capital development performance in Nigeria. Bringing these innovations into the paper, no doubt, represent further motivations and value-additions to the literature and policy imperatives of the role of ICT on human capital development in Nigeria.

Aside from the introduction, section 2 is concerned with the review of the relevant literature, comprising the theory and empirical evidence. Section 3 contains methodology, model and data. The results, analysis and discussion are presented in section 4, and the paper is concluded in section 5 with some relevant policy perspectives.

2. LITERATURE REVIEW

2.1. Conceptual Review

ICT refers to the technologies used to manage, process, and exchange information electronically. It encompasses various digital and technical tools, systems, and services such as:

1. Information technology (IT), comprising computers, and software and data storage
2. Telecommunications: Voice, video and data transmission
3. Broadcasting: Radio, television, and digital media
4. Internet: Online services, social media, and e-commerce

    Examples of ICT are

    (i)   Computers and laptops
    (ii)   Smartphones and tablets
    (iii) Internet and world wide web

    Social media platforms, e.g. Facebook Twitter, LinkedLn)

    (iv)   Email and messaging apps (WhatsApp, Skype, TikTok, Instagram, YouTube, Snap chat, Yahoo, Google and the Internetts, e.t.c.)
    (v)   Cloud computing (AWS, Google Cloud, Azure)
    (vi)   Database management systems (MySQL, Oracle)
    (vii) Cyber security solutions, e.g. firewalls, antivirus software
    (viii) Virtual and augmented reality technologies
    (ix)   Artificial intelligence and machine learning.

ICT no doubt has diverse applications including education, healthcare, business, tourism, government, hospitality, entertainment, e.t.c. Several benefits of ICT to business include improved communication and feedbacks, enhanced visibility, greater accessibility, improved decision making, economic growth, employment and poverty reduction (Ozekhome & Adesokan, 2022). Human

capital development (HCD) involves investing in people's skill, knowledge, education, training and other human capacities to improve their productivity performance and overall well-being (Bloom & Van-Reenem, 2010). Basically, HCD comprises training and development and health capacities. Increased investment in human capital development, organizations can unlock their employee's full potential, propel business growth and achieve sustainable success (World Bank, 2018; OECD, 2019). Human capital development has the ability not only to stimulate productivity growth but reduce income inequality through the redistribution of income and wealth. By creating greater capacities to earn income, inequality is reduced.

2.2. Theoretical Review

The role of ICT, technology and innovation in human capital development cannot be emphasized. By means of a combination of developed infrastructure, technological advancements driven by a well-developed IT sector, innovative economy characterized by innovative start-ups, human capital development is stimulated. ICT stimulates human capital development by enabling unprecedented access to information, knowledge, critical skills and talent. It enhances individual productivity and innovative capacity through better and informed access to quality information, education, training and healthcare. Through the creation of an ecosystem that fosters information and knowledge diffusion, technological advancements and innovation as well as improved production techniques, ICT drives the development of human capital World Bank, 2020; Ozekhome & Adesokan, 2022).

In the endogenous growth theory, increases the rate of technical progress in the host country through a contagion (externalities or spillovers) effect from advanced technology, infrastructure and managerial expertise result in improved production and efficiency of human capital. Through imitation and internalization of new technology, as well as learning-by doing and the resulting contagion effects, greater productivity of human capacity results (see Helpman, 1992; Romer, Ozekhome, 2016). The model extends the old neo-classical growth model by emphasizing the role of endogenous factors like human capital stock, and research and development (R &D) as endogenous factors in the growth process.. The understanding of technical progress changes from being an exogenously determined unexplained variable to one that develops based on the 'learning-by-doing' effect that occurs between human and physical capital. Overtime, this results in increasing returns to scale in productive activities. The

model postulates that it is not only resources and capital stock that matter but more so the stock of knowledge. In this regard, internal processes and investment priorities of a country such as those on ICT and human capital that spurs innovation, productivity, output and growth as opposed to some external factor.

By determining the long-run equilibrium that allows a constant rate of innovation and thus a balanced growth path that effectively postpones any binding constraint indeûnitely through, innovation (technical progress), human and capital accumulation into the model, output growth is not inhibited. As long as there is sufûcient accumulation of human capital and a productive R&D sector, then technical innovation may be sufûcient in the long run to overcome both the problems posed by a declining capital stock and a growing unskilled population (Romer, 1990; Aghion & Helpman, 1991b).

2.3. Empirical Review

Few studies have examined the impact of ICT on human capital development, as preponderance of the existing studies have tended to focus on the impact of ICT on other variables such as business, SMEs, economic growth/ development, and so on.

Specifically, Lai (2007) examined the effect of globalization and the adoption of ICTS on human capital development. The results show that firm-level variables, such as financial capacity and technological absorptive capacity influence the intensity ICT adoption, and that globalization strongly influences the adoption of new technologies

Agwu, Agumadu and Afieroho (2016) examine the role ICT and innovation on competitiveness in Nigeria based on conceptual review approach. The study progresses to \discuss the benefits of innovative technology on SMEs and the associated constraints. The findings indicate that innovations drive SMEs and that increased usage of ICT propels SMEs competitiveness. The paper recommends government and policy assistance in the adoption of ICTs to enhance SMEs performance in Nigeria.

Ofoezie (2021) examines the impact of ICT on human capital drawing evidence from 42 emerging market economies over the period 2014-2018. He uses the dynamic system GMM approach in the empirical analysis. The findings reveal that ICT has a positive and significant impact on human capital growth

in emerging economies. Other studies that found statistically significant impact of ICT on human capital development is Ejemeyovwi (2018), OECD (2019), Qamruzzaman (2020); Hianin (2021).

Aydinabas and Erdinc (2023) investigate the effects of ICTs on human capital, utilizing panel data involving 10 emerging economies for the period 200-2019. Human capital index was used as the dependent variable, while the main explanatory variable were share of ICT exports in total exports. A vector of control variables that influence the nexus, such as education index and life expectancy at birth were included. The empirical findings revealed a positively and statistically significant effect of ICT on human capital, alongside educational index and life expectancy. In the light of the findings, the study recommend increased investment in ICT infrastructure as well as educational capacity to drive human capital development to sustainable levels.

Yuwono, Suroso and Novadanri (2024) use a systematic literature review approach to examine, identify and analyze the predominant patterns, obstacles and influences that affect the adoption of ICT in SMEs in developing countries. They utilize a sample of 25 publications already published in Scopus data based, with selection of works with significant citations and been published between 2014 and 2023. The PRISMA statement form was employed in the explanation of the comprehensive procedure of pertinent paper selection and publication. The study concludes that despite the widespread research on the role of ICT, there is need to customize strategies and policies that can support and encourage SMEs in the ICT sector, especially in developing countries.

Gap(s) in Literature

Based on the review of the extant literature, the impact of ICT on human capital development has not been given pronounced attention. Besides, none of the existing few studies (e.g. Qamruzzaman 2020), Aydinabas & Redinc, 2023), to the best of the researchers' knowledge did has included research and development (R &D) in the modeling of ICT and human capital development nexus, given the inevitable role of R&D in infrastructural and human capital development drive. Furthermore, due to differing measurement and methodological approaches, the existing few studies have found mixed evidence. The current study takes a radical departure by using a disaggregated modeling approach based on evidence from Nigeria, thus creating value-addition and further motivations in the subject matter.

3. METHODOLOGY

3.1. Model Specification

Following the review of the theoretical literature and the global culture-ICT and SMEs nexus the model for this study is specified as:

$$HCD_t = f(ICT_t, R\&D_t, POPG_t, INST) \tag{1}$$

Where HCD_t is the dependent variable, indicated as human capital development; ICT is information and communication technology, R&D is research and development, POPG is population growth, INST is instructional quality, and t is time period. Following this, the empirical specification of the model is:

$$HCD_t = \alpha_0 + \alpha_1 ICT_t + \alpha_2 R\&D_t + \alpha_3 POPG_t + \alpha_4 INST_t + \varepsilon_t \tag{2}$$

$\alpha_1 - \alpha_4$ are the parameters to be estimated, and ε is the unobserved error term.

Apriori, expectation: $\alpha_1, \alpha_2, \alpha_3, \alpha_4 > 0$

3.2. Definitions of the Variables and Measurement

The definitions of the variables in the model, unit of measurement, as well as the sources of data are provided in Table 1.

Table 1: Definition of Variables and Data Sources

Variable	*Definition/Measurement*
Human capital development	A World Bank composite human development index component that measures sustainable human development capacity in terms of broad development indicators of income, education and health, including the productivity of the workforce. The Global Innovation Index (GII), a composite index also measures innovation capacity, including human capital and research.
ICT	ICT index from the Africa Infrastructure Development Index database developed by the African Development Bank on a scale of 0 to 100, with 0-20- very low; 21-40- low; 41-60- medium; 61-80-high; and 81-100- very high
Research and Development (R& D)	Investment in R&D as percentage of GDP

Variable	*Definition/Measurement*
Population growth	Growth rate of population in percent
Institutional quality	Institutional quality index as average of six average of six institutional quality indicators by the World Bank, encompassing rule of law, political stability and violence, government effectiveness, regulatory quality, transparency and accountability, control of corruption and risk of expropriation and government repudiation of contracts

Source: Authors' compilation.

3.2. Data and Estimation Approach

The data for the study covers the period 1986-2023. The choice of the period is hinged partly on data availability and by virtue of the fact it characterizes increased investments, development and proliferation of ICT infrastructure, innovations and human capital development in Nigeria, due to the accelerating globalization pace. All the data are obtained from the World Development Indicators (WDI) of the World Bank. The dynamic Error correction Model (ECM) tevhnique is used to analysed the relationship. Prior to this, the preliminary characteristics of the variables using descriptive ststistics, unit root test and cointegration are conducted. The onus for conducting the unit root test is based on the notion that time series properties may possess unit roots, and where they are non-stationary, they may not be amenable and consistent for policy formulation and implementation purposes unless made stationary (see Engle & Granger, 1987).

4.1. Descriptive Statistics

The descriptive statistics of the variables used for the analysis are presented in Table 2. The mean value of human capital development in Nigeria for the period is 0.47, depicting a very poor performance. ICT infrastructure has a mean value of 67.7, indicating a modest ICT infrastructure development. The mean value of Research and Development (R & D) as percentage of GDP of 0.071 is highly negligible, indicating poor investments in R&D, Population growth has a mean value of 2.6percent, with a maximum of 3.25 percent. Institutional quality index stands at 0.072 indicating poor institutional capacity. The combination of these variables seems to have explained the low human capital development in Nigeria during the period in focus.

Table 2: Descriptive Statistics

	Mean	*Median*	*Max.*	*Min.*	*Std. Dev.*
HCD	0.47	0.43	0.88	0.03	0.25
ICT	67.7	69.2	92.3	21.5	15.7
R&D	12.84	11.05	36.75	5.82	6.50
POG	2.60	2.58	3.25	1.25	1.26
INST	0.072	0.61	2.23	-1.17	0.07

Source: Authors' computation

4.2. Unit Root Test for Stationary

The Augmented Dickey Fuller (ADF) test is employed to analyze unit roots in this study. The results are presented in levels and first difference in table 3.

Table 3: Unit Root Stationary Test for Variables in Levels and First Difference

Variables	*ADF Statistic (in Levels)*	*ADF Test Statistic (in First Difference)*	*Order of Integration*	*Remark*
HCD	-1.077	-5.327**	I(1)	Stationary
ICT	-0.975	-5.821**	I(1)	"
R&D	-1.016	-6.107**	I(1)	"
POG	-1.177	-5.844**	I(1)	"
INST	-0.858	-5.644**	I(1)	"

** (***) denotes significance at 5% (1%) level

Source: Author's computation

The results of the unit roots in the table using the ADF indicate that the variables are non-stationary at levels. Following Box, Jenkins and Reinsel (1994) that non-stationary time series in levels maybe made stationary by taking their first differences, the first differences of the respective variables is conducted. After first differences, the variables became stationary i.e. $t_{cal} > t_{tab}$ in absolute term. This implies that the variables are difference-stationary, attaining stationary after first difference. They are thus integrated of order one (i.e. I [1].

4.3. Co-integration Test

The cointegration test is carried to determine if the variables converge to stability or long-run equilibrium in the case of any shock in the economy. The result of the two-stage residual-based cointegration test is presented in Table 4.

Table 4: Engle and Granger Residual Based Cointegration Tests Results

Variable	*Test Statistic*	*95 Percent Critical Value*	*Remark*
Residual Vector	- 5.770***	5.110	Stationary

*** indicates cointegration at the 0.01 level

Source: Authors' computation

As can be observed, the test statistic of -5.77 is greater than 5 percent critical value of 5.11, indicating stationarity of residuals. This is a confirmation of the existence of a cointegrated series and long-run relationship between ICT and human capital development in Nigeria.

4.4. Error Correction Model

The confirmation of the existence of cointegration among the variables provides plausible justification for estimating the error-correction model, which shows the dynamic response of human capital development to ICT and other regressors in Nigeria, as shown in Table 5.

Table 5: Dynamic Error Correction Model Results

Variable	Coefficient	t-ratio
Dependent Variable: HCD		
D(HCD (-1)	-0.032	2.013
D(ICT)	1.082	2.220
D(R&D)	0.072	1.021
D(POG)	0.230**	2.117**
D(INST)	0.042**	1.113
C	0.085	0.190
ECM(-1)	-0.887	-3.220**
R-squared	0.943	
Adjusted R-squared	0.901	
F-statistic	30.6 (0.000)	
Post-diagnostics		
Mean VIF	5.22	
Breusch-Godfrey LM Serial Correlation Test Statistic	1.57 (0.23)	
Breusch-Pagan-Godfrey Heteroskedasticity Test	= 0.73 (0.55)	

** (***) denotes statistical significance at the 5% and 1% level, respectively

Source: Authors' computation

The adjusted R^2-value of 0.90 is an indication that 90.1 percent of the net systematic changes in human capital development (HCD) is explained by the regressors, and the ECM, making the model fit, with good predictive ability. The overall goodness of fit statistic shown by the F-value of 30.1 is significant at the 1 percent level, validating the hypothesis a significant linear relationship between the regressors and human capital development. Lagged human capital development {HUC(-1)}, a measure of past human capital agglomeration is positively related to current human capital development, and significant. This implies that past realization of human capital development tend to stimulate current or future development of human capital. This implies that human capital development has a persistence and 'forward –inducing' and 'carrying effect', particularly in the case of skills and knowledge spillovers.

ICT is positively related to human capital development and significant test at the 5 percent level. This implies that ICT infrastructure propels human capital development by facilitating greater human productivity, reducing complex human work, and reducing transaction costs. This finding supports the findings of of the World Bank (2020). In general, Infrastructure (proxied by ICT is critical in integrating local producers and investors into international technological and communication networks, and in attracting vertical human investment (see Addison & Heshmati, 2003; Ozekhome, 2017). A 1 improvement in ICT infrastructure is associated with a 1.1 percent rise in human capital development.

Although research and development (R&D) rate variable exhibits a positive direction, aligning with theory, it does not yield statistically significant results. This observation stems from the characteristic weak level of investments in R & D in most developing countries, particularly Nigeria. The poor investments in R&D explains the weak level of technology and innovation in the country, a factor that has contributed to the poor human capital development in Nigeria, unlike those of advanced economies of the world and some emerging economies.

The result reveals a significant positive association, reaching statistical significance at the 5 per cent level between population growth and human capital. development Invariably, a growing population can provide a larger workforce, that has diversified skill set, experiences and perspectives, leading to a more innovative and productive workforce. With positive and positive technological spillovers and innovation, greater and better human capital is produced that drives productivity growth. The finding is in accord with the

findings of Ozekhome (2023). A 1 percent increase in the rate of population growth is associated with a 0.23 increase in human capital development. Although the institutional quality variable demonstrates a positive relationship with human capital development, it is however not significant. Since its t-value is greater than 1, it implies that good institutional settings propel human capital development, but the impact is weak in on account of the poor institutional framework in Nigeria.

Aside the diagnostic statistics, the coefficient of the error term is appropriately negative and significant at the 5 percent level. With a coefficient of 0.88, about 88 percent of the contemporaneous adjustment of human capital development to long-run equilibrium after a temporary disequilibrium or perturbation is completed in the first year, an indication of a high speed of adjustment capacity. The post-estimation evidence shows a mean variance inflation of 5.72 that is below the threshold of 10; an indication that multi-collinearity is not a problem in the model. The Breusch-Godfrey LM serial correlation test leads to the non-rejection of the null hypothesis of no serial correlation. The heteroscedasticity test using the Breusch- Pagan-Godfrey test approach also confirms the absence of heteroscedasticity in the model. The estimated model is therefore fit and consistent for policy formulation and implementation perspectives.

5.   CONCLUSION

This paper empirically examined the impact of ICT (including a vector of other variables) on human capital development in Nigeria. The results strongly indicate that the ICT infrastructure has a significant positive impact on human capital development in Nigeria. Invariably, ICT, has become a critical factor in driving the competitiveness of the work force and its productivity and sustainability. With the growing pace of globalization, integration, technological advancement and innovation, it is important that increased policy focus be given to infrastructure development in Nigeria. This, without doubt, will enable the economy fit into the ever evolving and dynamic global architecture. In this regard, increased investments in ICT and other human capital development driven infrastructure is imperative..

References

Addison, T & Heshmati, A. (2003). The new global determinants of FDI flows to developing countries: The importance of ICT and democratization. *WIDER Discussion Paper* N0. 45.

Aghion, P. and Helpman, E. (1991b). Innovation and growth in the global economy. Cambridge, MIT press.

Agwu, J.N.T , Agumadu, M., & Afieroho, E. (2016). The role of ICTs in the improvement of the competitiveness of SMEs. *Asian Journal of Information Technology*, 15(18), 3414-342.

Akomea-Bonsu, C., & Sampong, F. (2012). The impact of information and communication technologies (ICT) on small and medium scale enterprises (SMEs) in the Kumasi Metropolis, Ghana, west Africa. *European Journal of Business and Management*, 4(20), 152-158.

Awah, H.O. et al. (2016). ICT adoption and use among SMEs in Nigeria. *Journal of Small Business Management*, 54(2), 347-363.

Aydinbas, G., & Erdinc, Z. (2023). The effects of information communication technologies on human capital: A panel data analysis. *Journal of Economy Culture and Society (JECS),* 2(1), 1-17. DOI:10.26650/JECS2023-1212299.

Dreher, A. (2006). Does globalization affect growth? Evidence from a new index of globalization. *Applied Economics*, 38 (10), 1091–1110.

International Telecommunications Union (ITU, 2020). ICT Development Index.

Ozekhome, H.O. (2018). Is human capital accumulation a growth driver in Nigeria? An empirical investigation, *Oradea Journal of Business and Economics (OJBE),* 3(2),.66-76, September.

Ozekhome, H.O. (2023). COVID-19 and African external trade performance: An Empirical evaluation. *HSRC Africa Insigh*t, 52 (4), 4-24.

Romer, P. (1986). Increasing returns and long-run growth" The Journal of Political Economy, Vol. 94, pp. 1002-37.

Romer P. M. (1990). Endogenous technological change. Journal of political Economy, 98, 871 − 1208.

Yuwono, T., Suroso, A. & Novandari, W. (2024). Information and communication technology in SMEs: A systematic literature review. *Journal of Innovation and Entrepreneurship*, 13(31), 1-17.

World Bank (2020). ICT Development Index 2020. World Bank Publications, Washington DC.

World Economic Forum (2020). Global Competitiveness Report, Geneva, Switzerland.