

Measuring of Information Communication Technology (ICT) Impact on Sustainable Development

Professor J.O. Adewoye^{1*}, Adebayo A.A²

¹Department of Management and Accounting, Ladoke Akintola University of Technology, Ogbomosho, Oyo State, Nigeria.

²Department of Business Education, Tai Solarin University of Education, Ijagun-Ijebu Ode, Ogun State, Nigeria.

***Corresponding Authors:** Adebayo A.A, Department of Business Education, Tai Solarin University of Education, Ijagun-Ijebu Ode, Ogun State, Nigeria.

Abstract: Information and communication technology (ICT) Impact measurement and the goal of attaining sustainable development with technology has become a subject of debate among policy makers, accountant, financial analyst and researchers. The concept of sustainable development of the nation is based on socio-economic, financial-economic and environmental conversation. Despite several studies regarding the impacts ICT on specific aspects of human life and the economy of developing nations like Nigeria, the measurement technique and extent to which ICT Impact on Sustainable Development mechanism has not been well explored. This research investigates the Measurement techniques of ICT Impact and how its influence the sustainable development through the socio, economic environmental perspective of developing nation. Finding from the study revealed that the Meta-Analysis technique was employed. Findings reveals that the integration of ICT has positive impacts on Nigeria development through effective support in all area of development mechanisms of nation like education system, health management, socio, and financial development. Further ICT infrastructure and services allow countries to participate in the digital economy and increase the overall economic well-being and competitiveness. The combination of ICT investment with investments in organizational and human capital trigger will trigger development. Based on the empirical findings of research, the study concluded that Measurement of ICTs impact can be done via several technique such as Analytical technique, case studies technique, Panel Studies technique, Statistical survey technique, Administrative Data and Other methodologies and data sources. Further the use of ICT is significant to the sustainable development of developing nation. It is recommended that government should regulate technology policy in a way that will strengthens capacity building of human resources.

Keywords: ICT Measure Technique, Sustainable Development Mechanism, HumanCapital, Technology Learning Practice

1. INTRODUCTION

Information and communication technology (ICT) has become an important source of innovation and improvement of efficiency for many sectors across the globe. Evidence from literature (Flor, 2021: Castells 2005 : Yinus *et al* 2021) show that we are in a contemporary societies where knowledge has become a critical resource and information is a primary commodity and thus, dramatically change our daily business operation, research, communicate with each other in our societies. Using these ideas as foundations, we theorize that from a sociological and economic point of view, the adoption of ICT in our day to day activities has achieved some level of relevance in education system, business development, governance, health system and thus it should be seen as a key independent variable for studying an array of diverse societal phenomena.

Studies (Yinus *et al* 2021: Adewoye and Salau, 2021: Youssef and Dahmani, 2018) posit that ICT has impact in the university context, in organization and in teaching and learning methods and enhance educational progress of students despite the threat of Covid19 pandemic. ICT has the potential to contribute to substantial improvements in the educational system through innovative teaching, learning and quality assessment. The adoption and usage of ICT is a critical determinant to development of knowledge-based economy and future sustainability. The existence of ICT

infrastructure provides business opportunities and helps firms build up business networks between suppliers, buyers, and customers. A large number of business tasks have succeeded via emerging technology. ICT plays a dual role, first as part of the technology stock and second as a channel for technology transfer from one organization to another. ICT usage is very significant to performance of corporate which will eventually trigger economic development of any nation. The success and continuity of business organizations depend greatly on their ability to deploy and utilize emerging. More so, current literature has it that ongoing advances in information communication technologies allow all establishment to achieve greater levels of productivity, efficiency, and service satisfaction which enhance sustainable development in the country (Adewoye, and Salawu, 2021: Oladejo, Yinus, Shittu, & Rutaro, 2021 ; Yinus et al, 2021 :Anumaka et al 2021). In this 21st century, organizations all over the world have come to realize that only those that overhaul the whole of their administrative systems and operations are likely to survive and prosper.

Evaluation from studies like (Farrukh et al 2020: Kayisire & Wei, 2016: Maresova & Klimova, 2015) revealed the effects of information and communication technology (ICT) resources on organizational development in different ways, such as human, social, and economic effects. Farrukh et al (2020) agitate that the effects of ICT projects are not limited to social and economic development, but are also categorized as strategic, managerial, informational, operational, transactional, organizational, infrastructure, and transformational development. Kayisire & Wei, (2016) argued that measurement of ICT development can only be evaluate based on ICT adoption and usage. More so, projects Maresova & Klimova, (2015) also conclude that measure of ICT Impact should be based on System efficiency, employee productivity, and the performance of other organizational stakeholders are the main factors used. proper development in proposing a framework for measuring ICT Impact on social, human, and economic development is essential and it has become a subject of debate among players such as ICT decision-makers, practitioners of ICT project , researchers and therefore, worthy of exploration in developing nation . This form the main thrust of the current study

Regarding the growing importance of ICT and the way it is transforming the world, many academicians and researchers have focused on studying the impact of ICT, several theoretical and empirical works have been conducted. The literature shows that many theories recognize that ICT plays an increasingly key role in speeding up all aspect of economic growth of a nation, but empirical studies on this relationship have produced mixed results (Vu 2011; Sassi and Goaid 2013). While a number of empirical studies confirmed that ICT diffusion plays a positive and significant role in improving economic growth, especially in developed countries (Roller and Waverman 2001; Inklaar et al. 2005; Koutroumpis 2009), other studies found that economic growth in many countries and regions of the world is negatively affected by ICT diffusion (Dewan and Kraemer 2000; Pohjola 2002; Papaioannou and Dimelis 2007; Yousefi 2011; Pradhan et al. 2015; etc.) Studies reviewed that compared to developed and Asian countries, research on ICT impact on economic development in Sub Saharan Africa regions especially in Nigeria is still in its infancy stage and needs further exploration and discussions to produce a clear idea on ICT diffusion Impact based on theories of information and development.

2. LITERATURE REVIEW

2.1. Information Communication Technology

Information Communication Technology can play an important role in bringing about sustainable economic development through several sector of nation .Implementation of Information Communication technology over the years has become important not only for business owners but for governance as sustainable solution toward driven effective the economic development of the nation across all the sectors (education sector, financial sector, Health sector, and manufacturing sector). Innovation has gained importance in the past few decades.

ICT increases the speed and responsiveness of the firm (Brynjolfsson 1995) which in turn enhance successful innovations and expected to trigger economic development of nations. The literature on information technology and the relationship with successful innovations and performance is to a great extent based on case studies and conceptual frameworks (Powell and DentMicallef, 1997)

2.1.1. Determinant Factors of ICT Usage

- **Personal Characteristic:** Personal characteristics such as educational level, age, gender, educational experience, competence, experience with the computer for educational purpose and attitude towards computers can influence the adoption of a technology, Schiller (2003). The feature of technology greatly influence their adoption and integration by an individual
- **Organizational capacity:** These are factors that is related to organizational capacity to provides the required technology
- **Perceive ease of use:** These are factors that mostly motivate individual and organisation in the adoption of ICT.

2.1.2. Component of ICT Facilities

Computer: Computer does not only relate to all human endeavors but encompasses almost all facets of human endeavors. Computer is an electronic device which stores information on disc or magnetic tape; analyses it and produces information as required from the data on the tape. Today, computer technology in schools is one of the most far-reaching and fast-growing developments in education. Development in science and technology has brought into lime light the indispensable roles of computer in the area of information technology, it is a new instructional system. The incursion of the electronic computer system into the educational parlance, according to Sherman (2005) provides the wherewithal to solve teaching and learning problems even more rapidly and accurately. Computers are widely used in every university in Nigeria today this has made its usage in the educational system to be more relevant. Computer has been found to be an effective device for presenting an instructional program either within the university or training centers.

Telephone: The smartphone is an indispensable device in the area of mobile learning which has become a part of every person's life. According to Technorati (2019) "A smartphone is a mobile phone with highly advanced features. A typical smartphone has a high-resolution touch screen display, WiFi connectivity, Web browsing capabilities, and the ability to accept sophisticated applications." Ebiye (2015) regards a smartphone as a smart device used for fast access to knowledge, geared towards students achieving their teaching and learning and academic research objectives. The global explosion of smartphones and its related devices has greatly transformed the operating system of all sectors of the nation.

2.2. ICT Impact on Sustainable Development

The report of the World Summit on Social Development (2005) acknowledged three core areas of sustainable development, called The Three Pillars of Sustainability. The pillars are economic development, environmental development, and social development, also informally known as profit, planet, and people. These three cores vary in basis, but, are similar in collective goal and place each other into consideration. Sustainability has been crossing boundaries in all areas of society. Nations around the world are taking major steps in creating a society that functions and Prosper with development through some basic sustainable development mechanisms like education, health management, socio, and financial development. According to ITU (2016) ICT usage contributes to sustainable development in particular helping to build resilient infrastructure, promoting inclusive and sustainable industrialization and fostering innovation. Efficient and affordable ICT infrastructure and services allow countries to participate in the digital economy and to increase their overall economic well-being and competitiveness.

2.2.1. ICT and Economic Impact

Considering the ICT impact on economic aspects of sustainability development, deployment of ICT substantially facilitates employment creation, economic growth and poverty alleviation (Word bank, 2012). ICT also raises demand for new skills and jobs. It influences employment, both as an industry itself and also as a required tool for other industries to operate in the digital era. Digitization of more and more aspects of work, as brought about by ICT, has redefined practices, processes and standards in almost every industry and, more importantly, in business. Incorporating ICT enhances the demand for professionals at various levels of skill and expertise, from programmers to managers who work in IT and telecommunications companies. In addition, as more industries and businesses enter into the electronic era, whether by integrating electronics into existing processes to some extent or a complete

switch to digital platforms, new career opportunities continue to increase. This, in turn, creates a great need for skilled workers to sustain the existing availabilities and generate new opportunities in order to support and boost development.

ICT is one of the largest and fastest growing sectors, creating millions of jobs directly and indirectly; this means the emergence of new services, products and even industries. A clear example of this is the growth and development of the telecommunication industry, which provides the infrastructure that is needed to perform business electronically. E-business, e-services, e-commerce, m-commerce (mobile commerce) and Internet marketing are examples of ICT applications that allow people and businesses to exercise online activities. ICT tools are powerful tools for marketing as they provide businesses with new ways of reaching out to and serving their customers. People now also have access to information and other aspects of the digital era, such as networking and social media, almost in every aspect of their everyday lives. In addition, ICT has also contributed to the rise of entrepreneurship [by facilitating access to various resources for entrepreneurs, namely resources and information on investment, regulatory requirements, marketing, leadership, practices and processes, not to mention social and supportive networks.

A high-speed Internet via broadband infrastructure facilitates macroeconomic growth by speeding up the distribution of information and ideas and also promoting competition. Some of the other prospective economic benefits obtained from broadband are: new economic opportunities, employment creation, rising incomes, higher productivity, innovation, lower costs, increased trade and exports, firm efficiency, increasing firm and community competitiveness and growing business links. All of these are examples of the positive impacts of broadband on a country's GDP, gained in several different ways.

Information and communication technology has roles in the creation of employment and self-employment opportunities. Impacts can be direct, through growth of the ICT sector³³ and ICT-using industries, and indirect through multiplier effects. In economies increasingly dependent on ICT, individuals will benefit by having requisite ICT skills, thereby enhancing their opportunities for employment. Arguably, ICT can also lead to loss of employment as tasks are automated. In respect of the ICT sector in low-income countries, telecommunication services might offer the greatest opportunities for employment creation (UNCTAD, 2010). Only a small number of developing countries have a well-developed ICT sector. For those that do, ICT manufacturing can be significant in employment terms, sometimes involving the poor. In China, for example, the ICT sector provides employment to about 26 million internal migrant workers, with evidence that a large portion of their earnings is remitted to poor rural and remote areas.

Mobile telephony penetration is increasing dramatically in developing countries (ITU, 2010b). In Nigeria, the positive economic impacts of a growing mobile telephony industry include growth in the industry itself and associated industries, creation of direct and indirect employment, and development of labour force skills (Pyramid Research, 2010). Broadband penetration can increase employment in at least three ways (Katz, 2009). The first is the direct effect of jobs created in order to develop broadband infrastructure, the second is the indirect effects of employment creation in businesses that sell goods or services to businesses involved in creating broadband infrastructure and the third is induced effects in other areas of the economy.

2.2.2. ICT Impact on Education and Health Sector

Evidence from literature (Anumaka et al 2021; Aristovnik ,2012; Yinus *et al* 2020) Literatures indicates that Information and communication technologies ICT is affecting every aspect of education from teaching-learning to assessment and evaluation. It improves the effectiveness of education. It aids literacy movements. It enhances scope of education by facilitating mobile learning and inclusive education. It facilitates research and scholarly communication. Impact of ICT and its potential for the education field is manifold. It positively affects all the stakeholders of the education field. The current papers discuss the same along with the various challenges posed by ICT. The challenges include economic issues, educational and technical factors. Appropriate content, Design and workability of ICT also play a crucial role in adoption of ICT in the education field. The paper delineates in brief the challenges and probable solutions.

Focusing on Health sector, Deployment of ICT assist to improve patient safety through the direct access to the medical case story, checking the treatments online, keeping track of the patients' progress and anticipating possible medical errors. ICT are regarded as generally

positive tools among professionals and users. Since they provide a way to increase the patient safety, their use is being promoted in many countries. Technology usage in health unit avail the opportunity to reduce administrative cost.

2.3. ICT impact Measurement Techniques

This involved the methodologies and data sources used in measurement of ICT impacts. It concludes with some based on reviewed studies on strengths and weaknesses of the different approaches. The approaches considered are not mutually exclusive. For example, analytical techniques will generally use existing survey or administrative data and case studies may use data from several sources.

Analytical Techniques

Various analytical techniques have been used to measure the economic impacts of ICT at the macroeconomic, sectorial and microeconomic (firm) level. The main techniques are econometric modelling using regression, growth accounting and input and output analysis. Econometric regression models have also been used in other areas of measurement, ICT impacts on educational outcomes. The Growth accounting attributes in GDP to increases in physical inputs, such as capital and labour, and advances or improvements in production technology (ITU, 2006). Data often come from different statistical sources and are linked at the firm level. They include firm performance, ICT investment, ICT use (varying from use of computers to advanced e-business applications), firm size and age, skill level, organizational factors and other forms of innovation. In some countries, these data are brought together in longitudinal databases, which provide data over different points in time. Economic impacts studied include labour productivity, multifactor productivity and value added.

Case Studies Techniques

Much of the work on measuring ICT impacts is based on case studies, often small scale and project based. They may be longitudinal, examining changes over time. They are generally very detailed and can involve a number of qualitative and/or quantitative data sources. They can take advantage of a number of existing, as well as new, data sources. Case studies can be used to explore causation within their scope. At the same time, case study findings are bound by the context in which they are conducted. While their results will not usually be generalizable beyond their context, they may indicate hypotheses or topics that could be assessed more broadly.

Statistical Surveys

Data needed to measure ICT impacts can come from various statistical surveys, including the following:

- Household surveys that collect information about the household entity, including its characteristics, income, expenditure, and access to ICT
- Household surveys that collect information from individuals, including their characteristics, income, expenditure, how they spend their time, how they use ICT and their perceptions of particular ICTs
- Surveys of businesses, including those in the ICT sector, that collect information such as employment, economic performance, innovation, expenditure on ICT, use of ICT and perceptions of ICT impacts
- Surveys of other entities such as government organizations that gather information such as employment details, economic performance, expenditure on ICT, use of ICT and electronic services offered. Perception questions provide causal information on the impacts of ICT

Panel Studies

Panel studies are longitudinal and may be survey based, in contrast with cross-sectional surveys, which collect data at a point in time across a population. A panel is selected at the start of the study and data are collected about its members, for example, individuals or businesses, during successive periods. Such studies can be useful in examining impacts, as they can provide good baseline data and account for time lags.

Administrative Data

An important data source in the field of ICT statistics is administrative data collected primarily for non-statistical purposes but used to form statistical indicators. The main examples are telecommunication or ICT infrastructure data collected by ITU from member Governments,

merchandise trade data compiled by the United Nations Statistics Division and ICT-in-education data compiled by UNESCO's Institute for Statistics. All three sources are used for the Partnership's core ICT indicators (ICT infrastructure and access, trade in ICT goods and ICT in education indicators respectively). Even though these administrative data are not usually collected for statistical purposes, through the efforts of organizations such as ITU, the United Nations Statistics Division and the Institute for Statistics, classifications and definitions can be applied to administrative data collection to enable statistical output.

Other Methodologies and Data Sources

Other methodologies and data sources include the use of focus groups, direct observation and document examination (Heeks and Molla, 2009). Scenarios may be used to establish impacts in different situations, using different sets of assumptions. Forecasting may be used to estimate the future impacts of ICT and can involve a number of techniques, data sources and assumptions

2.4. Empirical Review

Reading related studies on ICT and Education Impact, Ting Seng (2005) review research on the impact of ICT on learning in Singapore. Findings from these research studies indicated small positive effects and consequently a need for more in-depth and longitudinal studies into the impact of ICT on learning in the future. In Nigeria, Olaore, (2014) review the Impacts both Positive and Negative of ICT on Education in Nigeria. The study found out that ICT has a positive impact on education but nevertheless the manner in which the subject is taught has a larger effect than the mere use of ICT. In developing country, Ghavifekr and Wan Rosdy (2015), study aims to analyze teachers' perceptions on effectiveness of ICT integration to support teaching and learning process in classroom and outcome revealed that integration has a great effectiveness for both teachers and the students. More so, Papaioannou and Dimelis (2007) and Yousefi (2011) using a panel generalized method of moments (GMM) and a fixed effect model for 42 developing and developed countries over the period (1993–2001). They found that ICT investments boost growth only in developed countries. With an indication that developing countries should undertake appropriate measures to benefit from the positive role of ICT in driving economic growth such as liberalizing the trade regime, improving human capital, and adopting favorable government policies. More recently, Albiman and Sulong (2016) examined the long-run impact of ICT on economic growth in the SSA region for a 27-year period (1990–2014). They found that ICT proxies, such as fixed telephone lines, mobile phones, and Internet, have a positive and statistically significant direct linear impact on economic growth. However, when they considered a nonlinear effect analysis, they found that mass penetration of ICT proxies seems to slow economic growth in the SSA region.

3. DISCUSSION AND CONCLUSIONS

Metal Analysis technique was employed for this study. This is done through thorough review of several studies that provides information on the study area. Finding revealed that the integration of ICT has positive impacts on Nigeria development through effective support in all area of development mechanisms of nation like education system, health management, socio, and financial development. Further ICT infrastructure and services allow countries to participate in the digital economy and increase the overall economic well-being and competitiveness. The combination of ICT investment with investments in organizational and human capital trigger will trigger development. Moreover, realizing the benefits of ICT integration depends to a large degree on whether and the extent to which the country and the governments appreciate the opportunities, while providing proper policies, regulations and management to ensure that the right supportive conditions are in place, therefore government policies play a key part in ICT development, returns on ICT investment and the potential to generate productivity benefits

Based on the empirical findings of research, the study concluded that Measurement of ICTs impact can be done via several technique such as Analytical technique, case studies technique, Panel Studies technique, Statistical survey technique, Administrative Data and Other methodologies and data sources. Further the use of ICT is significant to the sustainable development of developing nation. It is recommended that government should regulate technology policy in a way that will strengthens capacity building of human resources.

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