HARNESSING THE POTENTIALS OF DIGITAL TECHNOLOGIES FOR ECONOMIC GROWTH AND SUSTAINABLE DEVELOPMENT IN NIGERIA

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Abstract
We currently live in an era when the digital economy is a mirror image of the changes that have taken place from the third industrial revolution to the fourth industrial revolution. We are in the midst of this change, which is characterized by the shift from analogue electronics and mechanical devices to digital systems as a result of the innovation and advancement of digital technologies. Thus, digitization has very quickly become inevitable as more and more aspects of human life have been tremendously transformed from previously manual and analogue methods to more advanced methods. The multipurpose nature of digital technologies means that their effects cut across activities and sectors. Therefore, this paper is aimed at exploring the benefits of digital technologies, particularly in major areas of the Nigerian economy such as agriculture, education, governance, health care, finance and manufacturing for economic growth and sustainable development. The paper started by appraising the digital economy, its characteristic features and its national policy and strategy, and then the various concepts associated with it before dwelling upon the link between ICTs, digital technologies and the digital economy. Thereafter, the paper highlighted the significant role of digital technologies in economic growth and sustainable development and identified some factors that influence the actual implementation of Nigerian digital transformation. It was concluded that if digital technology is effectively applied in various sectors of the economy, it will present a unique potential for Nigeria to attain economic growth and sustainable development and therefore improve the overall living standards of its populace. Therefore, the paper recommended, among others, that both individuals and governments should focus on creating awareness and trust in digital solutions as a requisite for widespread adoption in the economic sectors. This can be done by expanding internet connectivity, improving the affordability of digital services, improving electricity supply, developing renewable energy solutions, enhancing digital literacy programs, strengthening regulatory frameworks, providing funding and support for startups and small businesses, addressing environmental concerns, and fostering social inclusion.

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Introduction

In today's world, the concept of digital economy is a central topic of discussion among experts in various fields (Kadlubek et al., 2022). Due to scientific and technological advancements, many countries have made significant progress, mainly through the introduction of digital technologies into economic processes. Thus, the digital economy is becoming a vital component of modern economic growth and sustainable development, both in developed and developing countries, transforming all aspects of society (Natalia, 2024). It is seen as a nascent development among third-world countries and most especially those states that were previously backwards in terms of resources and literacy (Cinjel & Chujor, 2024). The digital economy is based on online connections to businesses and has become the pillar of trade and investments across the globe. Various attempts at categorizing the size of the impacts on traditional sectors have been

made through a digital economy platform (Garuba & Aminu, 2020). One of the main drivers of the digital economy today is digital technologies. The digital technologies, just as digital economy is one of the newest concepts in international terminology and it is characterized by some key factors as: desire and motivation to implement innovations; level of business development; the country's economic and financial situation; economic indicators; labor market instability; and participation in international economic processes. Thus, Natalia (2024) stated that innovative digital technologies and intelligent systems increase the competitiveness of the economy and labour productivity, create new professional jobs, stimulate economic development, reduce costs, make information more accessible, and enable education and access to new markets. These, in turn, have a multiplier effect on the growth of the entire economy. Thus, the faster the rate of digital adoption in Nigeria, the more quickly and extensively the country will benefit from its effects.

Popoola et al. (2024) cited an instance of significant effect of digital technologies by stating that as the global economy adjusted to the COVID-19 pandemic outbreak during the period, digital economy activities increased remarkably, including online transactions, electronic payments, electronic finance, and electronic marketing. Within a short period, these activities have been introduced in Nigeria, and the need to sustain these digital services by encouraging the use of digital payment platforms and promoting the spread and use of mobile financial services provides opportunities for employment and wealth creation to improve the living standards of the citizens sustainably. Likewise, Zainab et al. (2020) established that the digital economy provides opportunities for government, private organizations and individuals to use technologies and perform tasks that were hitherto impossible to execute better, faster, more reliably and more efficiently. The nation's growth and development have shifted from infrastructural development to economic developments and advancement, such as manufacturing, retail, transportation, financial services, education, healthcare, media, job creation and growth in Gross Domestic Product (GDP), among others, through technology (Zainab et al., 2020). They further affirmed that global economies heavily rely on digital technologies such as new media for growth; this is why developed countries such as United States, United Kingdom, China, Germany, Japan, among others, are the biggest economies and world powers as a result of adoption of digital technologies in all their economic sectors.

Besides, while delivering lecture on the role of digital economy for national economic development at the 2019 pre convocation lecture of the Federal University of Kashere, Gombe, Nigeria, Dr Isa Ali Ibrahim (Pantami), the Honourable (pioneer) Minister of Communications and Digital Economy acknowledged that "economic development is one of the primary objectives of any government that wishes to enhance and improve the socio-economic well-being of its people". He therefore affirmed that the digital age we are living in today has not only transformed the way economies function; from the nature of markets, how commodities are produced, how goods and services are delivered and paid for, human capital requirements etc, but it has also created new economic opportunities by boosting productivity, exposing businesses to new innovative ideas and technologies, and optimizing resources. Likewise, he stated that the contribution from the digital technology sector has been one of the fastest-growing components of Nigeria's GDP and is emerging as its most important long-term growth prospect. He supported his claim by further analysis that "in the second quarter of 2019, ICT contributed 13.85% to the GDP calculations, as against Oil and Gas putting in 8.82% in comparison. With the right policies and strategy, the digital technology sectors can double their contribution to the economy over the next five years" (Isa, 2019).

While highlighting the necessities for every sector and organization to be information and communication technologies (ICTs) compliant in the Nigerian economy to survive in a global competitive environment

(Ojokuku & Sajuyigbe, 2018), cited in Solomon (2022), enumerated the various benefits of the digital economy. For instance, they explained that ledger books, paper invoices, printed materials and business trips are being replaced with online billing and payments, an elaborate website with product information and real-time teleconferencing across continents and time zones. They added that the digital economy's goal includes the elimination of physical labour, the ability to obtain accurate information, and the ability to do more in less time, which is associated with e-business, which is conducted based on digital technologies. Also, the Economic Commission for Latin America and the Caribbean asserted that adoption of these technologies by such institutions would increase the efficiency and effectiveness of provision for services such as health care, education and transport. It would also improve citizen participation in democratic processes, increase transparency in government operations and facilitate more sustainable practices (ECLAC, 2022). By illustration, during periods of confinement and restricted face-to-face activities, digital technologies have been critical in sustaining jobs and business activities. The ability to work from home has enabled many companies, organizations and institutions to limit the socioeconomic impact of the crisis. In light of the above, leveraging digital technologies and innovation in Nigeria is the key to addressing economic, environmental, and social challenges, ensuring inclusive and sustainable growth (Okonkwo et al., 2024). So, there is a need to highlight the opportunity that the digital economy has for individuals, organizations, as well as the government to use digital technologies to carry out their tasks in a better, faster, and different fashion than they did before the arrival of the digital economy.

The Concepts of Digital Economy

The digital economy is a broad range of economic activities that include using digitized information and knowledge as the key factor of production, modern information networks as an important activity space, and the effective use of information and communication technology (ICT) as an important driver of productivity growth and economic structural optimization (G20 DETF 2016). The digital economy is the amalgamation of several General Purpose Technologies (GPTs) and the range of economic and social activities carried out by people over the internet and related technologies. It encompasses the physical infrastructure that digital technologies are based on (broadband lines, routers), the devices that are used for access (computers, smartphones), the applications they power (Google, Salesforce) and the functionality they provide (internet of thing, data analytics, cloud computing) (Dahlman et al., 2016). Oliver (2023) defined the digital economy as the economic activity that results from billions of online connections that occur every day between people, businesses, devices, data, and processes. A key component of the digital economy is hyper connectivity, which is the increasing interconnection of people, organizations, and machines that is a result of the internet, mobile technology, and the internet of things (IoT).

Some other groups of researchers, like Okonkwo et al. (2024), saw the digital economy as a transformative shift in economic activities, resulting from billions of online connections among people, businesses, devices, data, and processes. It is characterized by the use of digital technologies and the internet to transform traditional economic activities and create new economic opportunities. Considering the various definitions above, we gather that the digital economy provides opportunities for government, private organizations, and individuals to interact, communicate, collaborate and search information on global platforms through digital networking infrastructures with the aim of economic transactions that were hitherto impossible to execute better, faster, more reliable and more efficient.

The characteristics of the digital economy include:

- The development of the digital economy depends on the information and communication technologies (ICTs) networks. If the networks disappear, the digital economy becomes impossible.

- There is a direct interaction between producers and consumers of goods and services. This enables a manufacturer to interact with end users, thereby shunning the middlemen's interference.
- It is personification. The digital economy makes it possible to provide goods and services that meet the requirements and needs not of the average consumer, but of each customer.
- The high growth rates ensured by the internet have led to an abundance of availability of goods and services. This has, in turn, led to the demand for products and services anytime and anywhere in the world and hence the growth of the digital economy.
- It is heavily reliant on data; it is common in the digital economy for businesses to collect data about their customers, suppliers, and operations for the use of a product or service.
- The virtual nature of goods and money is the unique feature of the digital economy because these can exist only in the virtual world (computer networks), unlike the traditional or real economy, which exists in the physical domain (Inna, 2020; Oliver, 2023 & OECD, 2023).

National Digital Economy Policy and Strategy (NDEPS)

In 2020, the Federal Ministry of Communications and Digital Economy (FMCDE) launched the National Digital Economy Policy and Strategy (NDEPS) with the aim of revolutionizing the Nigerian economy and establishing itself as an active member in the worldwide digital market. This strategy has the goal of enhancing digital infrastructure, advancing digital literacy, addressing digital technology gap challenges, and cultivating innovation and entrepreneurship within the nation. The adoption of NDEPS by Nigeria is a sign of its commitment to utilizing digital technologies for economic advancement and societal progress. Thus, by effecting a strong digital framework, businesses of all sizes were able to use technology to expand into untapped markets, optimize their processes, and stimulate economic development. Hence, the National Digital Economy Policy and Strategy (NDEPS) focuses on addressing key objectives, including:

- target 75% broadband penetration in 4 years;
- accelerate the digitalization of government processes and improve service delivery, transparency and accountability;
- improve trust, confidence and security around digital processes and activities;
- attract and grow digital jobs across all sectors of the economy;
- develop the technology start-up ecosystem by actively promoting innovation and entrepreneurship;
- support the digital literacy of Nigerian citizens, business and government workers and enable them to acquire cutting-edge digital skills;
- develop a digital education curriculum to meet the current and future needs of the digital economy;
- ensure that indigenous technology companies can participate actively in government-funded technology programmes;
- Ensure that the policy and regulatory instruments are fit-for-purpose and support the digital business environment (FMCDE, 2019).

The Concepts of Economic Growth and Sustainable Development

Economic growth and sustainable development are interconnected concepts that aim at improving the well-being of individuals, communities, and nations while protecting the environment. Economic growth is an increase in the production of economic goods and services, compared from one period of time to another. Traditionally, aggregate economic growth is measured in terms of gross national product (GNP) or gross domestic product (GDP), although alternative metrics are sometimes used (Solomon, 2022). According to Bartholomew (2016), economic growth is the increase in the inflation-adjusted market value of the goods and services produced by an economy over time. It is conventionally measured as the per cent rate of

increase in real gross domestic product, or real GDP, usually in per capita terms. It is an increase in the capacity of an economy to produce goods and services, compared from one period of time to another.

Similarly, sustainable development, according to the World Commission on Environment and Development (WCED) in its report "Our Common Future", is a concept that "meets the needs of the present without compromising the ability of future generations to meet their own needs as well." It balances economic, social and environmental considerations (UNWCED, 1987). A concise and lucid version of sustainable development is the one further captured by Udoudoh et al. (2019), that is "not using up resources faster than the planet can replenish or restock, maintaining better quality of life now and for incoming generations to come". Accordingly, the relationship between economic growth and sustainable development is that when economic growth can contribute to sustainable development by reducing poverty, improving living standards, and increasing access to education and healthcare, sustainable development can support economic growth by conserving natural resources, promoting innovation and technology, and enhancing human capital.

Thus, emphasizing the position of digital technologies to economic growth and sustainable development, ECLAC (2022) submitted that digital technologies foster ecological innovations that contribute to sustainable development by reducing environmental impacts and optimizing resource use. For example, unlocking the potential of the digital economy for economic growth and sustainable development involves a multifaceted approach that integrates many sectors of the economy, such as agriculture, education, finance, inclusion, production, manufacturing, transportation, healthcare, transparent governance and so on. These services are pivotal in enhancing the digital economy, stimulating economic growth, and promoting sustainability. These offer innovative solutions to reduce poverty, improve health and education, and foster economic growth (World Bank, 2022 & Echu et al., 2024). Thus, digital economy and sustainable economy are interconnected, with digital technologies playing a crucial role in promoting sustainability across various sectors (Okonkwo et al., 2024).

Link between ICTS, Digital Technologies and Digital Economy

The term "digital economy" has a long history. It was coined amid the rapid and active formation of information and communication technologies (ICTs). Truly, the global and overall development of the World Wide Web (the internet) and various possible mobile communications is the basis of the digital economy. Technological innovations in ICTs, as well as innovations in ICT-related economic activities, are among the most important factors for inclusive economic growth and development. Accordingly, the digital economy is defined by the World Bank (2022) as "a system of economic, social and cultural relations based on the use of digital information and communication technologies (ICTs)". ICTs, which convey the concepts of the use of technologies, have been the slogan for technologies for the last few decades. But, in recent years, there has been a merging of the sub-sectors of ICTs, including information technologies, telecommunications and broadcasting, now regarded as digital technologies (Oliver, 2023).

Digital technologies are referred to as all electronic tools, automatic systems, technological devices and resources that generate, process or store information (HPC, 2021). It cuts across basic technology, such as websites, to the advanced, which includes artificial intelligence/machine learning, blockchain technology, voice interfaces and chatbots (Samuel, 2022). A business transformation is therefore digital when it is built on a foundation of digital technologies. Digital technologies have advanced faster than any other breakthrough in history, reaching nearly half of the world's population in barely two decades and revolutionizing industry and society as a whole (United Nations, 2020), cited in Oduntan & Isere (2022). Digital economy then includes various economic activities in which the use of digital information and

knowledge plays a key role. Modern information networks are increasingly becoming an important area of activity, and the effective use of ICTs) acts as an important driver to improve performance and optimize the structure of an economy. It is an increasingly important driver of global economic growth and plays a significant role in accelerating development, increasing the productivity of existing industries, creating new markets and industries and achieving sustainable growth (Inna, 2020). Since the late 1980s, the digital revolution has transformed the economy and society. First came the development of a connected economy, characterized by mass take-up of the internet and the roll-out of broadband networks. This was followed by the development of a digital economy via the increasing use of digital platforms as business models for the supply of goods and services (ECLAC, 2022). Consequently, the use of digital technologies in business transactions is often employed as a complementary model to the traditional mode of business transactions. It is obvious that the penetration of internet access and components of the industrial revolution have improved productivity and stimulated creativity, where the rise of emerging technologies has provided a platform for developing countries like Nigeria to use digital technologies to drive their economy.

The Role of Digital Technologies in Economic Growth and Sustainable Development

The Federal Ministry of Communications and Digital Economy has stated clearly and concisely that "our daily lives revolve around technology, and it's changing ultrafast. Technology advances in medicine, education, communication, and productivity have increased life expectancy around the world by lifting hundreds of millions of people out of poverty. The ability to connect to people and information has now become commonplace and is transforming economies, businesses and society" (FMCDE, 2019). So, digital technologies can significantly contribute to building a sustainable economic growth in Nigeria by promoting efficiency, reducing waste, and enabling new business models (Okonkwo et al., 2024). Some ways digital technologies can support sustainability include digital agriculture, digital education, e-healthcare, e-government, digital manufacturing, financial inclusion and skills development. These sectors are considered the identified pathways for digital economic growth and sustainable development in Nigeria.

1. **Digital Technologies in Agriculture / Agricultural Technologies (Agritech):**

   The importance of the agro-industrial sector as one of the main drivers of the Nigerian economy and one of the sectors with the largest share of employment in the rural areas cannot be overstressed. Thus, using digital tools and technology in agriculture to increase production, sustainability, and efficiency is essential (Awoniyi et al., 2023). Accordingly, digital technology is an important opportunity to help farmers produce more efficiently and develop sustainable solutions to climate change and other factors impeding large-scale production. In the opinion of Nikola et al. (2019), technologies can also support farmers to anticipate and respond to pest attacks, crop failures and climatic changes through timely weather-based agro-advisory messages. Moreover, as a result of technological interventions, farmers have now been able to gather, view, and evaluate crop and soil conditions at various stages of production in an efficient, cost-effective, and convenient manner. Agricultural digitalization involves monitoring and managing crops, soil, and water resources using sensors, drones, Global Position System, and other technology. It also uses artificial intelligence and data analytics to make more informed choices regarding planting, irrigation, and pest control (Awoniyi et al., 2023).

   Several technologies and methods are used to achieve the benefits described in the statements above. For instance, incorporating sensors into conventional agricultural machinery such as tractors, sprayers, and harvesters can transform them into networks of smart devices with yield

monitors, autopilot or sensors for seed distribution and spraying (ECLAC, 2022). Smart agriculture uses the Internet of Things (IoT) sensors, drones, and data analytics to optimize farming practices, reduce resource use, and increase crop yields. Blockchain technology enhances supply chain transparency, ensuring fair practices and reducing food waste. Precision agriculture uses IoT sensors and data analytics to optimize water and fertilizer use (Okonkwo et al., 2024). The use of guidance systems during planting and fertilizer application can lead to cost savings in terms of seed, fertilizer and tractor fuel, and can reduce working hours in the field. Companies that use AI help farmers to scan their fields and monitor every stage of the production cycle. AI can improve resource use, support early decision making via predictive models and maintain 24/7 monitoring systems. Also, field agrobots are already being deployed to help farmers measure, map and optimize water and irrigation use (Nikola et al., 2019).

However, these technologies often require significant financial resources, large farm sizes and close integration with other technologies and agrifood chain processes. It is therefore a greater challenge for small-scale farmers to adopt such technologies, whereas larger farmers and agribusiness companies will be more easily able to implement them. In order to alleviate these financial challenges, it is now possible for farmers to receive credit through digital payments as a result of the development of digital channels in order to enhance productivity, support savings as well and increase the standard of living. This is one of how digital or online banking contributes to the productivity of farms, as well as to the incomes of farmers.

Due to the use of mobile money, farmers in rural areas have an incredibly large number of options at their disposal as a result of the widespread use of the system. For instance, mobile-phone-based services can ease farmers' access to knowledge on extension services, market information, weather forecasts and agronomic advice. Furthermore, they can offer price information services for inputs and outputs, enable demand and supply aggregation, and facilitate e-marketplaces (Awoniyi, 2023). Therefore, digital technologies have great potential throughout the production chain, from the purchase of inputs to the marketing of goods. According to Mathew et al. (2024), access to technology and precision agriculture increases crop yields between 10.5% and 20%, and profits up to 23%. They evaluated further that the adoption of digital technologies by small-scale farmers throughout Nigeria has the potential to add 3.3 trillion NGN to value-added in the agricultural sector, equivalent to 2.8% of the sector’s value-added by 2028. It would result in additional employment in agriculture of around 1,056,000 people by 2028 and 273 billion NGN in additional tax revenues from the increase in value added to the economy.

2. Digital Technologies in Education / Educational Technologies (Edtech)

The rate at which education has influenced our economic activities and daily lives today cannot be over emphasized (Kadłubek et al., 2022). According to UNESCO (2021), one of the main aims of education is to prepare future generations for this digital future, and to equip them to deal with the rapid development of technologies, cope with the continuous access to vast amounts of new knowledge and information, and foster critical thinking, sense-making, creativity and collaboration skills to excel in digital contexts. For that reason, digital technologies are used in education to provide engaging learning environments that inspire and motivate students to learn. Various studies have established connections between digital technologies and student engagement, motivation, and positive learning outcomes. This involves opening classrooms to engage in connected learning

and exploration beyond the boundaries of the school, and incorporating technologies into the curriculum to facilitate diverse and flexible delivery of content. Hence, according to Richa & Anoop, (2021), advancements in ICTs have made it possible to develop new and cost-effective approaches to expand the reach of education to all learners, including those who need continuing education to satisfy the demands of the information age, the fast-changing existence of employment, and life-long education in the knowledge society. For instance, online education and skills development are provided through e-learning platforms, preparing the workforce for a sustainable economy. Education and skill development are also crucial, with e-learning platforms and digital literacy programs providing access to quality education and skills (Okonkwo et al., 2024).

Some of the digital tools or devices used in education are mobile devices like smartphones and tablets, which have become one of the most valuable tools for students in higher education and have come to play an important role in in-class learning, study organization and management, student/community life and planning, dealing with finances, and personal safety and security (Aina & Opeyemi, 2020). Moreover, artificial intelligence (AI) can be applied in the classroom to tailor each student's educational experience, review student data to pinpoint areas where a student needs additional assistance and offer specialized criticism and direction (Rajesh, 2019). The interactive whiteboards (IWB), also called smart boards, are digital devices that allow images from a computer to be displayed through a digital projector onto a large (usually wall-mounted) board. The digital tools enable both teachers and students to interact with the content on the board using fingers or a stylus. The above categories of digital technologies can be employed in education in a variety of ways, each with special application areas and advantages such as digital storytelling (DST) which according to Megan et al; (2021) is a multimedia presentation of narratives, which combines a range of media such as text, images, video, audio, and interactive elements, to tell a story. Another example is the interactive digital technology, which can provide dynamic math instruction in everyday classroom practice by enhancing the learning process and making math concepts more understandable (Niemi et al., 2018, cited in Megan et al., 2021). Also, many researchers have proven how interactive audio-visual songs can develop vocabulary awareness and understanding in primary school children when delivered on computers and touch screen devices. For example, a study carried out by Wilkes et al. (2020) pointed to the importance of technology and teachers working in unison to augment language learning outcomes. They examined the use of digital tools in a blended learning setting to augment reading proficiency.

3. Digital Technologies in Governance / Digital Governance (E-Government)

Digital governance has received worldwide acceptance due to the various transformations it has brought in governance; the modern state as an independent government has transitioned from old analogical practices, which used to be slow, weak and complex, to a simplified, fast and result-oriented practice (Cole, 2020). There is no unit in a modern state that digitalized government has not impacted, it is in the office, home, factory, and all areas where human involvement is essential (Benson, 2020). For example, digital technologies is a remarkable opportunity for most government departments/offices, ministries and agencies such as Nigerian Armed Forces (NAF), Economic and Financial Crimes Commission, (EFCC), Nigerian Police Force (NPF), Federal Road Safety Commission (FRSC), Nigerian Drug Law Enforcement Agency (NDLEA), Economic and

Financial Crimes Commission, (EFCC), State Security Services (SSS), Joint Admission and Matriculation Board (JAMB), National Business and Technical Examination Board (NABTEB), West African Examination Council (WAEC) among others in Nigeria. Highlighting its significance, Garuba (2014) reiterated that e-governance is useful in the promotion and restoration of democratic activities in the state with the help of improvisation of the participation of the people in government by giving adequate feedback on the activities of political elites and technically influences government decision making to suit the interest of the people. As a consequence, e-government has offered hope for transforming public service delivery in Nigeria, given the country's widely perceived corrupt state of public administration, and by this means greatly improved productivity for digital economic growth and sustainable development in the country.

Similarly, one of the central tenets of the current thinking on development is the importance of sound governance for sustainable economic growth and poverty reduction, a key component of which is the conduct of transparent, free and fair elections. The mobile phone, drawing on its new-found ability to transmit text, numerical, video and other data to a central computer, is transforming election monitoring from the formerly slow and laborious process of observing the balloting, recording the data manually on paper, and verification and transporting or faxing completed forms to a distant regional center for entry into a central computer (Gibson & Frannie, 2011). So, governance and transparency are enhanced through e-government services, data-driven decision making, citizen participation through social media platforms, and sustainable supply chains through blockchain technology for transparency and supply chain optimization (Ruggerio, 2021, cited in Okonkwo et al., 2024). While portraying the positive impact of digital technologies to transform government through transparent, free and fair elections and the delivery of public services, Matthew et al. (2024) asserted that accelerating digital government programmes will have a transformative impact on efficiency, effectiveness and reach of public services. They echoed that Nigeria has already seen improved efficiencies in payments and compliance through e-taxation programmes, automation of processes and the use of digital technology for voter enrolment and registration for the 2023 elections. Likewise, they cited the 2023 census as Nigeria's first Digital Census, utilizing the use of mobile handset devices data and geographic information systems to create digital census maps to inform the census enumeration process.

4. Digital Technologies in Healthcare /Electronic Healthcare (E-Health)

Prevalent internet use has opened up a new perspective on healthcare by surpassing the logic of face-to-face care, as has been seen during the COVID-19 pandemic. Digital healthcare, also known as e-health or digital medicine or telemedicine, involves the use of medical information transferred from one site to another through electronic communications to improve patients' health care, including diagnosis and treatment (Isizoh et al., 2013). Therefore, e-health influences technology to deliver healthcare services, improve health outcomes, and enhance patient experiences. Digital healthcare applications, according to Mathew et al. (2024), range from telemedicine consultations allowing doctors to consult with patients over a digital voice or high definition (HD) video, to e-health records that enable more accurate diagnoses and reduction in administrative costs. Digital payments can also support and improve processes for insurance claims and facilitate contributions to national health insurance requirements. E-health solutions, such as telemedicine and health apps, can bridge the gaps between urban and rural healthcare services (Okonkwo et al., 2024).

From a public health perspective, digitalization is supporting the transition from curative to preventive medicine, helping to put patients at the centre and empowering them, and making service management and delivery more efficient, safe and cost-effective. E-health can help bring care closer to those populations that are most vulnerable because of their economic status or because they live far from major urban centres, thereby eliminating the constraints on the provision of quality care that arise from the limited supply of general practitioners and specialists to serve those groups. Thus, digital healthcare solutions can deliver better well-being outcomes through improved access to healthcare services, as well as contributing to the economy via cost savings and increased productivity. Most of the digital innovations in healthcare, such as personalized medicine, genetic testing, telemedicine and e-healthcare, hold profound prospects for improved healthcare delivery, but raise the twin concern of privacy and security. Without doubt, data privacy and security are central to the practice of medicine and the delivery of healthcare. However, the Nigerian Data Protection Act (NDPA), signed into law on the 12th of June 2023 by the executive government, is a solution to the challenges of privacy and security. Part of its purpose is to foster safe conduct for transactions involving the exchange of personal data, and to afford a just and equitable legal and regulatory framework on data protection, which is in tune with international standards of best practices.

Among the emerging technology tools used in healthcare for digital transformation are artificial intelligence (AI) and blockchain. The AI in healthcare encompasses the use of machine learning algorithms and cognitive technology within medical settings, representing the convergence of human and medical learning. AI in healthcare can help facilitate finding new links between genetic codes, power surgery, automate administrative tasks and personalizing treatment. In some instances, AI has been used to screen diagnostic tests and blood work to detect cancer in its earliest stages (Otaibge, 2022). Similarly, blockchain is a system that maintains records of transactions across computers linked in a peer-to-peer network. It is a technology that enables secure and transparent sharing of data through a network linked by cryptographic hashes. Blockchain has immense potential to facilitate the transfer of health information of patients for treatment and research purposes. Its use is also very beneficial as the technology is immutable and secure, and almost eliminates the possibility of interference with the data stored and transferred through the network.

5. Digital Technologies in the Financial Sector (Financial Technologies, Fintech)

Financial technologies (Fintech) refer to the use of technology to deliver financial services and solutions. Fintech innovations have the potential to drive sustainable economic development in Nigeria by promoting efficiency, transparency, and financial inclusion. These technologies facilitate cost-effective and secure financial transactions, enable access to credit for underserved populations, and foster entrepreneurship and innovation in various sectors of the economy (Aremu & Adeyemi, 2022). This dimension of digital finance includes various innovative technologies and applications, such as artificial intelligence, blockchain, robo-advisors, peer-to-peer lending, and crowdfunding (Okoye & Nwosu, 2022). The adoption of digital payment solutions, blockchain technology, insurtech, and peer-to-peer lending platforms has surged, providing individuals and businesses with easier access to financial services and driving financial inclusion (Olaniyan & Lawal, 2021). The use of digital technologies in the financial sector has helped to remove some of

the biggest obstacles to financial inclusion. Their application has changed the way traditional financial sector activities (financing, investing, trading, payments, planning, etc.) are carried out, with major implications for end consumers (ECLAC, 2020). About financial inclusion in particular, Okonkwo et al. (2024) remarked that financial inclusion and economic participation are further enhanced through digital financial services, crowdfunding, and microfinance initiatives.

The Central Bank of Nigeria has introduced various initiatives to promote cashless transactions and drive financial inclusion, thereby creating an enabling environment for the growth of digital payment systems in the country (Ajayi, 2021), cited in (Echu et al., 2024). One example is the use of mobile money (telephony) service by people in rural areas, which provides the financial sector with a widely used and low-cost platform as long as the infrastructure is in place. Mobile money accounts include the ability to transfer money and to make and receive payments through mobile phones. They are available to the unbanked population and have a large network of physical access points to ensure that they can be used by people outside the traditional financial system, in particular (ECLAC, 2022). Therefore, mobile money is linked with a higher money multiplier, improving the effectiveness of monetary targeting (Mathew et al., 2024). Commenting on the key sectors and trends of digital economy, Christian, (2022) cited in Popoola et al., (2024) stated that the proliferation of digital banking, mobile money services, and fintech innovations in Nigeria has been instrumental in bridging the gap between traditional banking systems and the digital economy, facilitating more efficient transactions and fostering inclusive growth. This digital transition not only supports economic diversification but also encourages environmentally sustainable practices by reducing the carbon footprint associated with traditional banking operations and promoting green finance initiatives (Echu et al., 2024).

6. Digital Technologies in Production and Manufacturing

Economic Commission for Latin America and the Caribbean described productivity growth as the main driver of sustained economic growth (ECLAC, 2022). Thus, in the long run, increasing productivity is the only way to maintain income growth and access to essential goods and services. The positive effect of the development and incorporation of new technologies into production processes, essential for growth, cannot be overstressed. According to Matthew, et al., (2024), adoption of new technologies by manufacturing firms – referred to as industry 4.0 technologies such as internet of things (IoT), 3D printing, virtual reality, data and analytics, artificial intelligence (AI) and machine learning could allow Nigeria to expand manufacturing capabilities, support diversification and increase labour productivity in the manufacturing sector.

There are many examples of the use and application of digital technologies in the production and manufacturing sectors. In the extractive industries, for example, and the oil industry in particular, sensors and machine learning equipment can be applied to regulate and correct the pumping system in a well in order to increase production and prevent malfunctions. Moreover, AI and machine learning can contribute to cost reductions in sales and input purchases by predicting the demand and supply of goods and services (ECLAC, 2020, cited in UNCTAD, 2024). In manufacturing, automation can enhance productivity and reduce operational costs through AI and robotics. Digital platforms can streamline supply chain processes and allow for customization and rapid prototyping, while smart manufacturing uses advanced technologies like 3D printing and robotics to minimize material use and production waste (Okonkwo et al., 2024). According to the Organization for

Economic Co-operation and Development, some of the main applications of new technologies in the manufacturing sector are in real-time order tracking and supplier logistics, virtual development systems, machine-to-machine communication, customer lifecycle monitoring and management, and business process automation supported by artificial intelligence (OECD, 2023).

The practical evidence has shown that digitalization of the manufacturing sector in Nigeria has the potential to add 5 trillion NGN in industry value-add, equivalent to 3.3% of the sub-sector's value-add by 2028. Also, the application of industrial internet of things (IoT) and industry 4.0 increases value-added between 15-25%. This would result in additional employment in industry of about 465,000 people by 2028 and 417 billion NGN in additional tax revenues from the increase in value added to the economy (Matthew et al., 2024). In addition, the expansion of digital technologies in production processes is speeding up innovation and generating productivity gains, with positive effects on economic growth through automotive technology (autotech), agricultural technology (agritech) and financial technology (fintech), among others. For that reason, Natalia (2024) stated that the digital economy is the basis for all types of production carried out with the help of digital technologies and electronic systems. He further reiterated that the transition to these systems increases efficiency, speeds up work, saves time, improves various types of machinery and equipment in production, and provides consumers with affordable and convenient use of products and services.

Factors that Influence the Effective Implementation of Nigerian Digital Transformation

In this new economy, the convergence of the physical and digital world has accelerated and changed how work is organized as numerous digital technologies, platforms and forms of human work emerge. To digitize and reap the values emanating from the digital economy, some social, organizational and technological barriers must be identified and reduced (Kumar & Maheswaran, 2023).

1. Knowledge and Consideration: The priority is to recognize the importance of digital transformation. In a large percentage of companies, this recognition is lacking, particularly when it comes to the need to adopt digital technologies at a sufficiently granular and precise level. The least advanced companies do not have access to information and knowledge about digital tools and their benefits, or about their relevance to their business. In Nigeria, unfamiliarity with technologies is one of the major obstacles to greater adoption among less digitalized firms. Some establishments consider the lack of information about available technologies to be a major obstacle to innovation, while some believe that the application of technologies is of no importance to economic growth.

2. Availability of Resources: The functionality of the digital economy is greatly dependent on the availability of technological resources. Once the potential of the digital economy is recognized, companies must have adequate resources and access to digital technologies to implement this solution. This includes financing to be able to acquire the solutions and access to suppliers with affordable solutions, as well as a policy and regulatory framework that facilitates these types of transactions. This is a large challenge for organizations undergoing digital transformation, both from an implementation and data integration perspective, as well as from an end-user experience perspective, especially in rural areas.

3. Digital Literacy: The use of digital technologies requires basic literacy and numeracy as well as special technical knowledge and skills. According to Oduntan & Isere (2022), digital literacy is "the ability to identify, search and utilize required information in multiple formats from a wide

range of sources presented through information and communication technologies (ICTs)". People without such competencies can end up marginalized in increasingly digitally driven societies (Nikola et al., 2019). Oduntan & Isere (2022) also saw that the wide publicity that is given to digital literacy and ICTs over the media presently is gradually improving the situation of digital illiteracy in the country. However, these researchers observed that those who do not have access to the internet and digitalized services have therefore been excluded from benefiting from the privileges offered by ICT facilities. Promoting digital literacy ensures that all citizens can benefit from digital technologies and participate in the digital economy (Okonkwo et al., 2024). On the other hand, the existence of a digital divide is a prominent disadvantage of the digital economy. Nigeria's digital divide refers to the inequality of Nigerian individuals, groups, or organizations in access to ICT infrastructure or to the internet for daily activities (Okoye et al., 2023). This division can thus result in inequalities concerning access to information, education, employment prospects and economic advancement, thus jeopardizing the digital transformation.

4. Privacy and Security Concerns: Data privacy and security are also critical concerns, necessitating robust cybersecurity measures (Sule et al., 2023, cited in Okonkwo et al., 2024). This is because the digital economy is significantly dependent on the acquisition and storage of personal data, which can create data privacy and security issues. Cybercrime, such as data breaches, cyber-attacks and unauthorized access to private records, can lead to financial losses, identity theft and various adverse outcomes. This development has resulted in a reduction in the use of the internet and online services by a portion of the population for economic activities.

5. Availability of Appropriate Industrial Training (IT) Skills: Digital Technologies in a sustainable economy require a skilled, high-performing IT workforce to succeed in the transformation initiatives. However, putting that together is difficult, especially given the present shortage of tech workforce in the country. According to a business survey (CIO Survey, 2020) cited in Oduntan & Isere (2022), 54 per cent of companies are unable to achieve their digital transformation targets due to a lack of technically trained staff. Thus, many organizations face issues such as a lack of cybersecurity, application architecture, software integrations, data analytics, and data transfer skills. Outsourcing the project work to outside confidential consultants and digital transformation experts might help organizations that lack IT personnel to overcome the implementation and migration issues.

6. Internet Accessibility: The most critical component for unlocking the possibilities of digital technologies use is access to the internet (Nikola et al., 2019). Access to digital technologies can offer significant advantages to smallholder farmers and other rural Small and Medium Enterprises (SMEs) by providing links to suppliers and information and allowing users to tap into workforce talent, build strategic partnerships, and access support services such as training, finance and legal services.

7. Society and Culture: Social and cultural beliefs play a significant role digital economy. Social and cultural barriers include resistance to change, traditional mindsets, awareness and trust, inclusion and accessibility, gender disparities, and language barriers. Traditional mindsets and resistance to adopting new technologies can slow down the digital transformation process (Okonkwo et al., 2024).

8. Government Policies and Regulations: Polices and regulation changes also determine the success or otherwise of Nigerian digital transformation. In many countries, government policies and frameworks are one of the driving forces behind digitalization (Nikola et al., 2019). The government of Nigeria, for example, periodically reviews and adjusts policies that have been established by current or previous administrations. According to the 2024 national trade estimate, Nigeria's National Information Technology Development Agency (NITDA) guidelines require ICT companies to use Nigerian businesses for the provision of at least 80 of all value-added services on their networks (NITDA, 2024). These guidelines define "value added service" vaguely, creating uncertainty for businesses seeking to comply with the measure. So, regulatory uncertainty, such as a lack of clear policies and fragmented regulations, can create uncertainty for businesses and investors (Okonkwo et al., 2024).

Conclusion

Through an extensive literature review, it was found that the digital economy presents a unique potential for Nigeria to attain economic growth and sustainable development and therefore improve the overall living standards of its populace. By influencing digital technologies in various sectors of the economy, Nigeria can subdue many of its galling challenges (social, cultural, political, ethnic, etc.), create new economic opportunities, and position itself as a leader through the digital economy.

Recommendations

- Based on the numerous reviews and for the digital economy to simplify the process of ensuring economic growth and sustainable development, the following recommendations were made:
- It is recommended to improve the policies and regulatory frameworks on the use of digital technologies to promote the development of the digital economy, including stimulating innovation, supporting digital startups, and increasing investment in research.
- Given the fact that digital technologies has begun to transform economic and social processes, it is necessary to encourage exchanges at various levels involving governments, private sector, civil society, international organizations, technical and academic communities, as well as other stakeholders, such as trade unions and associations both within the country and internationally.
- Every business organization adopting the digital economy should recognize and familiarize itself with today's emerging technologies to enable it to better connect with its existing customers, respond more quickly, and also be more efficient and effective in terms of customer service. Besides, they should prepare to explore what is the best way to utilize or develop emerging technologies to prevent themselves from being left behind as the digital economy as a whole continues to develop.
- Since the digital economy requires a highly skilled workforce and intellectual technologies, it is important to use the best practices of developed countries to create digital systems, which, in turn, necessitates a scientific study of the transformation processes of institutions in the digital domain.
- Efforts should be intensified in reducing the digital divide between different segments of the population, particularly in rural areas, through the collaboration efforts of government agencies and technology corporations. This can be done by setting up more computer training centres (cybercafés), expansion of the existing infrastructure, and training on computer use with low tariff charges.
- To unlock the full potential of digital economic transformation, there is a need for significant administrative capacity building among governments at all levels in Nigeria. This can be achieved by creating an enabling regulatory environment for both local and foreign business investors.

- To promote a sustainable digital economy, Nigerian governments should focus on creating awareness and trust in digital solutions as a requisite for widespread adoption, mostly in sectors like finance and healthcare. This can be done by expanding internet connectivity, improving the affordability of digital services, improving electricity supply, developing renewable energy solutions, enhancing digital literacy programs, strengthening regulatory frameworks, providing funding and support for startups and small businesses, addressing environmental concerns, and fostering social inclusion.

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