Proceeding Paper

Inclusion, Organizational Resilience, and Sustainable Development in Nigeria: The Role of Digital Innovations †

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Abstract: This study investigates the roles of digital technologies in promoting inclusion, resilience, and sustainable development in Nigeria. The study surveys relevant literature and concludes that the agricultural, e-commerce, financial, and transportation sectors majorly use digital technologies to promote inclusion, resilience, and sustainable development in Nigeria. Therefore, the study recommends that the Nigerian government and leaders of industries should work together and address the factors hindering the adoption of industry 4.0 technologies in Nigeria to minimize the possible effects of future internal and external shocks on the Nigerian economy. In addition, it is imperative that an incentive system that promotes digital innovations is developed to keep the country on the path of growth and sustainable development.

Keywords: digital innovations; inclusion; industry 4.0 technologies; organizational resilience; sustainable development

1. Introduction

The digital revolution has contributed tremendously towards accelerating the pace of economic and social advancement across the world. It has impacted virtually all sectors of many economies and enabled the critical sectors to respond promptly to global disasters, especially pandemics. Digital technologies have provided a formidable platform that helps industries, most notably manufacturing, finance, education, medical, and communication sectors, mitigate disruptions that are associated with global crises, such as the COVID-19 pandemic, and drive inclusive economic growth, and sustainable development. Moreover, it has redefined government operations, customers' expectations, and business models. It has also impacted all aspects of life and livelihood, including communication, business, work, religious activities, leisure, etc. In addition, it has created an enabling environment for the actors in different walks of life to develop strategies and resilient approaches to achieve inclusive growth. Therefore, countries worldwide have leveraged digital and industry 4.0 technologies to address poverty and inequality, promote food security, boost productivity and provide an eco-friendly environment that is greener and decarbonized [1]. Technologies have also been used to stabilize the trading system, eliminate trade restrictions and curb the transmission of the COVID-19 virus in different parts of the world. China and India are among the countries that have recorded massive technology-driven economic transformation recently, and they are largely recognized as emerging advanced technology super-states across the world [2,3]. The transformative and sustainable development impacts of digital and industry 4.0 technologies have gradually been recognized in Africa. Over the last decade, digital technologies have contributed to skills and capacity development in Africa. In addition, it has provided the necessary tools to leapfrog the continent's traditional development trajectory [4].

Recently, African leaders developed Agenda 2063 to spruce up the standard of living, health quality, and wellbeing of the African citizens through education and skills acquisition, underpinned by science and digital technologies [5]. These efforts have yielded results, as many African countries have taken advantage of digital technologies to extend critical services to the underserved communities; digitalize their economic sectors; and improve financial inclusion, access to trade, and public services, thereby accelerating sustainable development. For instance, M-Pesa and Flutterwave, among others, have transformed the financial or banking industry in Africa. The flawless transaction services rendered by these companies enhance financial inclusiveness, uplift business activities, promote sustainable development, and help businesses circumvent the negative impacts of the COVID-19 pandemic. Similarly, mPedigree has helped bridge the gap between the rich and the poor by providing healthcare services both in urban and remote areas [4]. In addition, the use of industry 4.0 technologies has also helped to boost the continent's productivity and put Africa on the path of achieving inclusive growth and sustainable development.

In Nigeria, digital technologies have been used by governments, firms, religious organizations, agencies, and businesses to reach the forgotten communities, strengthen economic resilience and achieve the common goal of inclusive growth and sustainable development. Industry 4.0 technologies, including disruptive technologies, big data analytics, cloud computing, cyber-physical systems, internet of things (IoT), blockchain, artificial intelligence (AI), drone technology, autonomous machines, and simulation, have been employed in different sectors of the economy, most notably e-commerce, educational, financial, and transportation sectors to respond and adapt to incremental changes and sudden disruption. For example, while Jumia and Konga have digitalized the trading system in Nigeria, Uber, OPay, and Lara Transport leveraged digital technologies to transform the transportation sector [6]. Furthermore, Piggyvest, a digital financial platform is focused on making saving inclusive and has helped increase people's access to financial or banking services in Nigeria. Similarly, Zoom and Ulesson have enhanced the education sector, while different agrotech companies have leveraged cloud data solutions to advance the agricultural industry. On the other hand, industry 4.0 technologies, such as prefabrication and building information modeling (BIM), have been used to advance the construction sector's development in Nigeria [7]. Evidently, the COVID-19 pandemic has brought the need to intensify efforts in developing and adopting digital technologies in Nigeria, especially in the manufacturing sector. This is with the view to boosting the country's capacity and promoting growth.

This study, therefore, investigates the roles of digital technologies in advancing inclusion, building resilience, and supporting sustainable development in Nigeria. Specifically, the study identifies industry 4.0 technologies adopted in different sectors in Nigeria and explains how they are used to develop resilient approaches to sustainable development, inequality, and economic backwardness. Moreover, the study establishes how digital technologies could be used to minimize the effects of future global disasters in Nigeria.

Besides this introduction, the next section presents the conceptual clarification. Section 3 identifies and presents digital technologies adopted in Nigeria, as well as their impacts on inclusion, resilience, and sustainable development. In Section 4, the study discusses Nigerian digital economy policy and strategy, as well as the factors hindering the adoption of industry 4.0 technologies in Nigeria. Finally, Section 5 concludes the study, highlighting how technologies can be applied to future global problems in Nigeria.

2. Concepts of Digital and Industry 4.0, Digital Inclusion, Organizational Resilience, and Sustainable Development

Digital technologies or industry 4.0 technologies are the ingredients of wealth creation because they add value to goods and services in any society and ensure a good living standard for all [8]. Digital innovations refer to the application of new or digital technologies to existing processes to enhance the outcome of the procedures. The fourth industrial revolution is commonly denoted by industry 4.0, and it encompasses end-to-end digitization and

integration of all physical, digital, and biological assets into digital ecosystems. Industry 4.0 challenges the status quo and marks the beginning of new technologies, including mobile supercomputing, intelligent robots, self-driven and electric cars and neurotechnological brain enhancements [6]. It also enables a seamless generation, analysis, and communication of data through a wide range of new technologies [9]. Disruptive technologies, big data analytics, cloud computing, cyber-physical systems, the internet of things, artificial intelligence, drones, autonomous machines, and simulation are the driving forces of industry 4.0 that improve productivity and change the way people work and live [10].

The digital divide is peculiar to a developing or backward economy, an economy characterized by inequality. Digital divide is a situation where there is a wide gap among the people, groups, and communities in terms of access, distribution, and use of information, communication, and technologies. On the other hand, digital inclusion is attributed to a digital economy whereby all entities, including governments, firms, religious organizations, agencies, and communities, have the opportunity to contribute to and benefit from the digital world. Technical and operational capacities are prerequisites to navigating the ICT world [11] and governments, firms, religious organizations, agencies, and communities are expected to effectively access and utilize information and communications technologies in a digital economy. There are four types of resources around which digital inclusion revolves, and these are physical resources, including computers and network connections; digital resources, such as digital materials available online; human and human attributes, including literacy and education and finally, social institutions, such as communication institutions and social structures [12].

Resilience refers to the ability of a group, organization, community, or nation to resist shocks, respond and adapt to incremental changes and sudden disruptions or recover rapidly from shocks. It can also be defined as an economy's or a society's ability to minimize the adverse effects of a given magnitude of disaster on welfare. There are two components of resilience, and these are instantaneous resilience and dynamic resilience. While instantaneous resilience refers to the ability of an economy or organization to minimize the immediate loss of a disaster or shock, dynamic resilience denotes an economy or organization's capacity to recover quickly from shocks or disasters [13]. Organizational resilience, therefore, refers to the ability of firms to deal with unforeseen circumstances or respond and adapt to incremental changes and sudden economic and social disruptions.

According to the Brundtland Commission Report cited in [14], sustainable development refers to the "development that meets the needs of the current generation without compromising the ability of future generations to meets their own needs." The needs of the present generation could be social, economic, and technological [11]. These needs focus on improving the standard of living of the people, so any attempt to improve the standard of living without damaging the ecosystems or causing environmental degradation, including deforestation, water, and air pollution, climate change, and extinction of species, is referred to as sustainable development. Furthermore, sustainable development is an essential factor that has received considerable attention in the global development policy and agenda [15]. This is because it explains how society interacts with the environment without risking the survival of the future generations.

3. Digital Innovations/Industry 4.0 Technologies Adopted in Different Sectors of the Nigerian Economy and Its Impact on Organizational Resilience, Inclusion, and Sustainable Development

The Nigerian economy is one of the largest economies in Africa with several sectors, including the financial industry, health sector, agricultural sector, educational sector, transportation sector, construction sector, manufacturing or industrial sector, e-commerce sector, and the oil and gas sector, among others. The country is highly endowed with natural resources and has the largest natural gas reserves in the African continent. Nigeria has about 200 million people, with an average age of 18 years, making it a country with one of the youngest populations on earth [16]. With respect to geographical location, Nigeria is located between the central and western parts of Africa. It shares a border with Niger

in the north, Chad and Cameroon in the east, Gulf of Guinea of the Atlantic Ocean in the south, and Benin in the west. Therefore, the country has gained a reputation for offering access to those that reside in Western and Central Africa, representing over half of the African continent.

Industry 4.0 technologies transform every aspect of life, both in developed and developing countries, including Nigeria. As of 2020, the contribution of the Information and Communications Technology sector to the Nigerian Gross Domestic Product (GDP) stood at 17.83%, which is highly impressive when compared to the 13.85% contribution to the GDP in 2019 [16]. In Nigeria, the contribution of digital technologies to economic transformation is growing every day. Digital innovations, such as virtual reality, have enabled Nigerians to transport to other parts of the world, interact with information in new ways, and consume goods and services that are not produced within the country. In addition, it has helped professionals, such as medical doctors, to diagnose patients, lawyers to handle legal proceedings, and lecturers to attend international conferences, among others. Furthermore, digital innovations have contributed enormously towards the reduction in the poverty level. They also enhance inclusion, help organizations resist shocks and global disasters, reduce maternal and infant mortality, and promote sustainable farming and decent work. Digital innovations equally help in achieving universal literacy, which forms part of the sustainable development goals. A brief description of how digital innovations/industry 4.0 technologies are used in different sectors of the Nigerian economy to promote resilience, enhance inclusiveness, and support sustainable development is provided below.

3.1. Agricultural Sector

The emergence of industry 4.0 technologies has contributed tremendously to the agricultural sector's transformation in recent times. Digital technologies, such as AI, IoT, blockchain, drone technology, and cloud data solutions, among others, have been used to transform the agriculture sector and support sustainable development in Nigeria. For instance, the BeatDrone firm uses drone technology to monitor and eliminate the death of crops, map farmlands, and collect essential agrodata. The drone technology sprays herbicides and pesticides to kill weeds and pests, respectively. In contrast, the thermal drone helps farmers examine the farmland's temperature and determine the appropriate time to irrigate the farmland. Furthermore, the drone technology uses data pooling and AI, such as near-infrared devices, to gather data on a farm's chlorophyll levels, which helps the farmers to know the health status of crops, apply the necessary precautions or cure, save crops' lives and increase farm yields [17]. These technologies also help farmers to build resilience against potential attacks.

Furthermore, the same blockchain, IoT, and AI technologies have also been used to uplift the performance of the agricultural sector in Nigeria. For instance, Hello Tractor, Thrive Agric, Farmcrowdy, Crop2Cash, TradeBuza, Verdant AgriTech, AFEX, and AgroMall have contributed immensely to the agricultural sector development in Nigeria. Hello Tractor is an IoT digital solutions platform that connects financial institutions, farm equipment owners, and dealers, especially tractor owners, to farmers in Nigeria. This IoT platform digitalizes the tractor services and helps poor farmers that rely on crude agricultural technology with low financial resources (which often result in under cultivation and late planting) improve their farming activities, and hence their productivity and income. Hello Tractor promotes inclusion by connecting small and poor farm owners that often rely on traditional farming methods to the tractor owners to improve their farm yields. Specifically, the digital solutions firm helps farms access financial resources by connecting farmers to financial institutions, thereby supporting financial inclusion. Furthermore, the platform helps farmers and tractor owners to build resilience by using data pooling and AI to collect data on farmers' activities and provide remote tracking of farm equipment to prevent loss, fraud, and machine misuse. These promote sustainable development, especially sustainable farming and decent work in Nigeria. Some other technology-driven firms have also digitalized agricultural activities in Nigeria and have driven inclusive

economic growth and sustainable development to an extent. These include Farmcrowdy, Thrive Agric, AgroMall, Crop2Cash, and Afex [17].

Likewise, digital platforms, such as YouTube and Zoom, have largely been used to build resilience against global pandemics, such as COVID-19, which called for social distancing and minimizing conversational communication costs in the agricultural sector. The two platforms have been mainly used to train both large and smallholder farmers on new farming techniques in Nigeria. Moreover, they have served as a means of communicating essential information and updating farmers' knowledge on the digital marketing strategies that will boost their income. Furthermore, social media platforms, including Facebook and Twitter, have boosted agribusiness by allowing agricultural marketers to reach consumers of farm products and producers of agricultural inputs effectively and engage them in commercial transactions. In precis, by connecting the smallholder farmers to the global market, digital technologies promote inclusion and support sustainable development.

3.2. Health Sector

The health sector is crucial in any economy because the quality of the healthcare centers in a nation determines the quality of life of the people. Evidently, the Nigerian digital health system is still at the infancy stage, begging for attention [18]. In Nigeria, data pooling and AI are used in a few hospitals to track and diagnose health issues and perform day-to-day activities, including record keeping and payment of bills. In response to the COVID-19 pandemic in Nigeria, Mairabot and mobile health information tools were developed to fight coronavirus and communicate the symptoms, transmission channels, and prevention measures to Nigerians. A digital platform, such as Whatsapp, was also used to update Nigerians on the state of the pandemic, including the number of confirmed cases, deaths, recovered and new cases in the country [19]. Furthermore, the digital translation of COVID-19 symptoms, precautions, and guidelines into several languages helps to reach over 98% of Nigerians. This promotes inclusiveness and strengthens the country against the COVID-19 pandemic. A few health start-ups, such as GeroCare, InStrat Global Health Solutions, LifeBank, AirBank, Omoni, Find-a-med, GenRx 54gene, WellaHealth, Otrac, and Truppr, have digitalized the operations of the health sector in Nigeria. For instance, GeroCare, a cloud-based primary healthcare center, leverages IoT and blockchain to promote inclusiveness and build resilience against attacks on the aging population, by providing healthcare services to elderly patients at the comfort of their homes in Nigeria.

InStrat Global Health Solutions utilized digital technologies, including AI, IoT, and blockchain, to transform and improve Nigeria's health service delivery. In 2020, when COVID-19 was a burden across the globe, InStrat helped to build resilience against the pandemic by developing and launching the Android COVID-19 App, through which they communicate accurate information on the pandemic to the health workers in Nigeria. The application also helps over 20,000 front-line health workers identify, screen, and manage suspected cases in Nigeria [20]. InStrat promotes inclusion in the health sector by leveraging satellite technologies, including Inmarsat and NigComSat. In addition, the firm utilized digital technologies to develop an effective and efficient electronic health data management, also known as the Clinical Administration Kit, to help health workers both in the rural and urban areas capture patients' medical histories and treatment options and disseminate them through available mobile or satellite internet networks. This allows the Nigerian health centers to build resilience against internal and external attacks. Furthermore, LifeBank leverages digital technology to develop a blockchain-powered blood system that enables patients and health professionals to access blood and study the safety records of blood and blood products. Others include AirBank, which utilizes disruptive technologies to provide emergency medical oxygen delivery services; Omoni offers digital solutions that help parents to monitor the health of their children and Otracenables health workers enhance their clinical knowledge and performance with relevant training and courses through an e-learning platform [18].

3.3. Financial or Banking Sector

Digital technologies play an essential role in the financial sector across the world. The prominent digital technologies used in the financial sector are IoT, AI, blockchain, cloud computing, big data analytics, and robots [21]. In Nigeria, the rise of financial technology companies, commonly referred to as FinTech companies, has transformed the banking services landscape over the past few years. Digital innovations, such as chatbots, blockchain, WhatsApp, digital banking, mobile lending and savings, peer-to-peer lending platforms, crowdfunding, and point of sale (POS) terminals, have transformed the activities of the Nigerian financial sector [22,23]. These innovations have helped the sector to build resilience against the COVID-19 pandemic and also kept the country on the path of sustainable development. In addition, digital innovations increase financial inclusion by promoting financial service delivery in rural areas where larger populations are unbanked. Moreover, the adoption of disruptive technologies gives birth to the digital database for identification, eases the customers' onboarding process, and promotes access to credit for small and medium-sized enterprises (SMEs) [22]. In Nigeria, fintech companies, such as Piggyvest, Cowrywise, Kuda Bank, Bench, Renmoney, Fairmoney, Paylater, Quickteller, and Carbon, among others, have digitalized financial services. These digital financial platforms have helped to improve financial inclusion and increased SMEs' access to credit in Nigeria.

3.4. Educational Sector

Globally, digital technologies have changed the operations of the educational sector. Digital and distance learning have opened up programs to students who would have otherwise been deprived of education, especially in developing countries. In Nigeria, however, the use of digital technologies is still at a low ebb, possibly due to the poor digital infrastructure, inadequate funding of the educational sector, limited expertise, resistance to change by the educational sector, overdependence of the educational institutions on the government and disconnection among the various digital learning enhancement initiatives [24]. The report of the Economist Intelligence Unit Limited, which ranks the ability of a nation to leverage information and communication technologies to promote a digital learning environment, revealed that Nigeria ranks 79th out of the 81 countries in 2018, with a digital readiness score of 2.125 [25]. This simply suggests that the Nigerian educational sector lags in the adoption of the digital learning system. Despite the digital backwardness of the educational sector, there are still a few notable efforts to promote a digital learning environment in the country. For instance, the National Open University Nigeria (NOUN), the most recognized distance learning institution in Nigeria, is changing the modus operandi of the Nigerian universities. Unlike the conventional universities, NOUN delivers lectures virtually through a combination of Web-based modules, including audio, videotapes, and textual materials [26]. This makes it possible for students who would have been excluded to have access to education in Nigeria. Digital learning also helps the institution to be resilient, especially during the COVID-19 pandemic. In response to the challenges posed by the COVID-19 pandemic, a digital education company, commonly known as uLesson, leveraged digital technologies to create a virtual learning environment for students, most notably primary and secondary school students in Nigeria. This has greatly changed how primary and secondary school students learn and study for their examinations in the country and has made them resilient against internal and external attacks that may disrupt their studies. The implementation of computer-based tests by the joint admission and matriculation board has also helped advance the use of digital technologies in the Nigerian educational sector and these methods are being implemented in major universities today.

3.5. Transportation Sector

Digital firms are seriously challenging the existing practices in the Nigerian transportation sector. For example, E-transport companies, such as Nairaxi, Uber, OPay, Lara

Transport, and Kobo360, rely on the power of technology to digitalize transport services in Nigeria, and hence build resilience against shocks, improve inclusion, and put Nigeria on the path of sustainable development. For instance, Nairaxi utilizes disruptive technologies, such as blockchain, AI, and IoT, to build a multi-service platform and digital payment technology that make it possible for people to order a ride service at an affordable rate. The digital platform also has a feature that allows people to shop, track and have groceries and other items delivered to them at the comfort of their homes. The firms that render similar services in the transportation sector include Uber, Taxify, and OPay.

On the other hand, Lara Transport is an AI chatbot that has helped ease people's movement in Lagos State, Nigeria. This chatbot provides critical information, such as step-by-step directions, fare estimations, and alternative means of transportation from one place to another. Furthermore, Kobo360 is another digital transportation firm that has transformed the transportation services in Nigeria. Kobo360 leverages big data and other technologies to build a formidable logistic platform that deals with logistic frictions, thereby reducing transportation costs in the supply chain. The logistic platform helps achieve an inclusive, sustainable, and efficient supply chain by connecting cargo owners, truck owners, drivers, and cargo recipients. Specifically, the firm enables farmers to increase their earnings by reducing agricultural wastages and helping manufacturers to expand their market share [27]. During the COVID-19 pandemic, when the Nigerian government put several measures in place to control the spread of the coronavirus, Kobo360 became a household name, as it helped to build resilience against the pandemic.

3.6. E-Commerce Sector

Digital technologies remain the driving force of sustainable development in the e-commerce industry worldwide, and the e-commerce industry is perhaps the most digitalized sector in Nigeria. In Africa, disruptive technologies are used to eliminate trade restrictions and stabilize the trading system. Digital companies, such as Jumia, Konga, Mall for Africa, Olx, and Jiji, have extremely changed the boundaries for marketers and consumers as they allow marketers or sellers to market their goods; and consumers to order items and get them delivered cheaply and quickly without any stress [28]. During the COVID-19 pandemic, these e-commerce firms were largely used to facilitate trade, and hence the e-commerce sector's resilience. The platforms also promote inclusiveness by extending their services to the underserved communities to support sustainable development in Nigeria.

4. The Nigeria Digital Economy Policy/Strategy and Challenges of Industry 4.0 Adoption in Nigeria

The Nigerian government has made several efforts to digitalize the Nigerian economy. These include the digitization of key activities, such as the use of the Bank Verification Number (BVN), virtual conferences and meetings, Treasury Single Account (TSA) and the Integrated Payroll and Personnel Information System (IPPIS), SIM registration, and data registration exercise for the National Identity Number. Digitalizing the key activities, most notably BVN, virtual conferences and meetings, and TSA, has enabled the government to save cost, fight corruption, and trail the path of sustainable development. In addition, it has led to an improvement in the citizens' participation in key activities and helped the country to build resilience against internal and external attacks. Recently, the Nigerian government reprogramed the Federal Ministry of Communications as the Federal Ministry of Communications and Digital Economy and charged it with the responsibility of developing and implementing effective digital economic policies and strategies that will fast-track the digitalization of the Nigerian economy [16]. Several factors have been identified as hindrances to the adoption of digital and industry 4.0 technologies in Nigeria. These factors are affordability, illiteracy/language barrier, disparities between urban and rural areas, lack of digital literacy, internet crime or computer phobia, fluctuating transmission signal, and institutional factors [11,29]. To promote the use of digital technologies and minimize the

possible effect of future global problems on the Nigerian economy, the government and leaders of industries must work together and address the factors hindering the adoption of industry 4.0 technologies in Nigeria.

5. Conclusions

This study investigates the roles of digital technologies in promoting inclusion, resilience, and sustainable development in Nigeria, especially during and after the COVID-19 pandemic. First, an attempt is made to identify the various technologies adopted in the different economic sectors. Second, the study provides a clear explanation of how different actors use digital technologies to determine innovative and resilient approaches to combat unsustainable development, inequality, and economic backwardness in Nigeria. Based on the available evidence, the study concludes that the agriculture, e-commerce, financial, and transportation sectors majorly use digital technologies to promote inclusion, build resilience and support sustainable development in Nigeria. Therefore, the study recommends that the Nigerian government and leaders of industries should work together and address the factors hindering the adoption of industry 4.0 technologies in Nigeria to minimize the possible effects of future internal and external shocks on the Nigerian economy. Furthermore, the government must develop strategies to prevent brain drain and formulate policies that will encourage the upspring of digital firms in Nigeria. Finally, the government and leaders of industries should create an incentive system that will promote digital innovations for sustainable development.

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