



FINAL REPORT

FOR

**“CONSULTANCY STUDY ON SECTORAL ADOPTIONS AND
INVESTMENTS IN ICT INNOVATIONS WITHIN THE NIGERIAN
ECONOMY”**

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Thank you.

EXECUTIVE SUMMARY

Introduction - The Objective of the Study

Information and Communication Technology (ICT) has emerged as a development catalyst in the globe. In Nigeria, it stirred the growth of the economy in 2021 with a contribution of 18.44 percent of the gross domestic product (GDP) making a positive strand towards the regeneration and diversification of the nation's oil dependent economy.

In addition, ICT is an integral part of most sectors of any economy. It has optimally enabled efficiency and effectiveness in the other sectors. Hence, the importance and need of an in-depth study and more investments in the ICT sector of Nigeria as an agent of transformation.

This study focused on examining the levels of ICT adoptions and investments in some sectors of the economy with the following objectives:

1. To investigate the level of ICT adoption and investment in Agriculture, Education, Energy, and Health sectors of the Nigeria economy;
2. To evaluate the level of adoption and innovations of ICT in the those sectors;
3. To evaluate why sectoral adoptions and investment in ICT innovation is low in some sectors of the Nigerian economy;
4. To analyse the factors responsible for the lower level of ICT innovation in the Nigerian economy; and
5. To recommend best practices and ways in which the identified factors and challenges can be solved using the best solution framework or model.

In the course of this project, a background study/comparism of sectoral adoption of ICTs in Malaysia, Singapore, South Africa, Kenya and Taiwan was carried out.

Methodology

The study covers four sectors of the economy - Agriculture, Education, Energy and Health sectors. Purposive sampling was used to select respondents for each of the sectors to which sector specific questionnaires were administered. Both quantitative and qualitative methods were used to analyse the data collected.

Results

Results showed varied degree of ICT adoptions and investments among the four sectors. This is due in part to the level of private sector involvement in the sectors and location of the entity/organisation concern.

Investment and adoption of ICT in the education sector is relatively higher than in the other sectors of the economy, this is largely propelled by the private sector.

Health sector's investment and adoption of ICT is also reasonably high. However, for the agricultural and energy sectors, there is a low level of investment and adoption basically due to economic factors.

Conclusion

The impact and benefits of ICT investment and adoption is overwhelming. It increases and boosts productivity, employment, economic diversification, security amongst others. It is therefore pertinent for any government to design a thriving environment for ICT.

The government of Nigeria must develop ICT policies targeted at each sector of the economy with its peculiarities and distinctions. This would help drive the desired economic growth and sustainability of each sector; the system of implementation would be designed to create all necessary guide and protection of the ICT hub and a gradual extension across the entire nation.

AI	Artificial Intelligence
DISCOs	Distribution Companies
FDI	Foreign Direct Investments
GPS	Global Positioning System
ICT	Information and Communication Technology
IPR	Intellectual Property Rights
ITU	International Telecommunication Union
M & E	Monitoring and Evaluation
SDoH	Social Determinants of Health
SMEs	Small and Medium Enterprises
UNESCO	United Nations Educational Scientific and Cultural Organisation
UNCTAD	United Nations Conference on Trade and Development
USO	Universal Service Obligations

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SECTION ONE

1.1 General overview of ICT innovations

Information and Communication Technology (ICT) has become an invaluable tool in the scheme of operations for individuals, corporate organisations and governments across the globe. ICT has become an ever-important part of life of everyone to the extent that it is regarded as the lubricant of the digital economy. ICT has been described by the United Nations Educational Scientific and Cultural Organisation (UNESCO) as a diverse set of technological tools and resources used to transmit, store, create, share or exchange information. These technological tools and resources include computers, the internet (websites, blogs and emails), live broadcasting technologies (radio, television and webcasting), recorded broadcasting technologies (podcast, audio and video players, and storage devices) and telephony (fixed or mobile, satellite, Visio/video conferencing, etc.)

The adoption of Information and Communication Technology (ICT) globally has proven to be an important driver of economic development. ICT has helped organisations achieve growth by becoming more efficient, effective, innovative and globally competitive. The adoption and use of ICT represent an enabling mechanism by which organisational leaders improve the efficiency and effectiveness of their business processes, as well as transform existing business models. Findings from various studies have come to a common conclusion that the adoption of ICT creates more jobs opportunities, financial benefits, improved efficiency, increased productivity and growth.

However, there is a wide gap between developed countries and their developing counterparts in terms of ICT adoption. ICT adoption within both large and small businesses in developed countries has significantly increased since 2005. These have helped organisations achieve growth by becoming more efficient, effective, innovative and globally competitive. There is also a wide disparity in ICT adoption among large scale firms and those that operate on a small scale. While large scale enterprises have profited considerably from the adoption of ICT in their operations, the rate of ICT adoption within SMEs in developing countries has remained relatively low and has contributed to the low rate of economic growth in the region.

The barriers to ICT adoption among developing countries include both internal and external barriers. The internal barriers include the political instability, cost of adoption and implementation and return on investment. External barriers include infrastructure, social, cultural, political, legal and regulatory barriers. Generally, inhibiting factors of ICT adoption among developing countries when compared to developed countries included human capital (such as inadequacy of skilled personnel and coherent ICT strategy), financial (such as high investment cost), infrastructural (such as access to power, internet bandwidth and reliable internet connection) and technological (such as the learning curve of evolving technology) factors.

ICT adoption has helped many countries, organisations and individuals to discover new ideas which have resulted in the development of new products which were not available in the past. Various sectors of the global economy have felt the impact of ICT in the last two decades. It has helped in the globalisation direction of the economies of the world. Below is a look at innovations in agriculture, education, energy and health sectors.

1.1.1 ICT innovations and Agriculture

Technological innovations have substantially shaped agriculture in the course of time. From the introduction of the plough to the global positioning system (GPS) and precision farming equipment, people have advanced new methods to make farming greener and develop better yields. Scientists are continuously working to discover new techniques to irrigate vegetation or breed greater sickness resistant varieties. These iterations are key to feeding the ever-increasing international populace with the lowering freshwater supply.

Agriculture is an essential factor in generating income and food for many families around the world. In the past few years, the sector has passed through many changes and improvements in various agricultural techniques and technologies. The techniques of modern agriculture and agricultural operations are very distinctive from many years ago, in particular because of technological improvement, which includes sensors, equipment, machines and information technology.

For example, today, inorganic fertilisers are used, much less pesticides are consumed, and different equipment and tractors are used. Also, state-of-the-art technologies include robots, temperature and humidity sensors, aerial photos and GPS technology. This modern equipment, precision farming and robot structures allow people in the business of farming to make more profit with greener, more secure and greater environmentally friendly. The availability of those inputs makes it vital to apply natural resources and approaches to enhance agricultural production and minimise costs. Farmers no longer need to apply water, fertiliser and pesticides evenly across the land. Instead, they can use the least amount and

target very specific areas, or even treat different plants. All these are made possible with the adoption of ICT. Some of the benefits of ICT adoption in agriculture include:

- Increased crop productivity
- Reduced impact on natural ecosystems
- Increased worker safety
- Decreased use of water, fertiliser, and pesticides, which in turn keeps food prices down
- Less runoff of chemicals into rivers and groundwater

In addition, robotic technologies allow for more reliable control and management of natural resources, such as air and water quality. It also gives producers greater control over the production, processing, distribution and storage of plants and animals, leading to:

- Greater efficiencies and lower prices
- Safer growing conditions and safer foods
- Reduced environmental and ecological impact

1.1.2 ICT innovations and Education

ICT innovations are having a significant impact on educational systems at all levels. Online courses, teaching aids, educational software, social networking tools, and other emerging technologies are disrupting the traditional classroom environment. Understanding the effects that ICT innovations have on students, teachers, and schools is critical to developing strategies and techniques to manage and use technology in education.

Although many people like to rely on traditional methods of teaching, the possibilities that open when ICT is brought into the classroom are endless. For one, access to education has been significantly broadened as a result, including a wide range of learning styles and degree options. Even if you are not a student or an education professional, it is crucial to note the importance of ICT in education.

ICT is helping education professionals in the monitoring of individual development and innovative lesson planning. Students who learn through various ICT technologies can create a set of skills that will help them throughout their own future careers. Among the benefits of ICT to students is:

- Simplification of access to educational resources;
- Improvement in the learning experience;
- Self-paced learning opportunities for students; as well as
- Preparation of students for their future careers.

The cost of education has significantly reduced, with options like online degrees and by eliminating the need to buy physical textbooks. By accessing scholarly articles from school databases, for example, one can easily choose to continue studies from another country or without leaving one's home.

Students do not even need to enrol in a full degree program to learn from the best universities in the world. Typically free for students, most academic journals will offer full digital versions of books originally produced in print. Even if one is not currently studying or involved in the education community, various articles, videos, etc., can be downloaded right to the phone, making the learning process both easily accessible as well as mobile.

ICT technologies have made education to be more flexible and accessible. There is a growing popularity of online degrees and mobile learning, physical boundaries have been eliminated, and many executives have embraced technology to supplement the further education of their employees. As teachers, a wide range of tools are used to enhance the classroom experience and motivate the engagement of students.

1.1.3 ICT innovations and Energy

A major driver of innovations in the energy sector is competition. This is important on the side of the suppliers (as they compete to satisfy the demands of their customers) as well as the consumers who have various energy products to choose from. However, there is a limit to which digital innovations can be adopted in the energy sector due to its uniqueness in terms of physical orientation, health and safety risks, engineer-driven culture and heavy dependence on third parties, global operations, long career and narrow exposure ^[1].

The energy business is sensitive to the laws of physics—whether the geophysics of an oil and gas reservoir, quantum physics of solar power, fluid dynamics of wind, thermodynamics of fossil power, or electromagnetics of power transmission. Hence, digital applications must contend with the laws of nature and be done in a way that safeguards asset health and frontline capability.

Digital innovations in the energy sector also require the assessment of cost and benefit of such innovations to the society at large. Some examples of innovations in the energy sector are stated as follow:

- **Internet of Things (IOT) in Power Industry**

The rapid growth in IOT is forcing traditional power utilities and industry participants to adapt, or be outpaced by strong new entrants possessing the benefits by this technological advancement. This has the potential to significantly transform the power sector by optimising operations, managing asset performance, and engaging customers to lower energy cost. The power sector is already reaping benefits from early consumer oriented IOT applications such as smart metres and smart thermostats.

- **Battery storage**

It is a known fact that the peak demand in electricity varies not only daily but also seasonally and annually. Meeting the peak demand is a costly affair, as utilities must either invest in additional capacity by building new power plants, which are not always optimal. Research carried out in storage technology has resulted in reduced cost of batteries and an increase in their performance. With this trend to continue, utilities in future are expected to switch to large battery banks as an alternative to building new power plants.

1.1.4 ICT innovations and Health

Health technology is defined by the World Health Organization as the "application of organised knowledge and skills in the form of devices, medicines, vaccines, procedures, and systems developed to solve a health problem and improve quality of lives". Healthcare innovations are eulogised for saving lives, improving health status, and improving the quality of care. Healthcare innovation is one of the most important battles in the fight to prolong human life. Various innovations have been developed in the health sector to improve healthcare delivery while reducing the cost. Many innovations in healthcare as a result of

uniqueness in health needs of the people, for instance, the outbreak of COVID-19 resulted in the development of health care products that use artificial intelligence (AI) to cater for health needs of the people. This is immensely helpful since it reduces the possibility of human contact which is the main channel of transmission of the COVID-19 virus.

Artificial Intelligence (AI) technology is being used in the diagnosis of diseases, as well as to offer customised solutions. For instance, it is being used to drive systems that process computed tomography scans by the thousands, in a mass detection scenario, as in COVID-19. This spares radiographers and physicians to attend to patients, besides providing supplementary information and thus improving the accuracy of diagnosis and monitoring.

Machine learning is being exploited in the pharmaceutical industry to identify new drug candidates without the long and expensive traditional method of sifting through chemical libraries while also replacing actual experiments with simulations, varying multiple parameters. The whole process is not only much less expensive but also much faster.

Robotic systems are being developed using AI and machine learning to replace humans in the performance of routine unskilled tasks now being done by skilled healthcare practitioners. This will free them to treat more patients with less time pressure, promoting a favourable outcome.

Telemedicine is an important innovation now practised in many countries worldwide due to pandemic restrictions on public travel. With this technology, clinical practitioners see patients virtually, avoiding personal contact, while still being able to diagnose and treat patients for a host of illnesses. The saving of time and money has made this an attractive

option for both patient and practitioner, and this trend has continued even after COVID-19 has subsided.

Augmented and virtual reality is being used in novel ways to distract nervous patients from surgical procedures or help train medical students outside the hospital and without the risk of harm to actual patients. A hands-free mode of operation is also enabled, allowing providers to access patient records or other information without leaving the patient or stopping the procedure they are engaged in.

Using all modern medical expertise and equipment, including lifestyle advice, it is estimated that patient outcomes change by up to 20% only, the rest being the product of social determinants of health (SDOH). When these are taken into account, doctors will soon be able to predict the course of the person's health and prescribe preventive measures to arrest the deterioration of health in a timely manner, rather than deferring the recognition of such events to a later stage, when sophisticated and costly interventions will become necessary. In all of these inventions, ICT adoption is the major reason why they are possible.

1.2 ICT and Economic growth

Theoretical and empirical evidences have pointed to a positive impact of ICT adoption on economic growth^[2]. This span across frontiers of both developed and developing countries. Due to the relatively high ICT investment and use, economic processes and trade are more influenced by the creation, dissemination, accumulation, processing and application of information and knowledge. ICT's multidimensional capabilities facilitate extensive innovations in products and processes, and thus lead to a more productive exploitation of

capital and labour ^[3]. ICT's wide scattered application allows new business models and management practices, new products embedding ICT, easier expansion to global markets and ICT-enabled emergence of new markets. Moreover, the impact is even more far-reaching through spill-overs induced by ICT- based networking, and has been much increased by the Internet, through the diffusion of ICT, transaction costs are reduced and facilitate more productive ways of interaction between businesses and division of labour worldwide^[2].

Furthermore, ICT allows an easier interchange of international innovators and dissemination of new technologies, and thus accelerates the invention and circulation of new ideas that in turn trigger further technological change. Due to these network effects, the impact of ICT increasingly grows crossing the threshold of ICT uptake and becomes more important than ICT investment and production with regard to contribution to economic growth.

The theoretical and empirical evidences also suggest that ICT production and diffusion generate significant growth returns in both industrial and developing countries, but less in countries lacking in finance for ICT-related investment, skills in the labour, ICT product and service sector and an ICT-friendly policy environment. ICT impacts the economy through three occurring macroeconomic channels that imperatively require complementary efforts by industry and policy to stimulate the impact. The first channel widens directly the capital deepening by investment in ICT but surges growth only in the short-terms; however, it is a prerequisite that establishes the base for the ICT usage. The second direct channel stimulates the Total Factor Productivity growth in the ICT sector induced by accelerated technological advances. The latter two channels require appropriate high per worker capital to be triggered

and the extent of impact is particularly strong in combination with a high stock of research and development (R&D) activities and associated subsidies, international openness and reduction of regulatory barriers. The third more comprehensive channel impacts the overall Total Factor Productivity growth by ICT use and positive spill over effects that create Total Factor Productivity increases throughout the entire economy. The more ICT diffuses and is applied, the more network effects lead to cross-firm integration and facilitate technological progress and innovations biased by extreme knowledge accumulation. Successful exploitation of ICT utilisation requires complementary efforts in building up a high stock of human capital and reorganisation, such as changes in human resource management practices and organisational structures, for adopting new knowledge or technologies respectively.

However, the macroeconomic differences in developing countries give reason to assume that the impact channels of ICT do not affect in the same extent and pace like in the developed world due to missing preconditions. The main challenge now is to understand how ICT should be deployed properly under the prevailing conditions in developing economies to benefit from ICT. Unfortunately, most of the research on ICT's impact has focused on developed countries, primarily due to reasons of statistical data availability and early awareness of ICT's extent of potential, but nevertheless provide valuable conclusions for the magnitude and dynamic effects of ICT. However, the studies on ICT and economic growth in the developing countries also have a common conclusion that ICT adoption has a positive nexus with economic growth in the long run ^[3], ^[4].

1.3 Justification of the Research

The impact of ICT in enhancing economic growth and development cannot be overemphasised. ICT is notable for its innovations and cost reduction benefits by reducing the need for transportation most times thereby freeing time which can be channelled towards other productive areas. Several countries have adopted ICT in their day-to-day activities and this has proven to be of more benefit to their economies as evident in increasing growth and creation of more value addition in the value chain of products and services.

The existence of Nigeria is not in isolation of series of innovations in the area of ICT across the globe. The youthful population of Nigeria has displayed a penchant for ICT innovations in recent times. Therefore, it is pertinent for the government to focus its lens on the development of the ICT sub-sector of the economy.

ICT has been adopted by most developed nations in improving service deliveries. For example, ICT has been applied in agriculture to manage climate resilient crops in order to boost production of food. The introduction of virtual classes has helped students in attending classes without the need of moving from one city to another. The health sector has also improved greatly due to the application of ICT in service delivery. It is therefore important to look into ICT adoption in Nigeria in order to disinter information on the areas that need attention. This will go a long way in improving the use of ICT in Nigeria thereby contributing to economic development.

This research is intended to examine the level of ICT adoption and investment in the Nigerian economy with special focus on Agriculture, Education, Health and Energy sectors of the economy.

1.4 Limitations of the study

The major limitation encountered in the course of this study is the inability of the data collectors to travel across the country due to the fear of insecurity.

1.5 Scope of the study

The scope of this study covers specifically the level of ICT investment and innovation in the Agriculture, Education, Energy, and Health sectors of the Nigerian economy. It also examined the most significant constraints facing ICT investment and innovation in these sectors.

The research was carried out in Nigeria and spanned across four sectors of the economy. Namely: Agriculture, Education, Energy and Health sectors.

Data was obtained primarily from organisations, Information Technology Managers, Experts, and top Executives using the questionnaires developed for the purpose of this study. Complementary data was gathered using various secondary sources especially from the online sources which span across the globe.

SECTION TWO

2.1 ICT Innovations and Investments in Nigeria

2.1.1 The role of government

Since the establishment of the ministry of communication and digital economy, concerted efforts have been made by the federal government focusing on creating an enabling environment in the ICT sub-sector of the Nigerian economy. This has paid off as the sector has become one of the major drivers of Nigerian economic growth in the last five years with the sector's contribution to GDP steadily increasing ^[5].

While ICT technologies have spread rapidly across most sectors of the Nigerian economy, the broader development benefits from using these technologies are yet to be fully achieved. To get the most out of the digital revolution, governments at federal, state and local levels need to work not only through ICT policies, but also by targeting “analogue complements”, this is to ensure all round development of the Nigerian economy.

Government at all levels need to:

Strengthen regulations that ensure competition among businesses,

Modify workers' and other people's skills to the demands of the new economy, and ensure that institutions are accountable.

Other factors include an investment friendly environment for public private partnerships and entrepreneurship, effective regulation policies, overcoming social challenges such as fear of

technology and bridging the gender digital gap, even though there are areas where women are very actively using ICT.

The United Nations specialised agency for ICTs provided four ways governments can ensure technology boosts development as follows:

- **Measure and monitor progress**

The first area relates to outcome measurement, policy review and target setting. Governments need to accurately measure progress achieved against the set outcome over time, better investigate the causes for this progress, set targets for improvement, and monitor the effectiveness of policy. ICTs, AI and “big data” have a major role to play in this.

- **Use ICTs to enhance government performance**

The second broad area relates to the government itself. ICTs can play an important role within government itself in particular to ensure efficiency in governance. E-government is the term given to the use of ICTs in facilitating better government performance. Governments need to embrace innovation and utilise ICTs to deliver effective services and engage people in decision-making processes so as to establish lasting foundations for growth and development.

- **Adopt enabling policies for ICT markets**

The third broad area relates to government policy directly affecting ICT markets. There are two broad subsets of related ICT markets here: i) ICT infrastructure markets, and ii) ICT applications and content markets.

On the role of Government in ICT infrastructure markets, attention focuses on the scope for considerable improvements in relation to state ownership of key telecommunications network assets, and in the extent and quality of spectrum licensing, competition law, access regulation and universal service obligations (USO). In ICT applications and content markets the focus is on the government's role in intellectual property rights (IPR), privacy law, and platform regulation generally.

- **Adopt enabling policies for non-ICT markets**

The fourth and last broad area is government policy in relation to non-ICT markets that nevertheless indirectly affect ICT adoption, investment and utilisation. Government policy on these non-ICT markets is having major and largely unforeseen effects in limiting the benefits of ICT. In non-ICT markets, policies designed for the pre-Internet era appear to be preventing the development of smart agriculture and smart food markets, smart water markets, smart energy markets, smart cities, smart transport, smart health, smart education and smart manufacturing markets—which are both more efficient and environmentally friendlier.

For this reason, governments urgently need to review and adapt their existing policies on non-ICT markets to ensure that they better suit the Internet era, thereby enabling cutting-edge ICTs to play their role in the development of the country in a sustainable manner.

2.1.2 Private sector involvement

Globally, there are enormous incentives for the private sector to adopt ICT in carrying out their day-to-day businesses. Firms that make use of ICT enjoy the positive impacts in the areas of performance, productivity, expansion as well as introduction of new products.

The United Nations Conference on Trade and Development (UNCTAD) published a Technology and Innovation report in 2021 where 158 countries were ranked based on their readiness for frontier technology. Nigeria ranked 124th in the world and 11th in Africa with a score of 0.20 out of a total of 1.00. South Africa, Mauritius, Namibia, Gabon, Cabo Verde, Ghana, Kenya, Eswatini, Botswana and Senegal all ranked higher than Nigeria in the ranking. The components of the ranking included ICT ranking where Nigeria ranked 124th, 106th in Skill, 74th in Research and Development (R&D), 155th in Industry and 149th in Finance ranking.

According to Statista in 2022, the total internet penetration in Nigeria increased from 26.75% to 38.73% between 2016 and 2022 respectively. Whereas in 2021, mobile internet users were around 48% of the population. The private sector is responsible for the high level of ICT use in Nigeria from corporate organisation to small and medium scale enterprises as well as the industries. The private sector is the major user of ICT products in health, finance and banking, education, agriculture, SMEs, industries among others.

Though the private sector is at the forefront of ICT adoption in Nigeria just as it is in other nations, there is more to be done by the private sector in Nigeria by not just being a major consumer of ICT products but also by producing ICT products of international standards that can be exported and generate foreign exchange for Nigeria.

However, one of the limiting factors that affect the private sector majorly is the inadequate domestic fibre-optic infrastructure network by implication the broadband penetration is low as only 10 – 15% of Nigeria’s incoming submarine cable capacity is currently being put to use^[6]. This in part is as a result of low demand for high-speed internet services particularly fixed broadband services. In addition, many Nigerian owners of domestic fibre-optic networks, which include most of the major telecoms players plus a handful of internet service providers, face major bureaucratic hurdles when it comes to obtaining right of way access to various parts of the country. Many Nigerian state governments levy high taxes on the telecoms industry. For instance, as of end of year 2015 about 50-70% of the cost of deploying fibre across Nigeria could be traced back to expenses related to obtaining right of way permissions. These constraints, plus the highly competitive nature of telecoms development over the past decade, have made it difficult for any single operator to build out a comprehensive, nationwide fibre-optic network.

2.2 Government budget on ICT

Over the years, there have been efforts by the federal government to fund ICT in order to accelerate its adoption in Nigeria. However, there was no clear distinction in the ICT budgets because of the single reason that no federal ministry was established to oversee the ICT sub-sector of the economy. The science and technology, communication and information ministries were partly responsible for the ICT related matters in Nigeria until the year 2016 when the ministry of communication was upgraded to ministry of communication and digital economy with a clear-cut responsibility of overseeing the ICT sub-sector of the Nigerian economy.

Although the Nigerian economy has always been regarded as agrarian because of the huge employment created in the economy by the agriculture sector, the service sector has always been a significant driver of the economy over the years. This is mainly because of the enormous share of the sector in the economy. The ICT sector which consists of Telecommunications & information services, Publishing, Broadcasting and Motion Pictures, Sound recording & Music sub-sectors used to contribute (on the average) around 0.7% and 3.5% to the nominal GDP in the 1980s and 1990s respectively, the sector gained momentum in the year 2000s by contributing an average of 5.45% to the GDP. This increase is largely due to the adoption of GSM in the early 2000s. The following six years witnessed a double-digit contribution to the GDP. In this period, the private sector of the Nigerian economy is already enjoying reasonable benefits of ICT in their operations.

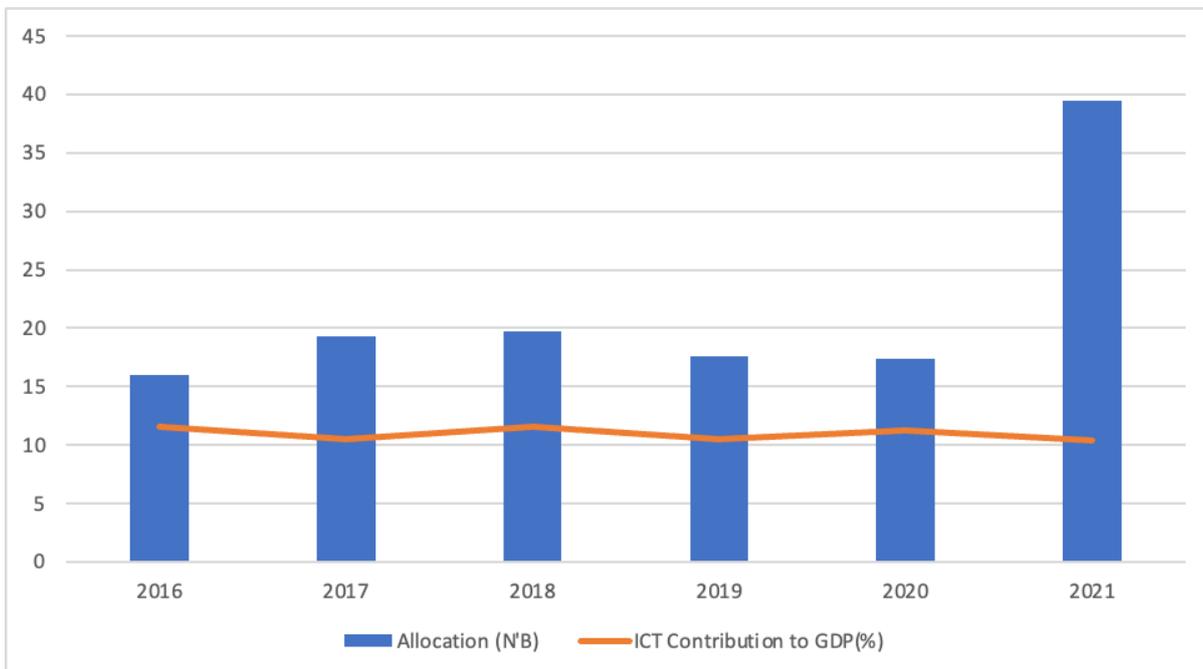


Fig. 2.1: ICT budget and contribution to GDP between 2016 and 2021

Figure 2.1 shows budgetary allocations to the Ministry of Communication and Digital Economy and ICT contribution to GDP between the year 2016 and 2021. The budgetary

allocations to the ministry averaged 18 billion naira between the year 2016 and 2020, whereas, the contribution of the sector was 11% on the average over the same period. The allocation to the ministry is less than 1% of the total budget. However, the chunk of the GDP is derived from the ICT sub-sector. The resilience of the ICT sub-sector in the face of global health crisis (COVID-19) is obvious as the contribution of the sector to the GDP remained unaffected during the period.

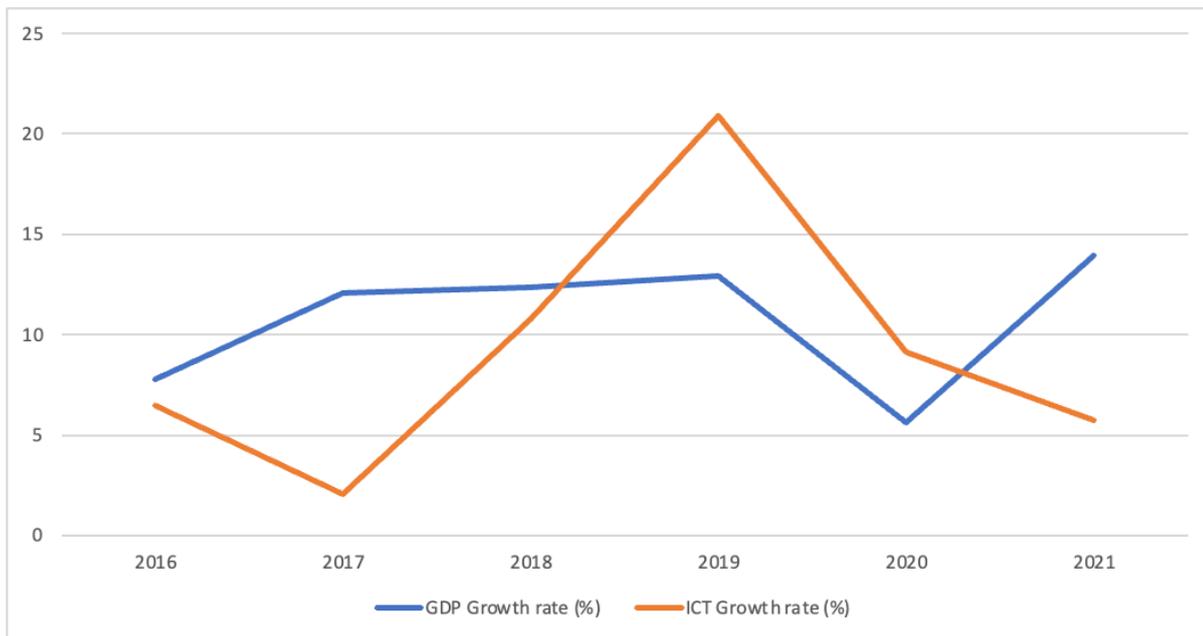


Fig. 2.2: GDP and ICT Growth rates between 2016 and 2021

Also, figure 2.2 shows both GDP growth and ICT growth rates between the year 2016 and 2021. The annual growth in the ICT sub-sector of the Nigerian economy is noticeable, in the year 2016 and 2017, the sector's growth rate was below the growth in GDP. This is largely as a result of higher growth recorded in the non-service sectors of the economy including agriculture, manufacturing and mining sectors. However, by the year 2018 growth in the ICT sub-sector surpassed the growth in the GDP. The resilience of the ICT sector in the period of global pandemic is notable in the year 2019 and 2020 when the sector recorded

20.98% growth and 9.13% respectively contrarily to GDP that dropped to 12.9% and 5.3% in the same period.

2.3 ICT through Foreign Direct Investment

Foreign Direct Investments (FDIs) is an investment made by a company or entity based in one country, into a company or entity based in another country. FDI generally takes place when an international business capital is purchased by a financial professional, including controlling interest or establishing ownership in foreign companies. FDI inflows through the provision of new investment, management skills and technological advancement lead to economic growth through improvement in the productivity level ^[7]. Not only that, FDI also contributes to the technology spill overs of the host nation ^[8].

There are studies that showed that FDI has positive contributions to economic growth in sub-Saharan African countries^{[9] [10]}. FDI is one of the major channels through which new scientific knowledge and related technological innovations are transferred among countries. Economies with high degrees of openness tend to attract more technologies than those with lower degrees of openness.

Empirical studies have also shown that there is a bi-directional relationship between FDI and ICT adoption. While FDI attracts ICT technologies in developing countries at the initial phase, the development of ICT technologies tends to attract FDIs after some periods of time when the domicile country must have adopted and developed the new technology to a level

that the country can also produce ICT and other ICT enhanced products and services. One of such examples is the Flutterwave¹.

African nations have welcomed FDI to spur economic growth in recent times. Considerable liberalisation of the prevalent investment regulations has been undertaken to facilitate the smooth flow of FDI into the continent. Substantial incentives have been provided to foreign investors to attract them into the African market. However, the economic performance of the continent has not been very stable especially as a result of global outbreak of COVID-19. Unlike decades ago, FDI flow into Africa has diversified from investment in natural resources to broader areas that can easily improve economic growth. Both the service sector and the manufacturing sector have become major areas that enjoy foreign investment. Africa, it seems, is slowly but steadily approaching the path of long run growth and development. International communities have promised increased aid for many African nations including Nigeria. International donors are keen to support Africa's regional development initiatives, provide increased market access to it and further its infrastructure development initiatives among other things. All these are components of FDI.

One of the major advantages of FDI is in its ability to attract technology diffusion and knowledge transfer. Over the years, FDI has helped Nigeria in the outsourcing of knowledge from mostly developed countries in the areas of mining, oil and gas, finance, industry and many other sectors of the economy. Policies to attract FDI to Nigeria can introduce world-

¹ The first Nigerian start-up that attracted a billion-dollar investment from outside the shores of Nigeria

class technology and technical expertise and processes to their existing work process. Foreign expertise can be an important factor in upgrading the existing technical processes. FDI offers several benefits to Nigeria. These often manifest in the form of increased domestic investments, exports and economic growth

SECTION THREE

3.1 ICT in other developing countries

ICT has become a part of the economy of every nation of the world; the only difference is the level of adoption. While the level of ICT adoption is typically high among the developed countries, less developed countries usually lag behind in the adoption of ICT ^[11]. In a rating of 158 countries by UNCTAD on ICT adoption in 2021, the best African country South Africa ranked 69th in the world. Nigeria ranked 124th in the world and 11th in Africa. In this section, we examine ICT adoption in South Africa, Kenya, Malaysia, Taiwan and South Korea who are all ranked higher than Nigeria. This will shed some light on policies that are put in place in these countries.

3.2 ICT in South Africa

South Africa comes in the first position in the adoption of ICT among African countries. Though the country is ranked 69th in the world, South Africa is considered one of the top nations with relatively developed ICT infrastructure on the continent of Africa. It is a middle-income country with an average GDP growth rate of close to 3% in the last couple of years. The country is also measured as one of the most competitive countries in sub-Saharan Africa, and among the region's most innovative countries.

During the apartheid era (pre-1994) the telecommunications infrastructure was developed to support the White-dominated "first economy". In the immediate post-apartheid period after 1994, efforts were made at increasing telephone density amongst the disadvantaged and mobile phone services were introduced and they became effective substitutes for fixed line

access. Commercial Internet services were also launched in 1994 and there was rapid growth until 2000 before it stagnated as levels of saturation were reached in the “first economy”.

ICT innovations in South Africa have led to relatively affordable and accessible high-speed broadband and acting as an important enabler for the country’s competitiveness across many areas. The government has reportedly made gradual efforts to provide support for nationwide development of internet connectivity through the National Broadband Plan while further infrastructure investment and development are also being carried out. Growth in infrastructure alongside high mobile penetration notwithstanding, the ICT sector was considered and perceived to be of high cost and controlled by monopolies. For some time, a large proportion of the population were on 2G, while the cost of broadband and other infrastructure such as electricity remained high. Opportunities are thus believed to be available in areas such as ICT infrastructure, multi-technology space, drones and artificial intelligence, automation and digitization of processes, digital manufacturers’ “clouds”, and distributed manufacturing driven by 3D printing.

ICT is also shaping governance in South Africa as the E-government platform is seen as an opportunity to address bureaucratic challenges, to provide much-needed awareness about policies or programs, and to improve collaboration with all stakeholders. The stakeholders include high growth technology companies and the ecosystems supporting them that are integrated into local or global value chains. These comprise high tech companies, system integrators, firms in ICT sectors, B2B technology platforms supporting SMEs, among others. These are critical for leveraging technological innovation and to create high growth industries and jobs.

Overall, it is believed that South Africa is facing significant challenges in leveraging new technological solutions^[12]. First, there is believed to be a monopoly of value chains by some large enterprises that have negatively impacted new entrants and entrepreneurs. Second, there is a lack of motivation for the private sector to invest in skills and training and activities in these areas are viewed as more of a compliance requirement. Third, soft infrastructure in the ICT sector is limited despite investment from the State Development Agencies.

To address the challenges, the government of South Africa continually review policies and programs that can nurture the formation of a technology ecosystem from the commercialization of innovation to the development of appropriate skills, and the improvement of public private partnership. Such changes provide the scope for large returns of investment in the ICT sector with the development and improved distribution of technology absorption capacity. Furthermore, there is growth in the number of ICT graduates and talented youths are hungry for opportunities in the sector and the impact of government policies will further open up the ICT sector in the country^[13].

3.3 ICT adoption in Kenya

Kenya has a robust ICT policy framework and implementation strategy with complete and measurable outcomes and time frames. The country promulgated a National ICT Policy in January 2006 that aims to improve the livelihoods of Kenyans by ensuring the availability of accessible, efficient, reliable and affordable ICT services. The policy has several sections, including information technology, broadcasting, telecommunications, and postal services.

The National ICT policy was formulated after broad-based public consultations in a number of iterations. This ensures that the policy captures the ICT ambitions of citizens and corporations and creates a framework for their timely realisation. Furthermore, the Kenya ICT policy takes close cognizance of the country's history, social, economic and operational environment, legal and regulatory framework, current capacities and capabilities and existing policies from all arms of government. Because the ICT policy was backed by strategic thinking and planning, it is being implemented and supported by all arms of government while enabling a competitive economy.

In March 2006, there was a review of the ICT Policy and this was inspired by the need to align the Policy with the new constitutional dispensation in Kenya and the country's Vision 2030. The review was specifically aimed to incorporate the lessons learned from the Vision 2030 Medium Term Frameworks and took into account the three underlying pillars of Vision 2030 (Economic, Social and Political) and the United Nations Sustainable Development Goals (UN SDGs). The focus was to provide access to ICTs, especially broadband to Kenyans and seamless connectivity to the East African Community member states with proactive collaboration at regional and international levels, leveraging on the country's leading position in Fintech and capital markets. In addition, the review was meant to provide a proactive framework that is in tandem with up-to-date technological realities and dynamics, and one that will guide the orderly development of the ICT sector so as to ensure maximum developmental impact for the benefit of all Kenyans.

The review of the National ICT policy in 2006 provided the foundation upon which the ICT sector experienced rapid technological advancement as well as the changes to the legal and

administrative framework and many emerging issues. The successes include the increased IT enabled services, increased demand on bandwidth and for Quality of Service, addressing challenges of cyber-security, integration of projects and harmonisation of ICT policies regionally and internationally.

Strategically, the ICT Policy of Kenya defined the forward-looking position of the Government and the objectives are as follows:

- a) To create the infrastructure conditions that will enable the use of always-on, high speed, wireless, internet across the country.
- b) To facilitate the creation of infrastructure and frameworks that support the growth of data centres, pervasive instrumentation (Internet of Things), machine learning and local manufacturing while fostering a secure, innovation ecosystem.
- c) To grow the contribution of ICT to increase the overall size of the digital and traditional economy by using ICT as a foundation for the creation of a more robust economy, providing secure income and livelihoods to the citizenry. Leverage regional and international cooperation and engagements to ensure that Kenya is able to harness global opportunities.
- d) To position Kenya to take advantage of trends such as the shared and gig economy, by enhancing our education institutions and the skills of our people and by fostering an innovation and start-up ecosystem that is able lead in the adoption of emerging trends on a global scale.

- e) To gain global recognition for innovation, efficiency and quality in public service delivery and the government services will be delivered in a manner that ensures a prosperous, free, open and stable society.

In terms of implementation, the Kenya National Policy on ICT focuses on the following 4 areas – (a) Mobile First; (b) Market; (c) Skills and Innovation; and (d) Public Service Delivery. The specifics from these focus areas are as follows:

Mobile First - The investment by the Government in internet connectivity infrastructure enabled access, mostly through mobile phones. The government believes that internet access is pivotal to the successful growth of a knowledge economy. The Kenya Government has committed to continue to invest in infrastructure for universal, always-on, high speed, wireless data connectivity.

Market – It is estimated that by year 2030, Kenya will have an estimated population of 66 million, with over 200 million devices and sensors connected to the Internet. It is predicted that aspects of human endeavours including money, security, governance, agriculture, tourism, education and health will be fully and seamlessly integrated into the digital economy. The government also projects that ICT will continue to catapult the growth of globalisation and trade across borders.

Skills and Innovation – The Kenya ICT National Policy outlines a careful plan designed to jump-start a self-supporting ecosystem that will produce world-class research, technology products and industries. The government through the relevant agencies working on ICT

commits to reassessing the research and development priorities and set new technology goals.

Public Service Delivery - One of the key targets of the Kenya ICT National Policy is to use technology to enable and enhance the delivery of public service to the citizens. Government services must be available online, that every Kenyan has online access and that government services are delivered quickly and fully at the time and place that they are needed.

3.4 ICT adoption in Malaysia

Malaysia implemented the first computer system in 1966 and since then, the Government has introduced various initiatives to facilitate the greater adoption and diffusion of ICT to improve capacities in every field of business, industry, education, and life in general. These measures include the enhancement of education and training programmes, provision of an environment conducive to the development of ICT, provision of incentives for computerization and automation, and creation of venture capital funds.

The Malaysia ICT Master Plan dates back to 1996 and the country has its 9th National Plan which recognizes that in the Information Age, ICT is central to competing in the global economy, increasing productivity and efficiency and enabling the enhancement of quality of life. The 9th National Plan outlines a number of steps to expand the ICT infrastructure, to promote the extensive application of ICT and to accelerate ICT usage in the various sectors of the economy.

The Plan clarifies several national strategies for adoption by the public, private and community interest sectors and these strategies are designed to achieve the following:

- a) Ensure widespread diffusion and acculturation of IT within and across sectors;
- b) Develop a national plan to ensure a more systematic approach to manage the development of ICT through the National Information Technology Agenda and the Multimedia Super Corridor;
- c) Increase and enhance IT education and training;
- d) Expand and upgrade the communications infrastructure to increase accessibility;
- e) Review laws and regulations to promote the growth of electronic communities and the development of a continuous learning environment;
- f) Promote the development of e-commerce, indigenous contents and the local IT industry, especially the software and knowledge products industries, to generate new growth opportunities; and
- g) Review and improve the national innovation systems to generate R&D output capable of driving the knowledge economy.

Recognizing the need for effective implementation of the Plan, the Malaysian government is strengthening the foundation to build an information-intensive and a knowledge-based society and economy with a technologically literate and innovative workforce, able to integrate the global environment. The Government thus established the National Information Technology Council (NITC) in 1994 and it is chaired by the Prime Minister. The NITC advises the Government on matters pertaining to the development of ICT in Malaysia and also provides direction on public policy formulators in the planning and management of ICT

as a strategic tool in the development of various socio-economic sectors. The National Information Technology Agency (NITA) was launched in 1996 by NITC and the primary objective is to ensure the orderly transformation of the Malaysian society into an information- and knowledge-based civil society. To enhance the realisation of NITA aims, the Malaysian government formulated a strategic agenda to provide the framework for collaboration by the public and private sectors as well as the general community in the five thrust areas of Sovereignty, Learning, Community, Public Services and Economy.

3.5 ICT adoption in Taiwan

Taiwan is considered to be a technological powerhouse that ranks among the world's top producers of notebook personal computers, flat panel displays, modems, motherboards, and other electronic components and products. The country has ranked highly in the production value of its IT hardware and also with a strong showing in the area of technology and innovation. Taiwan is also believed to have exceptional strength in technology issues, including an impressive capacity for innovation, firm-level technology absorption, university/industry collaboration in research, and its pre-eminent position in the use of the latest technologies, from mobile telephones to personal computers and the Internet.

The interaction of ICT and social and economic development in Taiwan has not only made a business of ICT, the country has used the technologies for social and economic development in the following areas:

- *The educational dimension*

The first effort of Taiwan at using ICT to develop its education sector initially focused on building research capacity in government-sponsored institutes. The country is using ICT to build an educational system that can meet rapidly evolving manpower requirements and contribute to the research needs of the economy. ICT application in the education sector is helping to expand knowledge and research capacity while new industry technical colleges are focusing on semiconductors and digital content. Overall, the educational system using ICT, is emphasising lifelong learning, using ICTs as well as programs in the science centres.

- ***The research dimensions***

Taiwan has made heavy investments in research and technology development to create an enabling environment for rapid development of the ICT sector. Through institutions like the Department of Industrial Technology, many programs are being funded and it has generally taken about 10 years of support for any one technology before commercial applications become profitable enough for the private sector to take over, allowing public support to drop back to a low level so that strategic new areas can be developed. Recognizing the importance of ICT to its development plans, Taiwan is increasing funding through public and private support for research and development.

- ***The human network***

ICT has helped propel Taiwan's human development, both through local science and technology education. The global information revolution and the rise of the Internet has been utilised effectively for enhancing skills development among ICT experts as well as among social groups. Given that the Taiwanese, as leaders in the ICT field, with their strong sense

of family, and large expatriate population, are thus benefiting from the networking possibilities.

- ***Taiwan as an ICT laboratory***

Taiwan has used ICT to what it calls an e-Taiwan and the goal is to have an e-Society envisaged and enriched through ICTs, an e-Industry integrated through ICTs and selling through e-commerce, an e-Government integrated and operated through ICTs, and e-Opportunities to close the digital divide by providing access and openness and reducing social inequalities. These are making Taiwan a test-bed for new technologies and applications and stimulate ICT innovations.

- ***Institute for Information Industry***

One key to Taiwan's success is a distinctive quasi-governmental structure at the heart of its ICT revolution. Its Institute for Information Industry was established in 1979 as a joint government-private sector think tank and management consultancy, to help promote the development of the ICT industry and deploy the information society. Funded by both government and the private sector, the Institute for Information Industry provides a neutral source of expertise independent of both partisan politics and individual corporate agendas. It is active in research and development, promotion of the ICT industry, and support and administration. The Institute for Information Industry Chairman is the science and technology adviser to the Prime Minister and President.

3.6 ICT adoption South Korea

South Korea is a top player in emerging digital technologies, with an outstanding digital infrastructure and a dynamic ICT sector (OECD, 2021). ICT is a key driving force behind socio-economic changes in Korea. It is also seen as a key element and strategy for improving the national system while it has been a principal force in the growth of Korea for the past 20-25 years.

Historically, the development of the ICT sector in Korea started between 1987 and 1994 and the period was called the *Digitalization* era (Rogers, 1995, Zhu & He, 2002). Some of the specific national achievements were the digitalization of projects for public administration and the National Basic Information System Project. Also achieved were reaching over 10 million telephone lines as well as the commercialization of the internet.

The period 1995 – 2002 was the *Informatization* era and instituted in the period were the Basic Plan on Informatization Promotion and Comprehensive e-Government Implementation Plan. Some of the legal frameworks put in place to facilitate the Informatization period include the Basic Act on Informatization Promotion (1995), Informatization Steering Committee (1996), e-Government Act (2001) and Act on Resolving Digital Divide (2001). The achievements in the period include over 10 million internet users as at 1999 and over 10 million mobile users in 1998.

E-Government was the focus between 2003 and 2007 with the development of the e-Government Roadmap and Basic Plan on u-Korea. To facilitate the process, the Presidential Committee on Government Innovation was set up in 2003 and some of the achievements in

the period were having over 40 million internet banking users in 2007 and attaining First position in the ITU Digital Opportunity index for 3 consecutive years (2005 – 2007).

Korea termed the period 2008 to 2012 as the Integration era in which the country developed its 4th Basic Plan on National Informatization. Some of the enablers were the Framework Act on National Informatization (2009) and the National Informatization Steering Committee (2009). Some of the achievements were attaining first position in the UN e-Government evaluation (2010 and 2012), having over 50 million mobile users and also over 10 million mobile banking a day (2012).

The *Creative Economy* is what Korea has been implementing since 2013 and this is being executive based on the country's 5th Basic Plan on National Informatization and the Government 3.0. The enablers included the Act on Disclosure of Public Data (2013) and the Special Act on ICT (2013). The targets are to ensure the creative use of ICT, resolving social issues with ICT and creating jobs through the application of ICT.

The key success factors for ensuring that ICT helps drive the Korean economy are as follows:

Government Driven Economy

- Designated Ministry for ICT.
- Continuous and evolving ICT Master-Plan.

Public-Private Partnership

- Research and Development
- Deploying Broadband network, etc.

Securing Designated Funds

- ICT Informatization Fund
- Broadcast Development Fund, etc.

Setting up Designated Expert Organisations

Specialised agencies or associations in the field of ICT, Informatization, Security, R&D, Standardisation, Promotion, Broadcasting, Spectrum, etc.

Overall, the Korea ICT strategy is based on the following:

- a) Developing policy based on the premise that technology developments in ICT fields are very fast and hard to forecast. There is thus a need for constant updates.
- b) National Informatization policy which entails long-term large-scale investment with ripple effects. In other words, long term planning is required.
- c) Policy serves as an effective tool to ensure the constant growth of the economy and improve the quality of people's life, and entails changes in social structure and systems as well as values, behaviour, and norms of people. In other words, cross-sectoral cooperation is required.

SECTION FOUR

4.1 Approach and Methodology

This research attempts to investigate the sectoral adoptions and investments in ICT in the Nigerian economy. The methodology adopted for the investigation was through both primary and secondary research. Data necessary for the line of investigation was obtained and collated through the distribution of questionnaires to relevant stakeholders in each of the sectors of concern and desk research using the internet to obtain information from relevant sources.

The investigations intend to answer the following questions

1. What is the level of ICT adoption and investment in the Agriculture, Education, Energy, and Health sectors of the Nigeria economy?
2. Why sectoral adoptions and investment in ICT innovation is low in some sectors of the Nigerian economy?
3. What are the factors responsible for the lower level of Information Communication Technology (ICT) innovation in the Nigerian economy?
4. What best practices and ways in which the identified factors and challenges can be solved using the best solution framework or model?

Based on the questions above, the questionnaire was developed to collect information on:

- a. ICT adoption and investment in each of the four sectors;
- b. Limitations to ICT adoption and investment in each of the sectors; and

- c. Best practice in ICT in each of the sectors.

4.2 Research Design

The research method was designed as thus:

Purposive sampling: is also known as judgmental sampling is a type of non-probability sampling technique in which the researchers rely on their own judgement when selecting the members of the population to participate in the survey. They are non-random in nature. This type of sampling technique is also known as authoritative sampling. This sampling technique is used in cases where the specialty of an authority can select a more representative sample that can bring more accurate results than by using other probability sampling techniques; more appropriately if one is interested only in the specific cases studied in which the focus is often to understand complex social phenomena. The process involves nothing but purposely handpicking individuals from the population based on the authorities or the researcher's knowledge and judgement.

Literature review: To put together this report, relevant literature on ICT adoption and investment were reviewed. This was mainly done through the use of the internet as the source of the literature review. The works of both Nigerian and non-Nigerian authors and researchers were reviewed to achieve a robust information gathering. The reports of the United Nations on ICTs, National Bureau of Statistics, were also reviewed in the course of this study.

Personal interview: Personal interview of Information Technology Managers, Experts, and top Executives in the four sectors of concern was another method employed in gathering the information for this report. Most of the people interviewed are in the private sector.

4.3 Data Gathering Tools and Analysis

Sectoral focused questionnaires were developed for each of the four sectors of concern in this study in order to obtain adequate data that address the unique information requirement in each sector. These questionnaires were sent to carefully selected respondents in order to collect relevant data that will be useful for the purpose of this study.

In order to adequately cover the six geo-political regions of Nigeria, an electronic version of the questionnaires was developed to collect relevant data using internet connectivity. This is in addition to face-to-face distribution of questionnaires to relevant stakeholders. Site visits were also carried out in some institutions and organisations to gather the requested data physically. Desk research was carried out on various websites that contain information related to study.

Data was analysed employing both quantitative and qualitative methods. This was achieved using excel and SPSS applications.

SECTION FIVE

5.1 Data Analysis and Results Interpretation

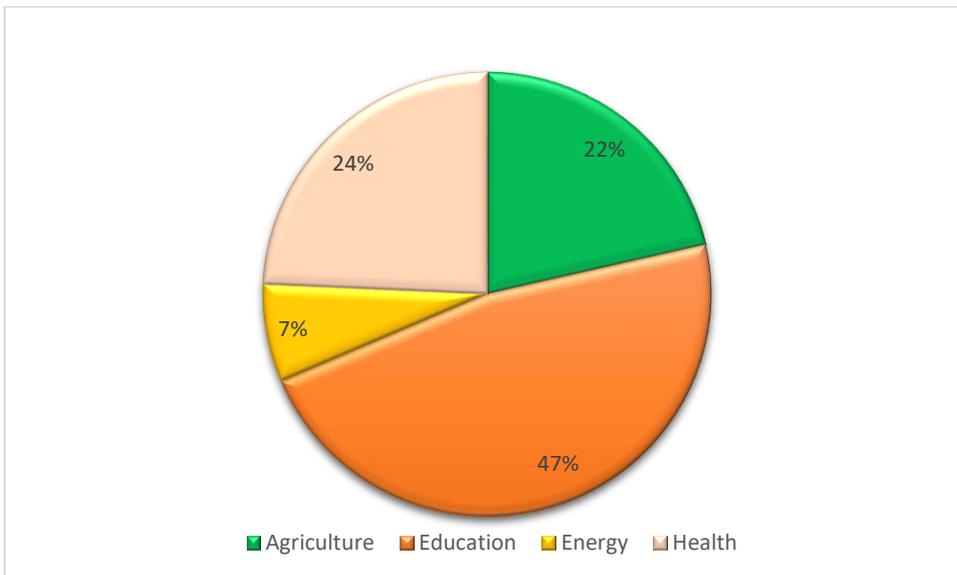
The following analysis covers the background information of respondents (organisations/institutions), ICT adoption and investment, limitations to ICT adoption and investment, and best practices in ICT adoption and investment. The focus is mainly the agriculture, education, energy and health sectors and the analysis tries to get a deep understanding of patterns of ICT usage among the respondents, what limitation they considered as the most pressing as well as the efficient solutions to invest and adopt ICT in the various sectors of the Nigerian economy.

Table 5.1: Respondents' identification

	Agriculture	Education	Energy	Health	Total
Number of participants (%)	30 (21.43)	66 (47.14)	10 (7.14)	34 (24.29)	140 (100)
Ownership structure					
Private	28 (93.33)	42 (63.64)	10 (100)	18 (52.94)	98
Government	2 (6.67)	24 (36.36)	0 -	14 (41.18)	40
Others	0 -	0 -	0 -	2 (5.88)	2
Availability of ICT department					
Yes	24	64	8	22	118
No	6	2	2	12	22
Availability of a Functional website					
Yes	22	60	10	20	112
No	8	6	0	14	28

Source: Authors computations from field survey.

In total, **one hundred and forty (140)** organisations/institutions answered the questionnaire. The majority of responding organisations/institutions (47%) are in the education sector, 24% are in the health sector, 22% in agriculture sector and 7% are in energy sector. The sample collected is very diverse and respondents across major strata of each sector are represented, yet the main analysis will focus on ICT adoption and investment, the limitations to adoption and the best practices.



Source: Authors computations from field survey.

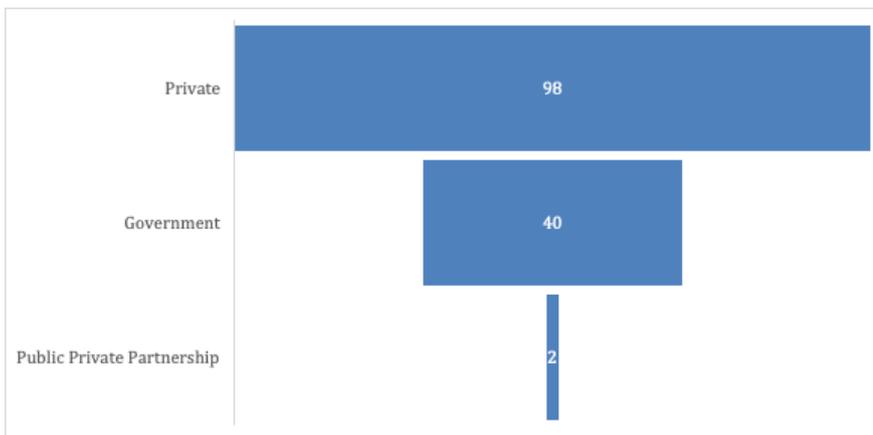
Fig. 5.1: Study sectors

5.1.1 Entity identification

In this section we examine various questions that were asked the respondents in order to establish the identity of the responding entity in terms of ownership structure and either the entity is a primary, secondary or tertiary entity.

Figure 5.2 revealed that generally 70 percent of the responding organisations/institutions are privately owned while 28.57 percent are publicly owned and uniquely, two (2) of the responding institutions have public private partnership ownership structure. The education

sector had (36.4% & 63.6%), agriculture sector (6.7% & 93.3%), energy sector (0% & 100%) in public and private ownership respectively. In the case of the health sector, more than half of the respondents are privately owned hospitals, fourteen (14) are government while two (2) are operated on a Public Private Partnership (PPP) ownership structure.



Source: Authors computations from field survey.

Fig. 5.2: Ownership structure of Institutions/Organisations

Of the total sixty-six (66) Institutions that participated in the study in the education sector, 48 are tertiary, 10 are secondary while 8 are primary this represents 72.7%, 15.2% and 12.1% respectively. Similarly, the health sector participants had 14 tertiary, 12 secondary, and 8 primary health facilities which represented 41.2%, 35.3% and 23.5% respectively. The participants in the agriculture sector are crop farming (12), rearing animal (2) and mixed farming (14), this represents 42.9%, 7.1% and 50% respectively. All the respondents for the energy sector are distribution companies.

Most of the respondents (80%) are having a functional website, indicating that they are accessible through the internet. However, more than half of the respondents (52.2%) have

no dedicated budget for ICT in their organisations/institutions. While respondents use multiple social media applications, it is worth noting that Facebook is the social media application of choice, followed by WhatsApp, twitter, and YouTube. Other social media application in use by the respondents is Instagram.

Table 5.2: List of some stakeholders contacted

S/N	Name of Institution/Organisation
1	Agrolog Limited, Kaduna
2	Nexus Farms and Consultancy, Kaduna
3	Temivibes, Kaduna
4	Z-Farm, Nasarawa
5	Feed the World Agrobusiness and General Merchandise, Ogun state
6	HVL Farms, Kwara state
7	Macks Farm, Osara, Kogi state
8	Mazota Farms and Agro-consult, Osogbo, Osun state
9	Molaojub Exclusive Intet Business
10	Pakit Foundation School, Niger state
11	Zenith Hills Academy, Niger state
12	Dorben Polytechnic Abuja
13	Bingham University
14	Prince Abubakar Audu University, Anyigba, Kogi state
15	Alkawthar Islamic School, Dakwa, Niger state
16	Bayero University Kano
17	Godfrey Okoye University
18	University of Nigeria Nsukka
19	University of Ilorin
20	Great Height Academy, Abuja
21	Olusegun Agagu University of Science and Technology
22	Calvary Crown Academy
23	University of Abuja
24	Federal College of Animal Health and Production Technology
25	Divine Wisdom International Schools
26	Federal University, Lokoja
27	Eliud International School
28	University of Jos, Jos
29	Kwara State University
30	Al-Minhaal Global Academy, Ile-ife
31	Pegasus Schools, Eket , Akwa Ibom
32	i-Scholars International Academy, Abuja
33	Federal University Dutse

34	Alfurqan Model School, Kano
35	Ado Gwaram Government Secondary School, Kano
36	Nigerian Army University, Bui
37	Abuja Electricity Distribution Company
38	Ibadan Electricity Distribution Company
39	Kaduna Electricity Distribution Company
40	Peacecare Clinic, Gwarimpa, Abuja
41	Primecare Hospitals, Gwarimpa, Abuja
42	University College Hospital, Ibadan
43	Plateau State Specialist Hospital, Jos
44	Bepos Hospital and Fertility Centre, Garki, Abuja
45	PSC Specialist Hospital
46	General Hospital, Ilishan
47	Muhammadu Buhari Police Hospital, Area 11, Abuja
48	Kubwa General Hospital, Kubwa, Abuja
49	Alpha Clinic, Kubwa, Abuja
50	Alliance Hospital, Abuja

Source: Authors computations from field survey.

5.1.2 Challenges Faced During Data Gathering

During the course of working on this exercise, particularly the data gathering phase of the assignment, our team faced the following challenges:

Poor Understanding of Requirement on the side of respondents - We realized that some of the respondents could not rank properly some of the responses that required ranking. Our team had to engage in a back-and-forth communication with the affected respondents in order to ensure that the affected questionnaires were properly attended to.

Lack of prioritization of the Survey – Our team also experienced lethargy in responding to the survey, and in some cases a complete show of lack of interest was experienced, this trend was experienced among many of the organisations in both private and government entities. We had to explore various means to gain the support of the organisations we eventually gathered data from.

5.1.3 ICT Adoption and Investment

Table 5.3: ICT adoption and investment

	Agriculture	Education	Energy	Health	Total
Number of participants (%)	30	66	10	34	140
	21.43	47.14	7.14	24.29	100
Means of payment for services					
Cash	4	4	0	14	22
Bank	0	54	0	6	60
Both bank & cash	24	6	10	14	54
Issuance of paper receipt					
Yes	22	24	10	30	86
No	2	42	0	4	48
Availability of ICT budget					
Yes	6	42	2	2	52
No	24	12	8	28	72
Sometimes	0	12	0	2	14

Source: Authors computations from field survey.

Respondents were asked across the four sectors on the means of payment for their services. The overall majority of the respondents (42.9%) said they use bank transfers, while 38.6% accept both bank and cash and the rest (15.7%) of them accept only cash payment. On the sectoral level, most of the schools only accept bank transfer while a few of them provided an option for cash. The situation is quite different for the health sector in which 17.6% accept only bank transfer and 41.2% accept both cash and bank transfers.

2 in every 3 of the respondents are yet to substitute the use of paper receipt with electronic receipt in their activities. This cuts across all the four sectors as shown in table 5.3, education entities (36.4%); health (88.2%). Both agriculture and energy sectors still issue paper receipt after every payment.

Around 2 in every 5 (37.7%) of the responding entities said that they have dedicated budget for ICT. 42 out the 66 schools in the education sector said they receive dedicated budget for ICT most of which are tertiary institutions and publicly owned. However, only few institutions among agriculture, energy and health sector receives dedicated budget for ICT.

5.1.3.1 Agriculture sector

Respondents were asked about the ICT applications they employ in their farms. These include GIS mapping, precision agriculture, automated irrigation system and digital farm data management. Majority (58.3%) of the respondents applied digital data management applications in their activities, while 1 in every 3 respondents applied GIS mapping in their activities with only 8.3% of the respondents using precision agriculture while none of the respondents employ automated irrigation system.

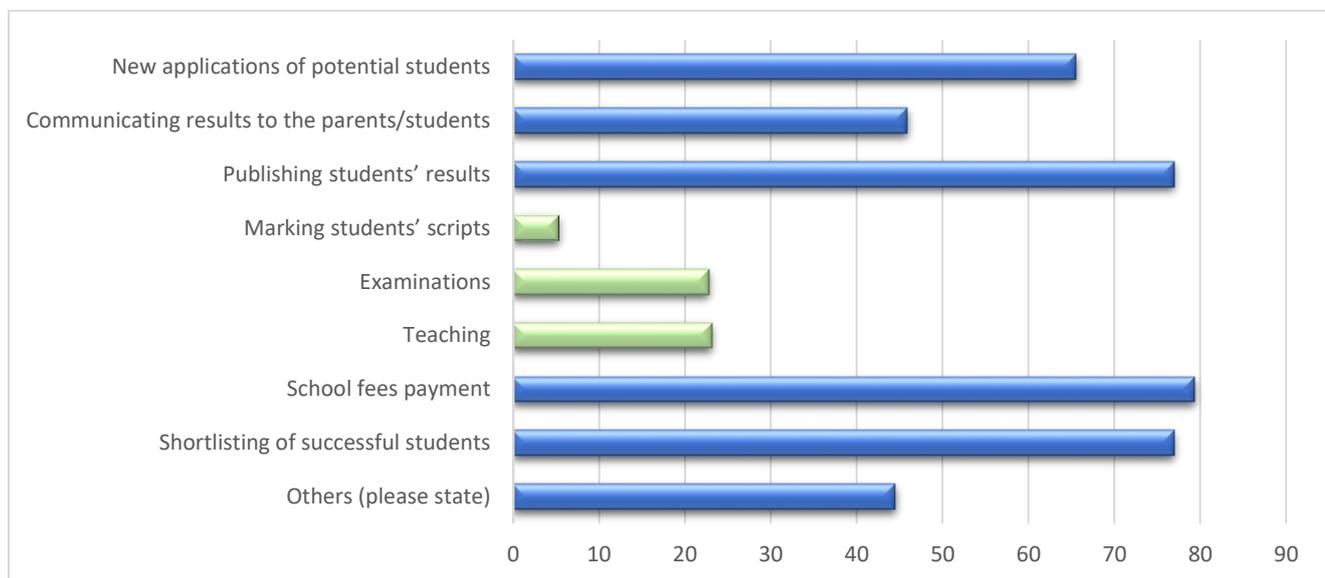
In addition, respondents were asked about the application of ICT in “taking stock of input, planning farming activities, general logistic management and output sales” all the respondents replied that they only apply those ICT applications partially in the running of their farm activities. This shows that the level of ICT use among the farmers is somewhat low.

5.1.3.2 Education sector

All the responding schools make use of at least one of the ICT applications in their teaching activities, 57.1% of the schools use at least two applications, whereas about 36.4% make use of at least 3 applications while 12.1% of the respondents make use of up to four of the applications listed. Also, most of the respondents (82.1%) said they make use of electronic

learning generally, half of the respondents use video assisted learning, 25% and 10.7% make use of virtual reality and augmented reality respectively while 39.3% make use of social media learning. In addition, most of the schools said their students have access to e-library (76.9%), virtual learning (46.2), augmented learning (15.4%) and learning analytics (15.4%).

ICT use in the education sector is relatively higher than in the other three sectors under consideration. In figure 5.3, respondents were asked about the application of ICT in the general activities of their school, 65.5% of the schools said they apply ICT in applications by potential students. Similarly, 3 in every 4 schools said they fully utilise ICT in shortlisting of successful students and payment of school fees. Marking students' scripts is the area with the least use of ICT among schools.



Source: Authors computations from field survey.

Fig. 5.3: ICT application in the general activities of school

5.1.3.3 Energy sector

Respondents in the energy sector were asked about the use of basic ICT technologies in the sector; all the respondents make use of Digital data management while only one out of five make use of Disaster monitoring devices. 40 percent make use of ICT in load management while 6 of the respondents make use of smart metering, this represents 60% of the respondents.

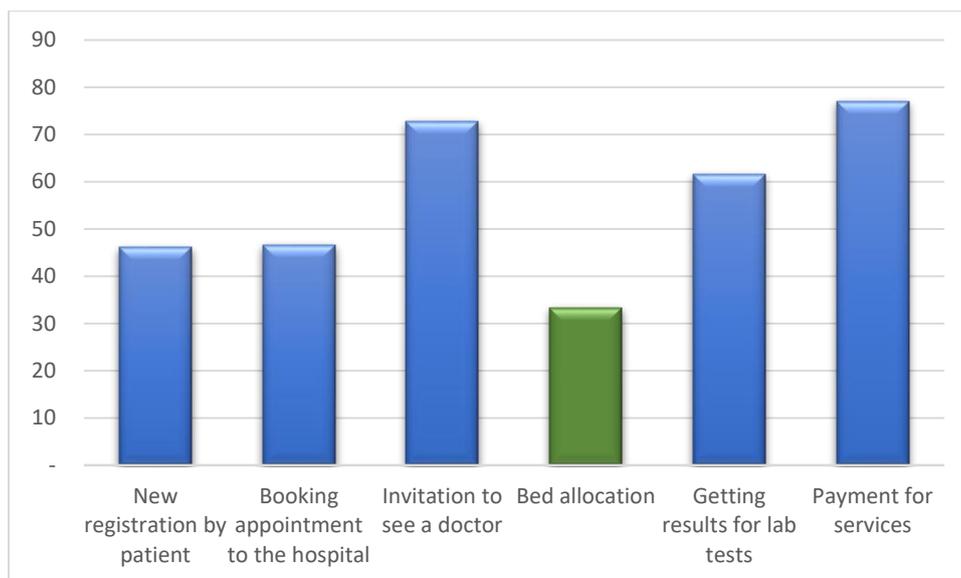
Respondents in the energy sector partially apply ICT technology in the conduct of their regular activities such as meter application, Electricity connection for new customers, Reconnection for existing customers, Payment for services and Lodging complaints. They also minimally make use of ICT in other activities that involve forecast of future demand for electricity, planning the servicing of equipment, equipment monitoring and disaster prevention and monitoring. Some of the major reasons for this is the uniqueness of the sector in terms of sensitive to the laws of physics—whether the geophysics of an oil and gas reservoir, quantum physics of solar power, fluid dynamics of wind, thermodynamics of fossil power, or electromagnetics of power transmission. Hence, digital applications must contend with the laws of nature and be done in a way that safeguards asset health and frontline capability [1].

5.1.3.4 Health sector

Though most hospitals rate the fear of cyber-attack/hack as a major concern in adopting ICT, more than 75% of the respondents use ICT applications in processing payment related services. This is understandable as the financial sector is the leading user of ICT in Nigeria with a high level of security against cyber hacks. Hospitals also rely on ICT in fixing

appointment for patients to see doctor as more than 70% of the hospital said they make full use of ICT in this regard.

However, only 1 in every 3 hospitals fully make use of ICT in bed allocation to patient and a little below half of the respondents make use of ICT in booking appointments to the hospital while more than 60% employ ICT in obtaining results from the lab test. Most of the hospitals in this category are primary health facilities. Overall, the use of ICT in the health sector is average and there are potential areas where ICT can be fully applied in the sector in order to improve the digitisation of the Nigerian economy.



Source: Authors computations from field survey.

Fig 5.4: ICT application in the general activities of hospitals

5.1.4 Limitations to ICT adoption and investment

The barriers to ICT adoption are classified into internal and external barriers. The internal barriers include the political instability, cost of adoption and implementation and return on investment [14]. External barriers include infrastructure, social, cultural, political, legal and regulatory barriers. Generally, inhibiting factors of ICT adoption among developing

countries when compared to developed countries included human capital (such as inadequacy of skilled personnel and coherent ICT strategy), financial (such as high investment cost), infrastructural (such as access to power, internet bandwidth and reliable internet connection) and technological (such as the learning curve of evolving technology) factors.

5.1.4.1 Agriculture sector

Respondents were asked on what they considered as challenges to adoption of ICT in their operations, cost of technology ranked first, while infrastructure was ranked second. Other includes unperceived economic and other benefit (3rd), capacity building (4th) and Farmers' inability to use ICT (5th).

Economic factor is considered among the most important factors affecting investment in ICT by the farmers, by this, it means that factors such as cost of equipment, cost of maintenance, return on investment, etc. comes first in the minds of the farmers before investing in ICT. Secondly, political factor (such as willingness of the government to develop ICT, government policies regarding ICT, bureaucracy, etc.) comes second according to the respondents on the factors that hinder investment in ICT. Social factor is the least considered factor when it comes to investment in ICT by the farmers as shown in table 5.4.

Respondents consider subventions on hardware by the government as the most important area where government can focus attention in order to improve the use of ICT applications in the agriculture sector. This is in line with the findings of Lal in 2007 who found that

inadequate physical infrastructure and cost of equipment is a major set-back in adoption of ICT in the agriculture sector among the developing countries. Respondents selected subventions on software as the second most important area that need government intervention. Communication equipment comes last among the three areas considered to require government subventions.

Table 5.4: Limitations to ICT adoption and investment in agriculture

Rank	Challenges to adoption of ICT in the operation of my farm	Factors you consider as hindering investment in ICT	Areas where you think government should provide subvention
1st	Cost of technology	Economic	Hardware
2nd	Infrastructure	Political	Software
3rd	unperceived economic and other benefit	Social	Communication equipment
4th	capacity building		
5th	Farmers' inability to use ICT		

Source: Authors computations from field survey.

5.1.4.2 Education sector

Respondents in the education sector ranked fear of cyber-attacks/hack first among the challenges to the adoption of ICT in their sector, cost of technology and infrastructure ranked second and third respectively while the respondents ranked capacity building and sustainability as fourth and fifth respectively being the least considered challenges in the adoption of ICT in the education sector. This is similar to the findings of Kweka and Ndibalema [16] in 2018 who found that inadequate ICT infrastructure and lack of capacity building among the instructors are major challenges to ICT adoption in Tanzania.

Social factors, economic factors and political factors (in this order) are considered as the major hindrances of investment in ICT in the education sector by the respondents. However,

similar to the agriculture sector, respondents ranked hardware, software and communication equipment (in this order) as the areas in need of government subvention in order to improve the level of ICT adoption in the education sector.

Table 5.5: Limitations to ICT adoption and investment in education

Rank	Challenges to adoption of ICT in the operation of this institution	Factors you consider as hindering investment in ICT	Areas where you think government should provide subvention
1st	Fear of cyber-attacks/hack	Social	Hardware
2nd	Cost of technology	Economic	Software
3rd	Infrastructure	Political	Communication equipment
4th	Capacity building		
5th	Sustainability		

Source: Authors computations from field survey.

5.1.4.3 Energy sector

Respondents were asked to rank what they consider as the challenges to the adoption of ICT in carrying out their activities, most of the respondents ranked “fear of cyber-attack/hack as the most important consideration when using ICT. Cost of technology is ranked second while infrastructure was ranked third. Sustainability and capacity building are the least considered challenges in the energy sector.

On factors that hinder investment in ICT in the sector, social factors (such as income level, culture, religion, level of education, etc.) first while respondents ranked economic factors (such as cost of equipment, cost of maintenance, return on investment, etc.) second and

political factors (such as willingness of the government to develop ICT, government policies regarding ICT, bureaucracy, etc.) ranked third.

Ranking of areas in need of government subvention is not different from the other sectors' choices as respondents choose hardware, software and communication equipment (in this order) as the most preferred areas where government should inject subventions in order to improve ICT adoption in the energy sector of the economy as depicted in table 5.6.

Table 5.6: Limitations to ICT adoption and investment in energy

Rank	Challenges to adoption of ICT in the operation of this organisation	Factors you consider as hindering investment in ICT	Areas where you think government should provide subvention
1st	Fear of cyber-attacks/hack	Social	Hardware
2nd	Cost of technology	Economic	Software
3rd	Infrastructure	Political	Communication equipment
4th	Sustainability		
5th	Capacity building		

Source: Authors computations from field survey.

5.1.4.4 Health sector

Respondents in the health sector also ranked fear of cyber-attacks/hack first among the challenges to the adoption of ICT in their sector, however, capacity building ranked second while sustainability and cost of technology ranked third and fourth respectively. Respondents ranked infrastructure as the least challenge they consider in adopting ICT in the health sector as shown in table 5.7.

On the factors that hinder investment in ICT, respondents see economic factor as the most germane. This includes cost of equipment, cost of maintenance, return on investment, etc. social factor (such as income level, culture, religion, level of education, etc.) is considered second in line while political factor (such as willingness of the government to develop ICT, government policies regarding ICT, bureaucracy, etc.) is the least considered factor hindering investment in ICT in the health sector.

The ranking of areas in need of government subventions is similar to every other sector's ranking. Hardware, software and communication equipment (in this order) is the ranking by the respondents across the health sector.

Table 5.7: Limitations to ICT adoption and investment in health

Rank	Challenges to adoption of ICT in the operation of this hospital	Factors you consider as hindering investment in ICT	Areas where you think government should provide subvention
1st	Fear of cyber-attacks/hack	Economic	Hardware
2nd	Capacity building	Social	Software
3rd	Sustainability	Political	Communication equipment
4th	Cost of technology		
5th	infrastructure		

Source: Authors computations from field survey.

5.1.5 Best practice in ICT adoption and investment

Studies on ICT adoption suggested several factors that should be considered when designing an ICT adoption strategy. Nurjanah, Santoso and Hasibuan in 2017 examined “infrastructure, application, user skill, utilization, policy and finance” in the Indonesian ICT adoption strategy [17]. Based on the literature reviewed and the peculiarities of the Nigeria's

economy, we adopted “legal framework, implementation mechanism, budget, capacity building, public private cooperation and monitoring & evaluation (M&E)” among others as areas that require attention when designing ICT adoption strategy for Nigeria.

Table 5.8 shows the ranking of items on the ICT adoption best practice in each of the four sectors under consideration. Legal frame was ranked first among respondents in the agriculture, energy and health sectors but ranked sixth by the respondents in the education sector. Cooperation between public and private sector ranked second among agriculture, education and energy sectors and fourth in the health sector.

Overall, legal framework ranked first, followed by public private cooperation, implementation mechanism, secured budget and support ranked third while timely capacity building and effective monitoring & evaluation (M&E) ranked fourth and fifth respectively. The least considered is the systemic implementation mechanism.

Table 5.8: ICT adoption best practice

	Agriculture	Education	Energy	Health	Total
Number of participants (%)	8 (14.5)	28 (50.9)	5 (9.1)	14 (25.5)	55 (100)
ICT adoption best practice					
Solid legal framework	1st	6th	1st	1st	1st
Systemic implementation mechanism	4th	5th	5th	3rd	6th
Secured budget and support	3rd	2nd	4th	4th	3rd
Timely capacity building	6th	1st	6th	2nd	4th
Cooperation between public and private sectors	2nd	2nd	2nd	4th	2nd
An effective monitoring and evaluation system	5th	2nd	3rd	6th	5th

Source: Authors computations from field survey.

5.2 Findings of the study

The findings of this study are presented as follow:

5.2.1 Objective One & Two

To investigate the level of ICT adoption and investment in Agriculture, Education, Energy, and Health sectors of the Nigeria economy;

Key Findings

- a. Data collected on the field showed that the four sectors of the economy have adopted ICT in various degrees. Most institutions in the four sectors make use of ICT services in carrying out their businesses in one or other ways. Majority of the institutions have at least a functional website. This is mostly observable among education, health and energy firms. However, only a few firms in the agriculture sector have a functional website.
- b. The adoption of ICT among the stakeholders in the agriculture sector is mainly in farm data management; this includes partial application of ICT in taking stock of input, planning farming activities, general logistic management and output sales. Stakeholders in the education sector however, deploy ICT in most of their activities, more than half of the institutions in the education sector use at least two (e-learning, video assisted learning, virtual reality, augmented reality and social media learning) applications in aiding their teaching activities. Similarly, e-learning is a choice application commonly used the students in attending their curricular activities.
- c. Findings on the use of ICT in the energy sector also revealed a considerable adoption of ICT in the sector. Operators in the energy sector make use of ICT in the areas of data management, load management and smart metering. To a reasonable extent, energy distribution firms i.e., Distribution Companies of Nigeria (DISCOs) also make

use of ICT in meter application, Electricity connection for new customers, Reconnection for existing customers, Payment for services and Lodging complaints.

- d. Similarly, findings in the health sector showed that application of ICT in the day-to-day activities of the hospitals revolve around payment for services, invitation for hospital visits, getting results from laboratory tests.

5.2.2 Objective Three & Four

To evaluate why sectoral adoptions and investment in ICT innovation is low in some sectors of the Nigerian economy;

Key findings

- a. The findings from the field showed that barriers to ICT adoption and investment in the four sectors under study vary considerably. High cost of technology and inadequate infrastructure are the major limitations to ICT adoption in the agriculture sector. Similarly, economic factors such as cost of equipment cost of maintenance and return on investment is the most important factor farmers consider before investing in ICT for their activities. Other factor which are largely political are also inhibiting investment in ICT in the agriculture sector, these factors include willingness of the government to develop ICT, government policies regarding ICT, bureaucracy among others.
- b. Findings in the education sector reveal that concerns about cyber-attacks/hack and cost of the technology are the major factors limiting the adoption of ICT in the sector. Other factors such as inadequate ICT infrastructure, capacity building and sustainability concerns also affect the adoption of ICT in the sector.

- c. Major factors inhibiting investment in ICT in the education sector relates to social factors. These include income level, culture, religion and level of education. Economic factors such as cost of equipment, cost of maintenance and return on investment also affect investment in the sector. Political factors are the least considered factors in the sector.
- d. Findings from the energy sector also show that fear of cyber-attacks and high cost of investment in ICT in the sector are the main hindrances to the adoption of ICT in the sector. Other factors such as infrastructure, sustainability and capacity building also contributed to the low adoption of ICT in the energy sector. Similar to the education sector, major factors responsible for low investment in ICT in the energy sector include social factors; such as income level, culture, religion and level of education. Economic factors; such as cost of equipment, cost of maintenance and return on investment also affect investment in the sector. Political factors are the least considered factors in the sector.
- e. There is a high level of adoption of ICT in the health sector however; factors like concerns about cyber-attacks/hacks and capacity building on the use of various ICT applications are the major concerns in the sector when taking the decision to adopt ICT. Other factors such as sustainability, cost of technology and infrastructure also affect the decision to adopt ICT in the sector.
- f. Investment in ICT in the health sector is largely affected by economic factors which include, cost of equipment, cost of maintenance, and return on investment. Social

(such as income level, culture, religion, level of education, etc.) as well as political factors also hinder investment in the sector.

5.2.3 Objective Five

To recommend best practices and ways in which the identified factors and challenges can be solved using the best solution framework or model.

Key Findings

Findings from the field revealed that six key areas are necessary for consideration when developing an ICT adoption strategy. These include legal framework, implementation mechanism, budget, capacity building, public private partnership and capacity building.

- **Solid legal framework** to ensure that bottlenecks to the adoption of ICT is removed. This is also to ensure high quality of internet services in terms of speed and coverage while guaranteeing security of the users from cyber-attacks/hacks.
- **Cooperation between public and private sectors** to ensure that government provide an enabling environment for the private sector to thrive and compete both locally and internationally.
- **Secured budget and support** to ensure consistent funding in line with set objectives. This will reduce the incidences of abandoned ICT projects across the country.
- **Timely capacity building** to ensure that users are up to date on the latest ICT applications in line with their area of work. Training and retraining of stakeholders in the sector of interest.

- **An effective monitoring and evaluation system** to assess if progress is made in achieving stated objectives, to spot bottlenecks in implementation and to highlight whether there are any unintentional effects (positive or negative) from an ICT adoption plan and its activities.
- **Systemic implementation mechanism** to ensure that plan actions are followed to the letter. This in a way ensures that there is clear responsibility definition and every actor is held accountable for their inaction when necessary action are not taken at the right time.

SECTION SIX

Summary, Conclusions and Recommendations

6.1 Summary

Information and communication technology is a sector on its own and an enabler of efficiency and effectiveness in other sectors of the economy. The role of ICT in the development of the Nigerian economy cannot be overemphasised. ICT has helped private sector to be more competitive and profitable both locally and internationally. The public sector is also benefiting from the huge opportunities in the ICT through various applications that has made governance more efficient.

Understanding the level of ICT adoption in Nigeria will go a long way in assisting the policy makers in coming up with policies that directly address the development needs of Nigeria.

The objectives of this study are to:

6. To investigate the level of ICT adoption and investment in Agriculture, Education, Energy, and Health sectors of the Nigeria economy;
7. To evaluate the level of adoption and innovations of ICT in the Agriculture, Education, Energy, and Health sectors of the Nigeria economy;
8. To evaluate why sectoral adoptions and investment in ICT innovation is low in some sectors of the Nigerian economy;
9. To analyse the factors responsible for the lower level of Information Communication Technology (ICT) innovation in the Nigerian economy; and

10. To recommend best practices and ways in which the identified factors and challenges can be solved using the best solution framework or model.

Both Descriptive and Analytical techniques are employed in achieving the objectives of this study, the descriptive aspect uses secondary data to describe how ICT is being deployed in Nigeria while the analytical aspect employs primary data to make inferences. The study is both qualitative and quantitative as it uses primary data from purposively selected respondents from the four sectors of the economy; and the responses were collated, quantified, analysed and used to make inferences on the level of ICT adoption and investment in the four sectors. The study is also Empirical because of its pragmatic and policy-oriented nature.

6.2 Conclusion

ICT adoption in Nigeria varies among agriculture, education, energy and health sectors. Private sector use is higher than the public sector across the sectors and depends on whether the entity in question have a dedicated budget for ICT and have an ICT department. One of the major findings of this study is that the fear of cyber-attack/hack makes the potential users of ICT to be chary of use.

The study finds that as much as there are common factors that affect adoption of ICT in the four sectors under consideration, there are many other factors that are unique to each of the sectors, hence the need for sectoral focused solutions to each of the identified factors. The outbreak of the COVID-19 pandemic has resulted into education and health sectors adopting more of ICT applications as this enabled them to continuously carry out major parts of their activities while guaranteeing safety from contacting the disease. These sectors have

continued to improve on the use of ICT post pandemic as they have been able to enjoy the various opportunities that come along with ICT adoption in their various sectors.

6.3 Recommendations

Based on the findings of this study, it is clear that ICT adoption and investment in Nigeria is still at a low level when compared to major developed countries and some leading countries in Africa. However, there are huge potentials for the Nigerian economy if proper policies are put in place to ensure that no sector of the economy is left behind in the quest to digitize the economy. The following recommendations are prescribed as a way to improve ICT adoption and investment in Nigeria.

- 1. Sectoral focused policies:** it has been revealed that there are variations in the level of ICT use in each of the sectors investigated, it is therefore recommended that sector focused policies should be developed in order to alleviate the unique needs of each sector in the areas of adoption and investment in ICT.
- 2. Promotion of cyber security:** when ICT users are confident that their hard-earned resources will not be swindled by criminals while using ICT, it will encourage them in adopting the technology and invest in it accordingly.
- 3. Provision of ICT infrastructure:** this is very important to improve the level of ICT penetration (especially in the rural areas) and eventual increase in ICT adoption in Nigeria.
- 4. Promotion of locally produced ICT products:** Most of the ICT products that are used in Nigeria are imported and this reduces the foreign exchange available in the economy. It is therefore recommended that government take necessary steps to

promote locally developed ICT products in order to attract foreign exchange, generate income, reduce unemployment and improve economic growth.

5. **Establish a public–private partnership program:** usually, resources in the purse of the government will not be enough to cater for every need of the economy across sectors hence the need to bring the private sector on board in order to pool resources together and accelerate the adoption of ICT in Nigeria PPPs may play a part in developing infrastructure and can be crucial to the development of digital content.

6.4 Key Innovations to be employed in various sectors

Agriculture Sector

- **Subsidy provision:** the agriculture sector in Nigeria is yet to attain the level of independence where it can survive on its own, this in part, is as a result of the fact that most farmers are poor therefore cannot afford state of the art ICT applications required to carry out their farm activities in a sustainable and profitable manner. Hence, there is need for government at all levels to subsidize ICT equipment for the agriculture sector in order to serve as an incentive to the adoption of ICT in the sector.
- **Improve ICT infrastructure:** nationwide intervention in ICT infrastructure improvement should be given attention. Efforts by Universal Services Provision Fund (USPF) to take ICT to unde-served and un-served areas should be expanded in order to bring connectivity close to the farming communities. ICT service providers should be committed by the government to devote some parts of their services towards the

rural underserved communities in order to ensure accelerated ICT coverage of the rural areas where most of the farming activities take place.

- **ICT education:** it is essential to educate the farmers on the benefits of adopting ICT in their various activities. When farmers are aware that by adopting ICT, they can minimize the use of resources in terms of water, fertilizer, pesticides among others and increase productivity while ensuring their own safety. Most of the farmers will be ready to adopt and invest in ICT in their activities.

Education Sector

- **ICT adoption and Investment strategic plan (Roadmap)**

This should come as the first step towards ICT adoption in the education sector. The strategic plan must focus on the following:

- Review of current level of ICT adoption and Investment in the sector;
- Identify/Indicate sector's goals and priorities in the area of ICT;
- Identify existing gaps or duplication to meet sector's goals/priorities;
- Conduct sector-wide staff technical capacity audit;
- Develop and review the budget need to achieve defined goals/priorities;
- Leadership support for new technology and training

After a well-developed ICT adoption and Investment strategic plan, the following reforms can be put in place to achieve the set-out goals/priorities in the strategic plan.

- **Administrative Reform:** Some administrative reforms affecting all aspects of education sector may be considered to facilitate the adoption of ICT in the sector. They include in particular: Mandatory training of the existing workers in the education

sector in areas of ICT applications in delivering their duties. Priority must be placed on computer literacy/ICT knowledge when recruiting new employees in the sector. Specific attention should be giving to candidates with experience in the use of ICT applications that are employed in teaching and related activities.

- **Budgetary reform:** there must be consistent funding mechanism for the education sector by revising the mechanism for the allocation of budgetary funds to education projects. The drip- feeding of projects by the annual budget, whereby limited funds available through the budget for capital projects are spread across a large number of projects results in many abandoned projects, with very few completed, often at multiples of the original cost and with major extensions in the completion time. The funding from the budget should guarantee full funding of the selected ICT projects and ensure close monitoring of expenditures and progress.
- **Curriculum reform:** ICT must be integrated into the school curriculum at all levels. Baseline must be defined for computer-to-student ratio and computer-to-teacher ratio and concerted efforts must be made by relevant agencies of the government to achieve this target in order to accelerate the adoption of ICT in the education sector. Combination of software, hardware, and connectivity aspects of ICT will lead to highly innovative teaching and learning methods in the sector.

Energy Sector

- **Cyber security:** the energy sector is a highly risky sector that necessitates caution in every decision. Operators in the sector want to ensure adequate protection against all forms of impact that may result into loss. It is therefore important to have a highly

protected cyber space before encouraging the adoption and investment in ICT in the sector.

- **Provision of subsidy:** high cost of operation due to the nature of energy sector is a major challenge in the adoption of new technology in the sector. Government needs to provide some subsidies as well as risk sharing system for the sector in order to encourage ICT adoption and investment.
- **Improve ICT infrastructure:** provision of high-quality ICT infrastructure is a prerequisite to ICT adoption. Nationwide broadband coverage with high-speed internet will unlock the potentials of ICT applications in the energy sector. Government must invest more in this aspect in order to foster faster ICT adoption in the sector.

Health Sector

- **Privacy security:** Often times, personal information of patients is required to be shared with online services when using ICT to access health services. In this process, data sometimes get compromised and misused if not handled securely. Secure ICT health applications help protect the patients' data from being hacked and ensures their security. It is important that government put policies in place to ensure privacy security when making use of ICT in the health sector. This could include host security, network security, malware prevention etc.
- **Capacity building:** ICT applications in the health sector are most times complex and change very fast. Therefore, it is important to put some measures in place to

continuously train and retrain medical personnel on the use of such applications in order to encourage the adoption of ICT in the sector.

- **Improve ICT infrastructure:** provision of high-quality ICT infrastructure is a prerequisite to ICT adoption. Nationwide broadband coverage with high-speed internet will unlock the potentials of ICT applications in the health sector and other sectors of the economy. Government must invest more in this aspect in order to foster faster ICT adoption in the sector.

6.5 Monitoring and Evaluation Measures

Evaluation of success of technology adoption can be defined in several ways depending on the set goals at the instance of the adoption. The common goal of the ICT adoption in Nigeria is to ensure it contributes to the economic growth. It is however, important to define the goal for bringing new technology into the mix and aligning it to a specific national goal it addresses.

There are several measures of monitoring and evaluating the level of ICT adoption in the sectors of concern, including:

- **Reducing inefficiency** (i.e., manual processes, duplication, etc.): evaluate the number of manual and duplicate processes that have been digitized since adopting ICT in the sector.
- **New and more efficient processes** (i.e., eliminating sacred cows): examine the number of new processes that have been developed since adopting ICT.
- **Enhanced collaboration and/or communication:** examine the level of collaboration among agencies in the sector that has adopted ICT.

- **Staff development** (increased skills and capacity): examine the skills and capacity of the critical staff who have adopted ICT in carrying out their day-to-day activities and compare with preadaptation level.
- **Percentage of users using new technology**: examine the number of users that are making use of the technology since adoption and compare their productivity with the preadaptation level.
- **Create a feedback loop**: this is an opportunity for users to share their experiences with the new processes. This is to ensure that any deviation from plan is addressed in a timely fashion.

Regardless of how success is defined, it is important to measure and share success stories and milestones. In addition, creating a feedback loop that allows for continued conversation will also build investment in technology review, champions/partners and other adoption strategies.

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Appendix

STUDY ON SECTORAL ADOPTIONS AND INVESTMENTS IN ICT INNOVATIONS WITHIN THE NIGERIAN ECONOMY

**A Survey of Selected Stakeholders in the Nigerian
Agriculture Sector**

By

WRIGHT ONLINE SUPPORT LIMITED

May 2022

Purpose and Consent

Dear participant

Please carefully read the following information about the survey:

- 1) This survey is part of a wider study on how sectoral adoption and investment in ICT innovations affect the Nigerian Economy, particularly in the agriculture sector.
- 2) This particular survey is tailored specifically to understanding sectoral adoption and investment in ICT innovations within the Nigerian Economy.
- 3) This is organizational/institutional focused research; therefore, we want to ensure that the respondent is representing the organization/institution of concern.
- 4) Your participation in the survey is voluntary and information derived herein will be used only for research purposes.
- 5) We are aware of the concerns that issues of confidentiality may pose. We guarantee that your participation will be accorded the maximum privacy as you are not required to provide any personal or sensitive information.
- 6) Your completion and returning of the questionnaire imply that you gave your consent to partake in the survey.
- 7) The estimated time for completing the questionnaire is 15 minutes.
- 8) Do not hesitate to contact the undersigned if you have any concern or require more information about the survey/research.

AMINU Yakubu

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Section A: Background Information of Organization/Institution

1. what is the means of ownership of the organization/farm?

▪ Private

▪ Government

▪ Others (*please specify*)

2. Your farm is best described as:

▪ Crop planting

▪ Rearing animal

▪ Mixed farming

3. When was this organization/farm established?

4. Is there a dedicated ICT department in the organization/farm?

▪ Yes

▪ No

5. Does the organization/farm have a functional website?

▪ Yes

▪ No

6. Which of the following social media accounts does the organization/farm have? *Please select all that apply.*

▪ YouTube

▪ Facebook

▪ Twitter

▪ WhatsApp

▪ Others – *Please state*

Section B: ICT adoption and investment in Agriculture sector

7. What is the means of payment by the users of your services?
- a) Cash payment at the designated office
- b) Bank deposit
- c) Both Cash and Bank are acceptable
8. After every transaction, do you issue receipt for the users of the services?
- a) Yes, we issue paper receipt for every transaction.
- b) No, the users print their receipt from the payment portal
9. Do you receive dedicated budget for ICT for the farm/organisation?
- a) Yes, there is a dedicated budget for ICT in this farm/organisation.
- b) No, there is no dedicated budget for ICT in this farm/organisation.
- c) Sometimes, we receive budget that are dedicated for ICT improvement.
10. Which of the following technology do you use in your service delivery? (*Select as applicable*)
- a) GIS mapping
- b) Precision agriculture
- c) Automated irrigation system
- d) Digital farm data management
11. Which of the following services do you use ICT to carry out? (*Select as applicable*)

		Fully	Partially
i.	Taking stock of input		
ii.	Planning farming activities		
iii.	General logistic management		
iv.	Sales of output (E-commerce)		
v.	Others (<i>please state</i>)		

Section C: Limitations to ICT adoption and investment in Agriculture sector

12. Rate the following based on how much you consider them as challenges to ICT adoption in the agriculture sector.

	1	2	3	4	5
Cost of technology					
Infrastructure					
Capacity building					
Inability of farmers to use ICT					
Unperceived economic or other benefits					

13. In what aspect of ICT do you consider to need the subvention by the government?

(Rank from 1 to 3)

Software	
Hardware	
Communication equipment	

14. What are the factors you consider as hindering investment in ICT in the agriculture sector?

(Rank from 1 to 3)

Social factors (such as income level, culture, religion, level of education, etc.)	
Economic factors (such as cost of equipment, cost of maintenance, return on investment, etc.)	
Political factors (such as willingness of the government to develop ICT, government policies regarding ICT, bureaucracy, etc.)	

15. Do you believe there are unique uptake problems with any of the following ICT?

		Yes	No	Not sure
i.	Decision Support Systems (DSS)			
ii.	Management Information Systems (MIS)			
iii.	Internet			
iv.	Precision Farming			
v.	Process Control			
vi.	Production Models			
vii.	E-commerce			

Section D: Best practice in ICT adoption and investment in Agriculture sector

16. Which of these areas should government focus more attention?

(Rank from 1 to 6)?

a.	Solid legal framework.	
b.	Systematic implementation mechanism.	
c.	Secured budget and support.	
d.	Timely capacity building.	
e.	Cooperation between public and private sectors.	
f.	An effective monitoring and evaluation system.	

THANK YOU FOR YOUR COOPERATION

STUDY ON SECTORAL ADOPTIONS AND INVESTMENTS IN ICT INNOVATIONS WITHIN THE NIGERIAN ECONOMY

**A Survey of Selected Stakeholders in the Nigerian
Education Sector**

By

WRIGHT ONLINE SUPPORT LIMITED

May 2022

Purpose and Consent

Dear participant

Please carefully read the following information about the survey:

- 9) This survey is part of a wider study on how sectoral adoption and investment in ICT innovations affect the Nigerian Economy, particularly in the Education sector.
- 10) This particular survey is tailored specifically to understanding sectoral adoption and investment in ICT innovations within the Nigerian Economy.
- 11) This is organizational/institutional focused research; therefore, we want to ensure that the respondent is representing the organization/institution of concern.
- 12) Your participation in the survey is voluntary and information derived herein will be used only for research purposes.
- 13) We are aware of the concerns that issues of confidentiality may pose. We guarantee that your participation will be accorded the maximum privacy as you are not required to provide any personal or sensitive information.
- 14) Your completion and returning of the questionnaire imply that you gave your consent to partake in the survey.
- 15) The estimated time for completing the questionnaire is 15 minutes.
- 16) Do not hesitate to contact the undersigned if you have any concern or require more information about the survey/research.

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Section A: Background Information of Organization/Institution

17. what is the means of ownership of the organization/institution?

- Private
- Government
- Others (*please specify*)

18. Your organization/institution is best described as:

- Primary
- Secondary
- Tertiary

19. When was this organization/institution established?

20. Is there a dedicated ICT department in the organization/institution?

- Yes
- No

21. Does the institution have a functional website?

- Yes
- No

22. Which of the following social media accounts does the school have? *Please select all that apply.*

- YouTube
- Facebook
- Twitter
- WhatsApp
- Others – *Please state*

Section B: ICT adoption and investment in Education sector

23. What is the means of payment for school fees by the students?
- d) Cash payment at the designated office
- e) Bank deposit
- f) Both Cash and Bank are acceptable
24. After every transaction, do you issue receipt for the students?
- c) Yes, we issue paper receipt for every transaction.
- d) No, the students print their receipt from the payment portal
25. Do you receive dedicated budget for ICT for the institution?
- d) Yes, there is a dedicated budget for ICT in this institution.
- e) No, there is no dedicated budget for ICT in this institution.
- f) Sometimes, we receive budget that are dedicated for ICT improvement.
26. Which of the following technology do you use in your teaching activities? (*Select as applicable*)
- a) e-learning
- b) video assisted learning
- c) virtual reality
- d) augmented reality
- e) social media learning
27. which of the following do your students have access to?
- a) e-library
- b) virtual learning
- c) augmented learning
- d) learning analytics
28. In what areas do you fully or partially apply ICT in your activities? (*Select as applicable*)

		Fully	Partially
i.	New applications of potential students		
ii.	Shortlisting of successful students		
iii.	School fees payment		
iv.	Teaching		
v.	Examinations		
vi.	Marking students' scripts		
vii.	Publishing students' results		
viii.	Communicating results to the parents/students		
ix.	Others (<i>please state</i>)		

Section C: Limitations to ICT adoption and investment in Education sector

29. Rate the following g based on how much you consider them as challenges to ICT adoption in your institution.

	1	2	3	4	5
Cost					
Infrastructure					
Capacity building					
Sustainability					
Fear of Cyber-attacks/hacks					

30. In what aspect of ICT do you consider to need the subvention by the government?
(Rank from 1 to 3)?

Software	
Hardware	
Communication equipment	

31. What are the factors you consider as hindering investment in ICT in the education sector?
(Rank from 1 to 3)

Social factors (such as income level, culture, religion, level of education, etc.)	
Economic factors (such as cost of equipment, cost of maintenance, return on investment, etc.)	
Political factors (such as willingness of the government to develop ICT, government policies regarding ICT, bureaucracy, etc.)	

Section D: Best practice in ICT adoption and investment in Education sector

32. Which of these areas should government focus more attention?

(Rank from 1 to 6)?

1	Solid legal framework.	
2	Systematic implementation mechanism.	
3	Secured budget and support.	
4	Timely capacity building.	
5	Cooperation between public and private sectors.	
6	An effective monitoring and evaluation system.	

THANK YOU FOR YOUR COOPERATION

STUDY ON SECTORAL ADOPTIONS AND INVESTMENTS IN ICT INNOVATIONS WITHIN THE NIGERIAN ECONOMY

**A Survey of Selected Stakeholders in the Nigerian
Energy Sector**

By

WRIGHT ONLINE SUPPORT LIMITED

May 2022

Purpose and Consent

Dear participant

Please carefully read the following information about the survey:

- 17) This survey is part of a wider study on how sectoral adoption and investment in ICT innovations affect the Nigerian Economy, particularly in the Energy sector.
- 18) This particular survey is tailored specifically to understanding sectoral adoption and investment in ICT innovations within the Nigerian Economy.
- 19) This is organizational/institutional focused research; therefore, we want to ensure that the respondent is representing the organization/institution of concern.
- 20) Your participation in the survey is voluntary and information derived herein will be used only for research purposes.
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- 23) The estimated time for completing the questionnaire is 10 minutes.
- 24) Do not hesitate to contact the undersigned if you have any concern or require more information about the survey/research.

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Section A: Background Information of Organization/Institution

33. what is the means of ownership of the organization/institution?

- Private
- Government
- Others (*please specify*)

34. Your organization/institution is best described as:

- Distribution Company
- Regulatory Agency
- Transmission Company

35. When was this organization/institution established?

36. Is there a dedicated ICT department in the organization/institution?

- Yes
- No

37. Does the institution have a functional website?

- Yes
- No

38. Which of the following social media accounts does the school have? *Please select all that apply.*

- YouTube
- Facebook
- Twitter
- WhatsApp
- Others – *Please state*

Section B: ICT adoption and investment in Energy sector

39. What is the means of payment by the users of your services?

- g) Cash payment at the designated office
- h) Bank deposit
- i) Both Cash and Bank are acceptable

40. After every transaction, do you issue paper receipt for the users of the services?

- e) Yes, we issue paper receipt for every transaction.
- f) No, the users may print their receipt from the payment portal

41. Do you receive dedicated budget for ICT for the organisation?

- g) Yes, there is a dedicated budget for ICT in this organisation.
- h) No, there is no dedicated budget for ICT in this organisation.
- i) Sometimes, we receive budget that are dedicated for ICT improvement.

42. Which of the following technology do you use in your service delivery? (*Select as applicable*)

- e) Smart metering
- f) Load management using ICT
- g) Disaster monitoring devices
- h) Digital data management

43. which of the following services can be applied for remotely? (*Select as applicable*)

		Fully	Partially
i.	Meter application		
ii.	Electricity connection for new customers		
iii.	Reconnection for existing customers		
iv.	Payment for services		
v.	Lodging complaints		
vi.	Others (<i>please state</i>)		

44. Which of the following services do you use ICT to carry out? (*Select as applicable*)

		Fully	Partially
i.	Forecast of future demand for electricity		
ii.	Planning the servicing of equipment		
iii.	Equipment monitoring		
iv.	Disaster prevention and monitoring		

Section C: Limitations to ICT adoption and investment in Energy sector

45. Rate the following based on how much you consider them as challenges to ICT adoption in the energy sector?

	1	2	3	4	5
Cost					
Infrastructure					
Capacity building					
Sustainability					
Fear of Cyber-attacks/hacks					

46. In what aspect of ICT do you consider to need the subvention by the government
(Rank from 1 to 3)

Software	
Hardware	
Communication equipment	

47. What are the factors you consider as hindering investment in ICT in the education sector?
(Rank from 1 to 3)

Social factors (such as income level, culture, religion, level of education, etc.)	
Economic factors (such as cost of equipment, cost of maintenance, return on investment, etc.)	
Political factors (such as willingness of the government to develop ICT, government policies regarding ICT, bureaucracy, etc.)	

Section D: Best practice in ICT adoption and investment in Energy sector

48. Which of these areas should government focus more attention?

(Rank from 1 to 6)?

1	Solid legal framework.	
2	Systematic implementation mechanism.	
3	Secured budget and support.	
4	Timely capacity building.	
5	Cooperation between public and private sectors.	
6	An effective monitoring and evaluation system.	

THANK YOU FOR YOUR COOPERATION

STUDY ON SECTORAL ADOPTIONS AND INVESTMENTS IN ICT INNOVATIONS WITHIN THE NIGERIAN ECONOMY

**A Survey of Selected Stakeholders in the Nigerian
Health Sector**

By

WRIGHT ONLINE SUPPORT LIMITED

May 2022

Purpose and Consent

Dear participant

Please carefully read the following information about the survey:

- 25) This survey is part of a wider study on how sectoral adoption and investment in ICT innovations affect the Nigerian Economy, particularly in the health sector.
- 26) This particular survey is tailored specifically to understanding sectoral adoption and investment in ICT innovations within the Nigerian Economy.
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Section A: Background Information of Organization/Institution

49. what is the means of ownership of the health facility?

- Private
- Government
- Others (*please specify*)

50. Your health facility is best described as:

- Primary health facility
- Secondary health facility
- Tertiary health facility

51. When was this health facility established?

52. Is there a dedicated ICT department in the health facility?

- Yes
- No

53. Does the health facility have a functional website?

- Yes
- No

54. Which of the following social media accounts does the health facility have? *Please select all that apply.*

- YouTube
- Facebook
- Twitter
- WhatsApp
- Others – *Please state*

Section B: ICT adoption and investment in Health sector

55. What is the means of payment by the users of your services?

- j) Cash payment at the designated office
- k) Bank deposit
- l) Both Cash and Bank are acceptable

56. After every transaction, do you issue receipt for the users of the services?

- g) Yes, we issue paper receipt for every transaction.
- h) No, the users print their receipt from the payment portal

57. Do you receive dedicated budget for ICT for the health facility?

- j) Yes, there is a dedicated budget for ICT in this health facility.
- k) No, there is no dedicated budget for ICT in this health facility.
- l) Sometimes, we receive budget that are dedicated for ICT improvement.

58. Which of the following technology do you use in your service delivery? *(Select as applicable)*

- i) e-health
- j) electronic data management for patients
- k) virtual care
- l) electronic data management for bed allocation
- m) Electronic data management for staff posting
- n) Trend of hospital visits by patients

59. which of the following do your services users have access to?

- e) electronic records of patient
- f) feedback on quality of services through social media

60. which of the following services can be applied for remotely in your health facility? *(Select as applicable)*

		Fully	Partially
i.	New registration by patient		
ii.	Booking appointment to the hospital		
iii.	Invitation to see a doctor		
iv.	Bed allocation		
v.	Getting results for lab tests		
vi.	Payment for services		
vii.	Others <i>(please state)</i>		

Section C: Limitations to ICT adoption and investment in Health sector

61. Rate the following g based on how much you consider them as challenges to ICT adoption in the health sector.

	1	2	3	4	5
Cost					
Infrastructure					
Capacity building					
Sustainability					
Fear of Cyber-attacks/hacks					

62. In what aspect of ICT do you consider to need the subvention by the government

Software	
Hardware	
Communication equipment	

63. What are the factors you consider as hindering investment in ICT in the health sector?

Social factors (such as income level, culture, religion, level of education, etc.)	
Economic factors (such as cost of equipment, cost of maintenance, return on investment, etc.)	
Political factors (such as willingness of the government to develop ICT, government policies regarding ICT, bureaucracy, etc.)	

Section D: Best practice in ICT adoption and investment in Health sector

64. Which of these areas should government focus more attention?

(Rank from 1 to 6)

1	Solid legal framework.	
2	Systematic implementation mechanism.	
3	Secured budget and support.	
4	Timely capacity building.	
5	Cooperation between public and private sectors.	
6	An effective monitoring and evaluation system.	

THANK YOU FOR YOUR COOPERATION