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The Role of Network Technologies in the Enhancement of the Health, Education, and Energy Sectors

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Abstract

The role of Network Technologies and Information Communication Technology (ICT) in the sustainable agenda is very germane, and as such, there has been a tremendous rise in the application of ICT towards realizing good health and well-being, quality education, attaining affordable and clean energy as indicated in the third, fourth and seventh development goals. Albeit information technology (IT) has enjoyed significant positive impacts across the globe, its adoption and utilization especially during the pandemic in various aspects of human needs has no doubt created positive influence. In examining the extent of Network Technology applications in the aforementioned sustainable development goals, this work highlights current state of the use of IT in the enhancement of the health sector, energy industry and the education system. The sustainability of its adoption both in the present and in the foreseeable future is also presented. The overview shows that during the COVID-19 pandemic the influence of ICT on the actualization of SDGs 3, 4 and 7 was at its peak.

Keywords: Health, energy, information technology, internet of things, sustainability

1. Introduction

The international institute of sustainable development (ISSD) defined Sustainable development as the development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Information Communication Technology (ICT) is an essential part of the contemporary world and it is driven by network technologies. This is due to advancements in technology that makes it possible to send, receive, store and process information from any location with the aid of electronic devices such as personal computers, mobile phones, smartwatches and wearable electronics, some of which are as small as a grain of rice. Today, ICT drives our access to information, enables new forms of communication, and serves many online services in the spheres of commerce, culture, entertainment and education (Ahmad, 2011). The current technologies- modern computers, mobile phones, tablets, the internet of things, 5G networks, artificial intelligence systems have revolutionised, and many other emerging technologies-have revolutionised much of human activities. Contemporary societies are consistently based on information and knowledge and the ubiquity of technologies. Figure 1 shows the relationship of ICT components towards sustainable development. ICT is encompassing, it includes Hardware, Software, Cloud Computing, Internet Access, Data, Communications Technology, Transactions and lots more.

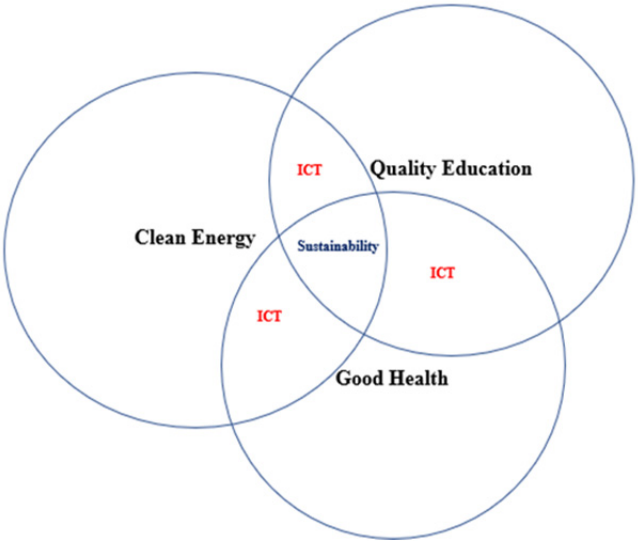

Figure 1. ICT Components and Sustainability

The developments seen in different countries of the world today shows that there has been a complete integration of ICT in all sectors. However, this study dwells more on health, energy and education sectors. These three sectors were seriously affected by the COVID-19 pandemic and many institutions around the world had to resort to the use of ICT in managing the sectors.

The COVID-19 pandemic has been a major driver of uncommon but unique transformation across all sectors of human endeavors, compelling leaders to change their judgments and standpoints on their existing principles and value systems of their various organization. Before now, scholars have proposed nexus between energy-food-water, however, the effect of the pandemic has called for emerging nexus as presented in this paper. The pandemic has had major impact on the global economy, and countries are experiencing slow economic recovery. The emerging perspective related to change is greatly embraced by developing economies (especially in Africa) whose budget, due to the impact of COVID-19 cannot accommodate commitment to all the SDGs simultaneously. By extension, many developing countries have been forced to reorder the priority and resources committed to the various SDGs. The pandemic has helped in redefining what SDGs takes priority during economic recovery period. As such, in many African countries, SDGs related to education, health and energy are now tied together because of the priority allocated to them (Figure 1). No doubt different SDGs addressed these major concerns; Neverthless, the authors of this work see a need to bring them together based on the impact that ICT has had on them because of the COVID-19 pandemic. Technology is known to be a bedrock and driver of most automated solutions in diverse sectors (Energy, Health, Education to mention a few). The emphasis on these three (3) major components is due to the relationships. Education drives the health sectors i.e., health professionals are trained in educational institutions, continuous professional development to address emerging health situation such as COVID-19 also comes with research and education. Health on the other way round also has its own relationship with education, as only a healthy soul can also be educated thus could hardly be separated.

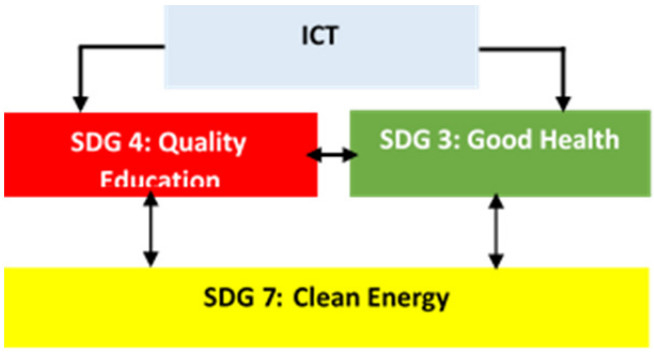

Figure 2. Relationship between SDG 3, 4 and 7

Meanwhile the provision of energy is a common denominator for both education and health. (Sasmaz et al., 2021) elaborated the relationship between the use of energy and health. Most of the operations in Education and Health sectors can only be efficient through the provisions of clean and affordable energy (Smith et al., 2013). Clean and affordable Energy use is key to human society, it is essential to social and economic development in achieving sustainable development goals and provides improved quality of life among other benefits (KESER, 2003). Accumulated education transforms lives for better, provide jobs for wealth and improves health (Mirowsky & Ross, 2017). These established more link between education (research and academics) and health (Pollack, 2008). Energy access is a requirement for high-quality health care, high quality education as well as efficient Information Communication Technology service, as illustrated at the top of Figure 2, this provision is critical to achieving universal coverage and the Sustainable Development Goals. (Porcaro, 2021).

With the emergence of COVID-19, most of the sectors had witnessed the usage of technology accordingly. ICT has gone beyond the bedrock of services in education, health, and delivery of energy services to become the major drivers. Robots are being used in the health care sectors, intelligent systems can capture electricity consumptions of consumers, alternative power generations techniques are emerging using artificial intelligence and neural networks, educational services are being provided with the use of virtual classrooms, e-learning, alternative to practical sessions to mention a few. These are some of the major changes that has been experienced through ICT due to the virus.

2. Network Technology in the Health Sector

The health sector is basically a systemic industry concerned with the healthcare of the people. The need for good health is key to every human; without good health every other area of life could hardly be achieved. Information Technology (IT) play a major role in the maintenance and or enhancement of the health of the people through varied process of prevention, diagnosis, treatment and recovery of various illnesses, infirmities, injuries and diseases. Fundamentally, the healthcare industry otherwise known as the health sector comprises a wide range of fields. Sanitation is a very serious component of good health; (Shekhar & Dwivedi, 2021) critically examined the role of innovation in expanding transition to sustainable development. While innovation is a component of ICT, it is worthy to note its relationship with good health. Health sector stakeholders, include practitioners, ambulatory services, dentist offices, hospitals, physician offices, nursing and residential care facilities, outpatient care centres, home healthcare practitioners, hospitals, medical and diagnostic laboratories, pharmacists, pharmacologists, physiotherapists among others. These all have a range of laws and regulations that helps ensure the quality of services. The health sector is a collective set of institutions that all work hand in hand so that no one field can exist on its own. For context, while the medical and diagnostic laboratories aids in the diagnosis of a disease in the patients, doctors and nurses in the health care practitioner department prescribe and administer treatment to the patients but only with medications created by researchers, scientists and corporations in the pharmaceutical. industry. Information technology has no doubted progressed since the emergence and utilization of electronic patient registration. Once in history, patient records were kept in paper files which could easy be lost, misplaced or destroyed in rare cases of accidents. People would often queue from hours to hours and days to days in the name of searching for health files just so that they could see a consultant often with the risk of sicknesses unattended to worsened by the days. The rise in the use of electronic patient registration has made this process both faster and easily. There seem to be a positive correlation with the emergence and utility of Information Technology with a reduced percentage mortality due to sicknesses and the plausibility of this fact is not far-fetched. Towards sustainable good health, figure 3 depicts some areas of medical practice that has been dominant by the application of ICT.

The application of this technology enhances the success of national health promotion and diseases prevention programs through quality research activities. This evident during the pandemic, as millions of scientists were able to quickly develop a vaccine to combat the deadly virus. Other areas affected my ICT as indicated in Figure 2 include, timely decision making through various decision support algorithms, accurate and timely treatment, end of life care, artificial intelligence included diagnosis, early detections, training and keeping well.

Figure 3. ICT and good health sustainability

Network technologies also offer modern measure to meet both the current and the future challenges of life. Further advances in ICT have tremendously improved our social and economic conditions across the world (Haluza & Jungwirth, 2015). ICT has rapidly improved the method of accessing and disseminating information in the health sector to all world. The provision of new tools such as modern software systems, enterprise applications, robots and artificial intelligence in the health sector also contributes to achieving sustainable goals for optimum results. Some of the core health sector areas positively affected by ICT are considered in the following sections.

2.1 Electronic Medical Record

The need to keep adequate records in the healthcare system cannot be over-emphasised. It is a significant part of running a fair and effective healthcare system, driven towards continuity in patient care and tracking medication details administered over a while. A critical component to achieving a digitalised hospital is Electronic Medical Record. An Electronic Medical Record (EMR) is a detailed aggregation of digital health information gotten from a particular patient or several patients (Funmilola & Ozichi, 2015). The EMR is widely recognised worldwide, and this is because it helps to ensure safe and excellent health care services through its unique features such as record keeping, drug prescription management, work ethics management, and general communication (Ayaad et al., 2019). The EMR is a software-based IT solution that provides an easier way to track patients' health status, record, lab record, and test. It helps to manage patients' databases to prevent data loss, promote efficiency, and provides better accessibility via the network (cloud) (Funmilola & Ozichi, 2015). EMR is a digital substitute for the conventional patient paper-based patient medical record, a method prone to human error, data loss, cost-ineffective, time inefficient (Asabe et al., 2013). EMR helps bridge the communication gaps between nurses, physicians, various departments, and the patient, fostering teamwork and effectively sharing information. Information in EMR includes (not limited to) patient's medical history, previous and current medication, diagnosis, allergies (Chaplin et al., 2015). In addition to EMR, when it comes to record administrations in health sector, in addition is the electronic health record EHR is the digitalized collection of a patient’s health history and information. This tool dominates aspect of quality and timely decision making on patient, since the past record can be recalled easily. It normally includes diagnosis, medicine, tests, allergies, immunizations, vaccinations, treatment plans. It is fundamentally the patient’s health chart. In disparity, the electronic health record EHR is a systemic collection of a patients records from numerous doctors and provides a more comprehensively extensive view of the patient’s health thus aids in making decisions about the patient’s care. The COVID-19 pandemic has emphasized both the significance of infection preventionists to the healthcare system and the importance of improving links between infection preventionists and information technology (IT). With information technology, EMR can be used to track confirmed or suspected cases of COVID-19 virus, including patients who have been during a previous hospital visit or those tested in other facilities and initiate an automated execution of quarantine order.

(Francis et al., 2020) Another efficacy of the EMR was in its hybridization with telephone calls to monitor and assist cancer survivors (CS) to reduce hospital exposure during the COVID-19 pandemic in Italy (Merz et al., 2021)(Merz et al., 2021). Furthermore, to forecast post- COVID-19 and shed more light on the differences in risk factors across age groups , previous medical information regularly collected in electronic health records (EHRs) can be used (Estiri et al., 2021).

2.2 Artificial Intelligence in Healthcare

Artificial intelligence can be traced back in history as far as to the ancient Greek myth about one Daedalus, a skilled architect and craftsman who was believed to have tried to create artificial humans. He purportedly was the first to create bronze sculptures of human form that is artificial beings that could move eyes, bleed, have tears and literally talk. Another mythical character is Mahavastu of the Buddhist myth which was said to be a seductive female robot (Mijwel, 2015). These shows that man has always sought some form of artificial intelligence to make life better and easier. The turning point in technology came to birth in modern terms when Alan Turing a mathematician began to ask, "Can machines think?". This question he was able to answer in his paper "Computing machinery and intelligence" which was published in 1950. He proposed a method of inquiry in Artificial Intelligence to determine whether a computer was able or not to think human-like which is called the Turing test. At that time, the intelligence level of the computer that passed the test was adequate. This test served as the basic for Artificial Intelligence. Following was a conference Artificial Intelligence session at Darmouth College in 1956 (Mijwel, 2015) which was the first of its kind.

As humans engage with training data, learning algorithms can become more exact and accurate, allowing humans to obtain unparalleled insights into diagnoses, care processes, treatment variability, and patient outcome through artificial intelligence. In 1957, John Maccarthy created the LISP (List Processing Language) an effective high-level programming language that enables the creation of flexible programs to represent basic operations with list structure. However, these were foundational bricks of the development of modern Artificial intelligence as applicability of Artificial intelligence did not start until the 1980s. More recently, Artificial intelligence are beginning to be used in the health sector (Davenport & Kalakota, 2019). There has been a significant development in the applicability of Artificial Intelligence in healthcare. One notable one is the utility of machine learning which aim at enabling machines to perform their jobs skillfully by using intelligent software (Mohammed et al., 2016). Artificial intelligence is a technology growing in acceptability in various sectors and industries due to its versatility, efficiency, performance, and scalability (Mintz & Brodie, 2019). Health care 5.0 is all about a technology dependent health care services, research has dramatically increased in artificial intelligence in recent times, with healthcare AI leading the investment chart amongst other AI projects in different sectors (Buch et al., 2018). In current times, artificial intelligence has been applied to several medicine areas, including (but not limited to) radiology, cardiology, genetics, emergency medicine, neurology, ophthalmology, oncology and drug design (Bouletreau et al., 2019). To connect to medical equipment, it requires fifth generation (5G) connectivity as a key network infrastructure and the goal of healthcare 5.0 is to improve the quality of life of patients and individuals all around the world. Artificial intelligence, often referred to as Machine Learning (ML), is one of the oldest but evolving computer science fields that aims to use machine interventions to solve real-time world problems with little or no human intervention. Although controlled by humans, it is intelligent and accurate in clinical decision-making, especially when human lives are involved (Holzinger et al., 2020). Medical Artificial Intelligence (AI) uses complex machine learning algorithms to learn from the pool of data available to acquire necessary insight in solving real-time clinical issues. It uses a feedback system that helps to improve accuracy (Jiang et al., 2017). AI uses an imaging-based algorithm to analyse and give clinical diagnoses useful in radiotherapy, chemotherapy, and other laboratory test (Choi et al., 2018).

Towards realization of Sustainable development Goal three (SDG-3). Artificial Intelligence is not merely a technology but a collection or simulation of technology that involves the building and development of machines that are capable of performing tasks with human intelligence such as a sense of consciousness and emotional intelligence. Typical examples are Google Maps and ride-hailing applications, text editors or autocorrect and E-Payments which we use in our day-to-day activities. During the pandemic, several covid patients were attended to with the aid of robots, temperature checks in the airport, luggage screening among several other activities are now technology inclined. At present, AI is triggering a conceptual change in health sector, and this is evident in its application to the present COVID-19 epidemic. Medical experts have applied AI in the prediction of locality of the subsequent outbreak, identification of potential drugs that can serve as therapy against the virus and the development of algorithm that could help in the design of new molecules that could stop viral reproduction (McCall, 2020). As a practical example, Infervision - AI medical technology company, developed an AI tool can reduce the time taken to diagnose a possible of COVID-19 pneumonia from 15 minutes (by manual check) to 10 seconds- this is enough time to save a patient's life (Mallio et al., 2021).

2.3 Internet of Things in Healthcare

Internet of Things (IoT) comprises a network of intelligent physical devices capable of communicating with other interconnected devices within the network without human interference(Le et al., 2018; Oyewo & Tran, 2021). A

thing on the internet of things is essentially any intelligent entity capable of working automatically without human input. The IoT "things" are objects in the physical world connected to the internet or shared network via sensors. IoT usage covers a diverse set of application domains such as smart cities, smart homes, smart industry, autonomous vehicles and healthcare. Recently, due to its smooth integration with electronic health (eHealth) and telemedicine, loT has been attracting much attention in healthcare (Qureshi et al., 2020). IoT applications in the medical field have come to be known as the Internet of Medical Things (IoMT) or Medical IoT (Limaye & Adegbija, 2018). As Limaye noted, the ideal IoMT will consist of a network of interrelated medical devices that securely shares data with the healthcare experts to foster cutting-edge medical solutions and services using many emerging devices-pacemakers, portable Magnetic Resonance Imaging (MRI), and Computerised Tomography (CT) scan machines, and wearables (Limaye & Adegbija, 2018; Leal Filho et al., 2018). Medical IoT applications include medical equipment and medication control, medical information management, telemedicine and mobile medical care, personal health management, and its significant advantage. Patients benefit from acquiring the best medical assistance, the minimum medical costs, the shortest treatment time and the most satisfactory health services (Lu et al., 2013). Today there are sustainable sophisticated medical equipment that are connected seamlessly to the cloud for remote operation monitoring, diagnosis and large data repository with the aid of IOT. At present, ICT devices such as smartphones incorporates several forms of sensors that transmits data to the cloud thereby highlighting the growing usage of IoT technologies. For the healthcare sector, physiological data from a patient can be collected using various wearable devices fitted with sensors and software application. These data are usually secured and transferred to medical practitioners or healthcare institutions. Based on the data collected from a patient, message in form of SMS or email is used to notify healthcare professionals about the medical status of the patient prompting them to take appropriate actions (Chen et al., 2016; Moser & Melliar-Smith, 2015). During the COVID-19 pandemic, IoT has been used to track the accessibility of ambulance devoted to COVID-19 patients (Kumar & Nayar, 2021).

2.4 Telemedicine

Distance is one of the barriers that limit patients access to adequate and quality healthcare. This limitation, sometimes, could be due to the unavailability of a specialist health practitioner, sophisticated modern equipment and many more. Telemedicine is a concept that bridges these gaps. Its adoption dated back to the era where the smoke sign informs people in remote locations about an infectious illness or disease (Waller & Stotler, 2018). Telemedicine is being used in many regions of the world including both developed and developing worlds. Among all patients, the elderly usually is one of the major target groups in telemedicine. Nowadays, remote medical diagnosis, treatment and care can be performed at the elderly's houses or nearby hospitals via telemedicine whilst ensuring the elderly a feeling of reassurance, safety and relief that they are well treated. Basically, there are two approaches to implementing telemedicine in any community. The first one involves joining the existing communities and the other is building telemedicine system. However, most countries are deficient of necessary regulatory framework to authorize, integrate, and compensate telemedicine in healthcare delivery for all patients, especially in emergency and outbreak situations like that of the 2020 COVID global pandemic (Ohannessian et al., 2020). Telemedicine, in form of video and audio consultations, were adopted and expanded during the COVID-19 pandemic to curb the probability of transmission, particularly in the United States of America, United Kingdom, and India (A. V Das et al., 2020; Ohannessian et al., 2020). During the height of the pandemic, medical professional in India hybridised tele-consultations (a form of telemedicine) and electronic medical records to promptly respond to patients during the lockdown (N. Das, 2020). The result of the experimentation provides further insights into how medical professionals can remotely manage patient to reduce cost and unnecessary exposure of patients with comorbidity.

3. Netwotk Technology in Energy Industry

The impression of Information technology is growing continuously in our everyday lives and that in an increasing number of nations and particularly in the energy industry. The energy sector, over the years, have been faced with revolution, especially with the rate of pollution, consumption, production and delivery of their services and products. The rapid depletion of fossil fuels has prompted the need to opt for other energy forms (Bao et al., 2020). The energy sector categorised into non-renewable energy, including oil and petroleum products such as natural gas, diesel fuel, nuclear, and renewable energy, including hydropower, solar power, and wind power, comprises all industries involved in the large-scale production, distribution sale of energy products needed for (Jacobsson & Bergek, 2004). The BP statistical review on World energy suggests that researchers estimated an increase in the global demand for energy in 2018 by 2.9% (Ruhe, 2019). Due to the rise in energy demand, several energy technologies were developed and deployed to improve and guarantee clean and efficient energy production and consumption. ICT has been adopted in the energy sector to improve service delivery, efficiency, and reliability of

products, improve environmental safety, and solve other real-time issues (Sagar & der Zwaan, 2006).

3.1 Notable Application in Energy Sector

In recent times, there has been a revolution in computing, Information and communications, and all indications are that technological advancement and use of information technology will no doubt continue to increase in a rapid manner. The advancement in information and technology in the energy sector has massively changed our lives in a positive way (Porcaro, 2021). With the aid of information technology, the energy sector possesses the potential to reach more customers (businesses and individual and in need of electricity), improve performance on how communities be better served as well as the innovation to new and existing methods, products and services and hence collaborate with suppliers and business partners from all over with ICT, is the advent of smart meters, smart distribution and effective record management. Information technology has offered wide application in the energy sector, providing sustainable energy transitions and optimisation. A notable application of information technology observed in the development and deployment of sensors, computer software, smart-grid system, metering and billing, security, automation, electric e-mobility. Climate change has been one of the most prominent matters discussed all over the world. Various scientific research findings suggest that climate change results from increasing greenhouse gases (Stallo et al., 2010). ICTs could play an essential role in saving the earth and improving the climate. Application of ICT identified in integrating control and monitoring capabilities in Heating Ventilation Air Conditioning systems (HVAC), integrating ICT-based energy technologies applied to industrial equipment such as motors, pumps and fans, and ICT based lighting system to improve energy consumption. Other application includes solar power satellites.

3.2 Smart Grid Application

One of the advanced applications of information technology with respect to energy is the use of a smart-grid system. Smart grids aim at integrating traditional electric power grid with telecommunication and information technologies to achieve a level of optimisation of the power grid network, fault detection and correction with minimal intervention (Al-Ali & others, 2015). Unlike the 20th-century traditional grid system that uses one-way communication, the smart grid uses two-way communication, which involves automation, sensors, computers, and other technologies to improve the existing grid system's deficiencies. Smart Grid technology features include (but not limited to) smart meters, data security, distributed generations, carbon emission reduction, renewable energy integrations, meter data management, distribution automation, electricity storage devices, IT computing, and automatic healing capability. Fundamentally, the Smart Grid market comprises of a good number of large and small vendors, supplying software, hardware and solutions throughout the market at the physical, communications, applications and services aspects of the market. Government policies, investments (both private and public) and a range of other factors are considering and devising several forms of solutions to curb problems associated with its use. Up until now, significant bodies are still yet to describe what a smart grid should look like, so much so that it is becoming quite profusely confusing (Lakshminarayana & others, 2014). However, they all agree on the fact that that any smart grid is expected to have the capacity of incorporating a wide range of energy sources whilst ensuring a considerable reduction in greenhouse gases. The ability for a grid to measure, visualize and use energy sustainably is a proof of its efficacy. When consumers are not supplied a high-quality power; when there is a problem of constant technical and commercial issues, then it is less of a smart grid. A smart grid should be efficient and sufficient in the monitoring of essential components, rapid and timely diagnosis and aptly respond to any event. Emergence and development of Information Technology has had a tremendous positive impact on smart grid application and its development. The inclusion of renewable energy technologies on the grid has necessitated the need for flexibility of the power system. The flexibility would permit the inclusion of energy storage devices that would cancel out the intermittent nature of the renewable energy power plants. The flexibility of such magnitude can be easily achieved through the use smart technologies (Babatunde, 2019; Heffron et al., 2021). In the wake of demand side management and demand side response for achieving energy efficiency, the use of smart technologies cannot the eliminated. The grid must be smart to communicate to both the supply side and demand side of the market. This would inform the consumers when to get cheap energy, when to sell to the grid and when maintained would be carried out. Operations, maintenance, and repair on the power grids are typically performed by personnel. However, as a first step to reduce the spread of the coronavirus, many countries placed restrictions on production-related and social activities. This precipitated a major bottleneck for personnel in this category because of the emphasis placed on their health. Hence, the operations, maintenance and repair were carried out under strict health protocols. This condition elucidates the need for the digitalization of the grid to make them smart enough to carry out some maneuverers and automatic reconfigurations to sustain a stable system (Chae et al., 2020).

3.3 Internet of Things (IoT) and Automation in Quality Energy

IoT is a significant innovation in the field of information and communication technology. It uses the internet to provide connectivity to physical devices (such as cameras, vehicles and home gadgets), providing an avenue for remote control and monitoring. IoT relies on sensor devices, communication connectivity, database and network applications to serve as the user interface. The user interface can be in software, hardware or webpage (Hossein Motlagh et al., 2020). In the energy sector, the existing distribution systems have somewhat of a built-in incompetence majorly because of the underdevelopment in the structure of the system. The same system has been used repeatedly without the necessary restructuring for the modern times of Information technology. A typical example is that a major part of the system is still monitored manually. Lack of automation in these aspects has led to maintenance not taking place only until breakdowns. The still used "Pre- Information Technology" system seldom ensures reliability and efficiency in the power system. There is a shortage of better planning and analysis without the use of Information Technology. As a result, there have been an increase in the deregulation of the energy markets and greater environmental concern and the health of the people. There is therefore a need for automation.

The Internet of things-based automation like the Systems Supervisory Control and Data Acquisition (SCADA) system enables an electric utility to remotely monitor, coordinate, control and operate distribution components, equipment and devices in a real-time mode from remote locations with acquisition of data for analysis, and planning from one central location. Infrastructure creation, database generation and indexing of consumers by digital mapping like the GIS- based system is another IoT- based automation system that makes life easier. Information system for consumer satisfaction and control would focus on trouble call management, load forecasting management and material movement, its planning and control. This ensures quality power production, distribution, utility and hence better living for all and sundry. Internet of Things (IoT) is fast-growing aimed at making devices smarter. Series of research activities and impact analysis of energy-based generation as carried out by (Adeyemi-Kayode et al., 2021) are fast becoming IoT based. Today, the energy sector drives at achieving energy efficiency, lowering CO_2 emission and reducing the rate of energy loss. The energy sector IoT has adopted in areas which includes (but not limited to) fuel extraction, operation and maintenance (O&M), a system such as IoT based energy management system is a product of IoT innovation. The IoT based energy management system is used to monitor real-time consumption and raise critical alerts, reducing the risk of production loss and outages. The use of IoT in the energy sector has helped drive automate industrial processes and provide an effective data acquisition system (Hossein Motlagh et al., 2020).

3.4 Smart Metering and Billing

As the demand for energy and the rate per unit increases, measuring energy consumption is of great concern. The smart meter is a device developed to measure real-time energy usage and sends the information wirelessly to the energy distribution stakeholders. The smart meter is replacing the conventional metering methods of taking manual readings and estimated bills (Ahmad, 2011). Smart meters have a display panel to show essential electronic characteristics such as utilisation, voltage, meter status and the connectivity capabilities to connect wirelessly to submit readings. The design architecture is closely compact to eliminate data loss or data theft while transmitting (Jagstaidt et al., 2011). In the nearest future, smart meters are to have local ad-hoc network capabilities (e.g., Bluetooth, ZigBee) internet connectivity (via Wi-Fi, Ethernet) and more advanced functionality (Jagstaidt et al., 2011). There are quite a number or challenges in metering and billing processes. The problem of difficulty of meter reader to each customer's meter manually such the likelihood of some customers away from home and perhaps the inadequacies in the probity and reliability several meter readers. Also, sometimes there are measuring error and other times the safety of the meter readers is not proper ensured. Utility of Internet of things smart metering ensures that information such as consumption of electricity utilized, current flow, voltage levels and correctly recorded thus ensuring correct billing instead of human workers that are fallible to human errors. This no doubt is sustainable and a major contribution to a common man's life when it comes to reasonable billing of energy consumed. The increase in the development of high-tech devices, tools and software will not only make production and distribution of energy smarter but adds to energy efficiency, clean energy production and reduce the level of pollution and waste. Incorporating technologies and several areas of automation are replacements of conventional methods. To a large extent, increased government policies and law enforcement plays a vital role in this transition, which also strengthen private partnership through investment. (Coroama & Hilty, 2009; Fettweis & Zimmermann, 2008).

4. Network Technologies and Education

In previous sections we have seen the numerous influences of ICT towards a sustainable development goal. This

section emphasizes on the influence of ICT on sustainable quality education at all levels. Somehow, Information technology has made communication more structured, faster, and relatively cheaper. There certainly is no education without communication. Full duplex communication techniques in real time have become order of the day as face to face is becoming less popular in most part of the world especially with the occurrence of pandemic. (Emenike, 2021). Although, direct communication (video) from different parts of the world is made possible with different platforms such as Zoom and Teams which were especially helpful during the 2020 global lockdown due to the pandemic. Students did not have to wait whole year before going back to school because Information Technology provided a quality means of education for students all around the globe. The question of how sustainable the adoption of Information and technology in education is paramount because the high pace Information technology advancement. Just few years ago, cell phones were invented, and then mobile phones accompanied by the internet. Androids, laptops and various internet usable gadgets were discovered. In this time and age, access to social media and various websites is not a luxury. Thus, there is not a question about the progress and advancement of the use of Information technology in education in the future but show sustainable its adoption would be. However, while most people feel education can be enhanced through diverse channels, others argue that it is such a huge distraction to learners' concentration, this work concentrate more on the positive impact of ICT on education, not shying away from some of its negative effects but not within the scope of this study.

In today's world, a vast majority of people are computer literate. In 21st century, being a computer illiterate could deny active participation in modern society despite acknowledged necessity and benefits of inclusive literacy through computing (Adebisi et al., 2018). Modern society is characterized by sudden growth and development of information technology resulting in large dependence of the society, in a wider sense, on the individual knowledge and competence of a person in the Information technology department. This dependence grows on daily basis, the human right to education and information is not extended to Information technology area. ICT has contributed to all the levels of education from creche, kindergarten, elementary, primary, secondary and tertiary institutions have used ICT to deliver knowledge. Emerging network technologies have contributed immensely to these possibilities. Learning resources are now available for reference, assessments are mostly online, grading, application and admission processes are made easy with the use of IT tools. Enterprise application development on mobile and web are too numerous to mention when it comes to IT influence on education towards excellent sustainability. Some of its aspects are discussed in the following sections.

4.1 E-Learning

This is a form of learning through electronic means. Learning Management System (LMS) an application designed to assist instructors in meeting their pedagogical goals of delivering learning content to students (Machado & Tao, 2007). It facilitates the management, delivery, and measurement of an organisation's corporate e-learning programs. LMS is one of the technologies for use in higher institutions of learning. They are used to deliver online courses and training materials, organise and manage the online classes, participants, results, and effectiveness. LMS are classified as either web-based or installed, open-source or closed source, free or commercial, cloud or hosted LMS. Famous examples of LMS are Blackboard Learn, Google Classroom and Moodle. However, there are also indigenous LMS such as TutorNg, Tangeine LMS and Vlearn. Mobile gadgets also known as Mobile Learning are not exempted from this influence (Blagoev et al., 2021). The use of wireless, smartphones, portable and handheld devices is gradually growing and diversifying across every education sector and across both the developed and developing world. The importance of e-learning is more appreciated as the COVID-19 pandemic ravaged throughout the globe. Many institutions of learning switched to virtual learning, which is basically aided by ICT.

4.2 Education and Artificial Intelligence

Artificial intelligence applications (AI) as seen from the previous section also influence the delivery of quality education sector, called Artificial Intelligence in Education (AIED) have skyrocketed over and beyond supercomputing to embedded systems. AI embedded into robots facilitates the development of robots that enhance students' learning experience (Xie et al., 2021). Artificial intelligence in education has been incorporated into administration, instruction or teaching, and learning (Chassignol et al., 2018). AI in online education started from simply providing materials online or for students to enhance their study. Nowadays, AIED has extended to include web-based systems that are intelligent and can adapt to learning using the teacher and student's behaviour and adjust itself to the personalised data, thereby enriching the overall educational experience. In robotics, for instance, according to a study by Timms, the application of robots in conjunction with teachers or colleague are being applied to teach children routine tasks, including spelling and pronunciation and adjusting to the students' abilities (Xie et al., 2021). (Adebisi et al., 2018) developed a framework that enables the use of Business Intelligence (BI)

as an IT tool for a productive advantage in education sector. It showcases the relevance of data warehousing and analytics in quality education, which are too many to mention.

4.3 Application of Internet of Things in Education

Higher education areas with the IoT systems include (but not limited to) attendance monitoring, personalisation through feedback, personalisation through learning analytics, physical access security, environmental conditions monitoring, and others. Allow access to learning materials and additional information by individual student remotely at their comfort and pace. Teachers can also use wearable devices and smartphones to improve teaching and learning (Alao et al., 2019). IoT introduces improvement to the educational process and the relationships of participants. The learning process is mobile and flexible to fit into students' needs with the sole requirement of physically connecting devices directly. It influences teaching and learning processes, including creating knowledge and its dissemination. Achievements of controversial and unavailable physical resources have been made possible through IoT, a typical example is the conduction of alternative to practical in institutions for experimental purposes, this no doubt has helped to transform learning into a better process (Kiryakova et al., 2017). IoT supports education in many ways, which include (but not limited to) efficient data gathering from sensors and wearable devices, performing meaningful actions based on these data. These systems allow students to explore an environment using embedded sensors, QR codes and other technologies (Banica et al., 2017). Access to learning materials and additional information from anywhere at any time. Teachers can also use wearable devices and smartphones to improve teaching and learning (Xie et al., 2021).

5. Sustainability Factors

Utilization of Information technology has helped to digitalize the various aspects of life as highlighted in the previous sections. The sustainability of these technologies depends on many factors, these are briefly discussed in this section. These factors must be considered to continuously sustain the numerous positive influences of ICT on the selected SDGs.

Table 1. Sustainability of ICT in the discussed SDGs

Factors	Health Sector	Energy sector	Education sector
Social factors	socioeconomic status physical environment social support networks employment	Installation by Unqualified/inexperienced Lack of Practical Preliminary Survey inadequate Social Awareness	Perceived usefulness Perceived ease-of-use Social influence processes Attitude toward use Behavioural intention Lack of Community Engagement
Technical factors	lack of flexibility attitude to new tools cutting-edge treatments effective technical strategies from the managerial level compute self-efficacy	Limited accessibility and network connection Limited awareness Lack of leverage on related sectors	limited ICT facilities lack of teacher's competence upgrade to modern tools usage inadequate infrastructure, inadequate technology, lack of sufficient technological tools, effective professional development (external factors),
Economic factors	supply of money (finance and loans) Health professional renumeration Medical equipment market regulation	the supply and demand for worldwide energy Customer attitudes to service payment market regulation Lack of investors	Cost of implementation Perceived cost of maintenance technological cost escalation, changing comparable professional pay scales, tax base variations, tax base fluctuations economics of students' homes.
Environmental factors	chemical pollution, air pollution, climate change, poor water quality	poor infrastructure damaged infrastructure due to hash weathers infrastructure natural degradation	Poor infrastructure usage by users Facility degradation Conscious and unconscious Damages

Policy factors	Nutrition, lifestyle, environment, and genetics	energy production policy. distribution policy energy consumption policy. energy growth policy	school size, class size, school choice, school privatization, teacher selection, teaching methods, curricular conten0t, graduation requirements

5.1 Economic Consideration

Just like every other sustainability factor, economic factors cut across health, energy and education. Cost is a major component of economy. The emergence of IT has led to relative increase in cost in most cases, additional cost for smart metres in energy sector, health sectors charges based on the sophisticated equipment being used while education is not a different ball game. Cost of technology during pandemic to reduce physical contact is a major economic consideration. The human rights universal declaration affirms that education shall be free, at least in the elementary and fundamental stages (UN General Assembly, 1948). Relatively persistent underfunding of higher education in some part of the world has led to an increase in tuition fees and the introduction of new charges to students' payment especially in higher institutions, this is gradually impacting how IT facilities could be adopted (Igwesi, B. N., and KEBBI, 2017). Unfortunately, the pandemic forced most sectors as identified to take seriously the economic factors for sustainability.

Ease of usage and portability is another economic factor which drives adoption and utilization of IT in the goals under discuss (Education, Health and Energy). With information technology most of the processes and workflows become easier to use and gives faster results with little turnaround time, they are easy to use. Engineers do not need to climb poles or monitor usage and most of the energy related operations have become digital, receptionist and nurses can now administer drugs based on records automatically, sophisticated equipment are now used for vitals to check basic patient information with little or no assistance to the patient, students can learn at a self-paced approach and get quality education, in some cases students can also carry out self-assessment for mock purposes in preparation for major assessments. These and many more are hurdles crossed with the influence of ICT towards sustainability with respect to economics. The Information technology era has shown that IT adoption promotes better teaching and learning in academic institution. For context, in a study carried out to investigate perceived instructional usefulness of ICT's by Lecturers in selected Technical Training Institutions in the world, the result indicated that lecturers in the TTI's perceived that the utilization of ICT is useful in instruction as it enhances and complements instruction (Islam Sarker et al., 2019). Several respondents, particularly 629 of the 2909 total population of lecturers were given questionnaires to fill their opinions. The result showed the ease of use of IT in teaching and learning of students. Thus, the researchers recommended that ICT's use in instruction be facilitated because of how greatly it impacts instruction.

5.2 Social Consideration

In addition to cost, some of the factors to be considered for ICT influenced sustainable development are social factors; timely deployment, most areas of energy, health and education still require automation, and this must be done with a very high level of urgency and deploy to time to meet the need and target of the sustainable goals in due course. The ongoing development of ICT and its diverse fields have led to various theoretical models for a better understanding of its diffusion, adoption, acceptance, and usage. Among the various efforts to understand user acceptance of information systems, the most cited theoretical frameworks are the Technology Acceptance Model (TAM) (Gibberd, 2014). Using this framework in education for example, Akinde discovered that the perceived ease of use and technical support may affect the extent of use of educational support system used in online learning for teaching and that the perceived usefulness of IT is dependent on the perceived ease of use (Akinde, 2016). Findings of the study by Olafare and Adeyanju on the acceptability of IT in Nigerian colleges showed the automatic acceptance by lecturers towards using ICT. According to the study, there was a noteworthy difference between first-degree holders and higher degree holders in their attitudes and a significant difference in attitude among lecturers in various areas of specialisations on attitude (Olafare et al., 2018). Ultimately the acceptability of Information Technology has followed the same trend in history has it been today. For some reason, humans have the natural tendency to oppose change whether in their subconscious or conscious especially when it comes to the emergence of any major new or alternative technology. In retrospect, the event may have been a funny one, but it was recorded that it traumatized those who believed the story. At lot of people had been taken in by the

program, despite the producer's warnings before, during the intermission, and after the program (Holmsten, 2001). Although everyone now uses their phones and radios without or doubt but there is no question about the fact that these shows a trend and pattern in human acceptance and adoption of new Information technology. In energy and health as well the acceptance rate has been positive as many customers want to be charged objectively and this is more justified with the introduction of technological oriented devices and smart meters, in health patients are getting used to avoiding the long wait and queue before being attended to, absence of these bottlenecks has no doubt increased the acceptance rate of the populace thereby creating an indication for positive and sustainable measures.

6. Conclusion

The adoption of Information technology to various spheres of life have been worthwhile. There is no question to the fact that it has positively impacted individuals and the society at large in ways innumerable. Despite the awe, the skepticism and fear in every process of discovery, invention and adoption of Information technology; it has been a backbone for many economies and the solution to so many problems that pre-modern era did not even know they had. More importantly, it has made life easier. While we expect the same difficulties in the future, it is foreseeable that Information technology will continue to develop, and man will continue to sustain its adoption even if that means he will have to adapt. This paper examined the adoption of information technology in three principal sectors that are important to the sustenance of modern civilization; these include health, energy and education. The review outlined the significant factors determining sustainability- timeliness, cost, acceptability and ease of use/portability. The global world is constantly evolving due to the adoption and progression of information technology. Insights from the review shows that there has been an increase in productively across many human regulated sectors across the world at large because of the emergence and use of IT. The world is increasingly interconnected than ever before with people, ideas, images, goods and money being distributed with time and accuracy than ever in history. Energy operations are at its peak since the industrial revolution and will ever progress as researchers' workday by day to ensure knowledge and technology increases. Although the scope of this work does not cover some of the challenges that may be identified with the influence of ICT in Energy, Education and Health sectors, but overall, ICT is of a great positive impact and influence on the identified areas which is obvious and tremendous. Thus, the need to ensure sustainability through applications and continuous implementation identified channels and sources requires urgent attention.

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