Global ICT Indicators and Disruptive Technologies: An Empirical Analysis

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Abstract

At the World Summit on the Information Society (WSIS) in Geneva in December 2003, world leaders and heads of government deliberated and agreed on the need to develop statistical measurements for ICT benchmarking. With a world population of 7.875 billion people and 5.168 billion internet users globally.The global ICT indicators are Fixed Telephone Subscriptions (FTS), Mobile-Cellular Telephone Subscriptions (MCTS), Active Mobile Broadband Subscriptions (AMBS), and Fixed Broadband Subscriptions. This study aimed to explain emerging technoloies that disrupt human activities such as Artificial Intelligence (AI), Big Data Analytics, Robotics, Blockchain Technologies, Cybersecurity, and Cloud Computing and analyze time-series data from 2005 to 2020 on global ICT indicators. The secondary data used for the study was sourced from International Technology Union (ITU) Database on Information Communication & Technology (ICT). The Vector autoregression model (VAR) with the aid of E-Views Version 9.0 software and Technology Acceptance Model (TAM) is the theory that underpins the study.ICT indicators are the way to go globally and align with Schumpeterian effects of 1936 with the power to eradicate poverty and its affiliates, as a linkage for integration and sustainability of the United Nations agenda, expansion of MSMEs, and other financial assistance to the developing ad third world countries with seamless monitoring with the help of ICT related indicators.

Keywords: Information Communication & Technology (ICT), Indicators, Disruptive, Vector autoregression model (VAR)

INTRODUCTION

Information Technology (IT) is a valuable tool that facilitates significant operational and information transmission worldwide (Connor & Martinsons, 2006). At the World Summit on the Information Society (WSIS) in Geneva in December 2003, world leaders and heads of government deliberated and agreed on the need to develop statistical measurements for ICT benchmarking. The key partners include the International Telecommunication Union (ITU), the Organization for Economic Co-operation and Development (OECD), Eurostat, the United Nations Conference on Trade and Development (UNCTAD), UN ICT Task Force, UN Regional Commissions, UNESCO Institute for Statistics and the World Bank. The global ICT indicators are but are not limited to the following: Fixed Telephone Subscriptions (FTS), Mobile-Cellular Telephone Subscriptions (MCTS), Active Mobile Broadband Subscriptions (AMBS), and Fixed Broadband Subscriptions (UN ICT Task Force, 2020). With a world population of 7.875 billion people and 5.168 billion internet users globally, the human race is confronted daily with changes in technologies and innovation. To this end, this paper seeks to analyze global ICT indicators and disruptive technologies such as Artificial Intelligence (AI), Big Data Analytics, Robotics, Blockchain Technologies, Cybersecurity, and Cloud Computing that shapes human life and activities worldwide, thus; this study aims at assessing the effect of Global ICT indicators and disruptive technologies around the world. The specific objectives of the study include to; examining the global ICT indicators and explain disruptive technologies around the world.

LITERATURE REVIEW

Conceptual Framework

Information Communication and Technology (ICT)

Information Communication and Technology (ICT) refers to the combination of informatics technology with other related technologies, specifically communication technology (Lambe, 2021). Informatics technology deals with designing informatics systems that can be applied in all facets of life. Global ICT indicators are core indicators for measuring ICT infrastructure and access, accessibility to and use of ICT by households and individuals, utilization of ICT by businesses and the ICT sector, and trading in ICT goods and services.

Artificial Intelligence (AI)

AI is attempting digitally to achievea human level of Intelligence using different automation of machines. This advanced technology allows machines or devices to mimic humans to sense, understand, act, and learn from humans (Kaur & Gil, 2020). As a result, AI., specifically Machine Learning (ML) and Deep Learning (DL), continuously improve performance,with minimal or without human intervention. As a result, Artificial Intelligence helps humans perform complex and multiple tasks with ease, and the AI systems are brilliant learners deployed across the economy. In addition, AI capabilities positively impacted robotics, natural language processing, games, speech recognition, medicine, education, and many more. Specifically, it includes;

i. Chatterbot; A chatterbot is a computer program that conducts a conversation via auditory or textual methods.
ii. Robotics; Robots are capable of learning new things by observation from the environment. Therefore, they learn more things from humans and use them better.
iii. Healthcare; AI plays a significant role in the field of healthcare. AI-based Healthcare systems assist doctors in predicting disease in a patient by comparing the patient's medical data with historical data. Such machines can also prescribe the most appropriate medication and laboratory tests for the patient.
iv. Gaming; AI plays a crucial role in games such as chess, poker, tic-tac-toe, and others, where the machine can think of a considerable number of possible turns based on the heuristic evaluation.
v. Vision systems; Understand, interpret, and grasp visual input on the computer.
vi. Speech recognition; AI-based intelligent systems can hear and understand the language in terms of sentences and their meanings. It can handle different accents, slang words, background noise, human sound changes due to cold, and much more.
vii. Handwriting recognition; AI-based handwriting recognition software can read the text written on paper by a pen or on-screen by a stylus. It can recognize the shapes of the letters and convert them into editable text.
viii. Banking; AI helps in the banking industry with chatbots, anti-money laundering (AML) tools, pattern detection, recommendation engines, fraud detection, and algorithmic trading(Kaur & Gil, 2020).

Big Data Analytics

Big Data Analytics examines large and different types of data to uncover hidden patterns, correlations, and other insights. Big Data Analyticsis the application of advanced analytics techniques in analyzing large amounts of data. Big data sets could be structured, semi-structured, or unstructured data stored in tetrabytesto zettabytes. The need for big data arises from the 2.5 quintillions of data we create every day. Also, data emanates from diverse sources in different formats. Thus, the enormous collection of data is 'Big Data'. Characteristics of Big Data: Volume, a massive amount of data, Variety, different formats of data from various sources, Value, extracted valuable data, Velocity, high speed of accumulation of data,and Veracity, inconsistencies, and uncertainty in data. The importance of Big Data Analytics (i) Making more innovative and more efficient organizations (ii) Optimize Business Operations by analyzing customer behaviour. For example, Amazon uses Big Data to analyze the behaviour and pattern of over 300 million customers that signed up. (iii) Big Data reduces the cost of operations (iv) use of Next Generation Products; for instance, Big Data tools are used to operate Google's Self-driving Cars. Netflix launched the seasons of its TV show Hours Cards based on user reviews, ratings, and viewership.

Stages in Big Data Analytics includes; firstly an identification of the problem; secondly, Designing Data requirements; thirdly, Pre-processing, Fourthly, Performing Analytics over Data and finally, Visualizing Data. Types of Big Data Analytics (i) Descriptive Analysis: What is happening now based on incoming data and summarizes it. (ii)Predictive Analysisuses statistical models and forecast techniques to understand what might happen in the future. (iii) Prescriptive Analysis uses optimization and simulation algorithms to advise on the possible outcomes and answer the question of what we should do. This technique goes beyond descriptive and predictive analyses to recommending a course of action. An example is the Google Self-driving Car. It analyses the environment and decides the direction to take based on data. (iv)Diagnostic Analysisis used to determine why something happened in the past, so it is characterized by techniques such as drill-down, data discovery, data mining, and correlation. It takes a deeper look at the data to understand the root cause of the events. Tools used in Big Data Analytics include (i) Hadoop, the tool used in data storage and processing platform; (ii) Kafka used for the messaging system; (iii) Hive warehouses data; (iv) Splunk the log analysis platform; (v)Talend is the software integration platform (vi) APACHE Spark a real-time processing tool (vii) APACHE HBASE a non-SQL Database that allows storage of unstructured and semi-structured data with ease and provides real-time read or write option (Edureka Training, 2021).

Robotics

Robotic systems are multiple technologies and disciplines to perform tasks including, mechanical and electrical engineering, machine learning, computer vision, planning and speech recognition. There are three categories of robots, manipulators, or robot arms they are physically anchored to their work place; secondly, mobile robots, includingunmanned ground vehicles and unmanned air vehicles such as drones and mobile manipulators that combined mobility with manipulations. Robots are built on sensors that enables robots to perceive their environment and effectors (Schastsky & Nyberg2021). One thing that makes robots hard is uncertainty because of working with parial information to tak decisions. In the fututure the world looks forward to interaction between robots and humans using natural language as opposed to using commands and machine lanhuage. The evolution of robot apocalypse, the development of terminators and Skynet and many more autonomous robots poses threats interms of job security; the concern here is that robots are getting smarter by the day and potentially capable of independnt thought (Markman, 2019). Robots can now see with lowcost, high-definition cameras. They can hear with with ultrasonic sensors and equally touch and even feel with dexterous limbs. Robots can think, too. All of this is getting better at an exponential rate.Jerry Kaplan, in his 2015 book, *Humans Need Not Apply*, summed it up perfectly: "If you own the robots you're going to do great, so get ready to make a lot of money. Robots will accelerate income inequality. However, if your job is repetitive, you're in deep trouble.". We can see these changes in real-time. When Amazon.com purchasedthe robotics firm Kiva in 2012, few observers expected automation's dramatic impact on its warehouse floors. In September 2017, the *New York Times* reported that robot deployment at the online retailer had swollen to more than 100,000. Human workers in Amazon warehouses have been cut by two-thirds and those who remain to perform only non-routine tasks. In January 2016, the World Economic Forum estimated that five million jobs could be lost to automation by 2020. No job is safe, according to researchers at Stanford University. Lawyers, accountants, and even surgeons can be automated away (Markman, 2019).

Internet of Things (IoT)

The Internet of Things has the potntial to change the world, just as the internet did. The 'Internet of Things' (IoT) is an emerging technology that enables interaction of uniquely identifiable computing devices that can be embedded with other interfaces like machines and humans, linked via wired and wireless networks, to capture contextual data from the environment it has been exposed to and create an information network to provide new functionalities and digital business models. It is also popularly referred to by the abbreviated name of 'IoT' (Chaudhuri,2019). Humans need to empower computers with their own means of gathering information, so they can see, hear and smell the world for themselves, in all its random glory. CISCO predicted that 500 billion devices will be connected to the internet by 2030. The five key attributes based on the 'S-E-N-S-E' framework (Goldman Sachs) that distinguish the IoT from the traditional form of the Internet are; Sensing - Leveraging sensors to generate contextual data; Efficient - Enhances efficiency in productivity terms by adding intelligence to 'things'; Networked - Creates a network of 'things'; Specialized - Ultimate use is focused on domain-based specialized offerings and; Everywhere - Can be deployed everywhere for a ubiquitous presence as per objectivity of use (Chaudhuri,2019).

Potential Applications of the Internet of Things

IoT connects cars, smart healthcare, smart retail, smart traffic systems, smart factories, and smart cities are all great examples of the potential benefits of IoT (Chaudhuri,2019). Designing cars with the help of IoT captures contextual data in predicting fuel usage. IoT-enabled health checks of the automotive components, GRPS-based location monitoring. There are smartwatches today that helps in monitoring and reporting the physical activities of humans and critical health parameters like blood pressure, heart rate, etc. There are also various kinds of IoT applications in the retail industry like wireless sensor-based monitoring of customer behavior in retail outlets that can help the retail owners to understand specific consumer behavior and product choices

Smart traffic systems can be enabled with the IoT in a city traffic network to determine traffic flows and to make necessary decisions for diverting traffic to avoid congestion and chaos. In addition, governments and city police can utilize the data gathered over specific periods from smart traffic systems to decide on infrastructure requirements for smooth traffic movements across the city network. Factories can be made more energy-efficient. The supply chain can be more integrated with demand and market needs by using the data generated by IoT devices fitted to individual components of the machines on the floor. Data gathered from these IoT devices can be analyzed to provide just-in-time information to the engineers and managers for prompt decision-making and efficiency in material usage, power utilization, and effluent treatment (Chaudhuri,2019).

Cybersecurity

A science of cybersecurity offers many opportunities for advances based on a multidisciplinary approach, because, after all, cybersecurity is fundamentally about an adversarial engagement. Humans must defend machines that are attacked by other humans using machines. So, in addition to the critical traditional fields of computer science, electrical engineering, and mathematics, perspectives from other fields are needed (Craigeh, Diakun-Thibault, & Purse, 2014). Cybersecurity is the organization and collection of resources, processes, and structures used to protect cyberspace and cyberspace-enabled systems from occurrences that misalign de jure from de facto property rights. Cybersecurity refers to preventative methods used to protect information from being stolen, compromised, and attacked. It requires understanding potential information threats, such as viruses and other malicious code (Gupta & Goyal, 2020).

Cybersecurity strategies include identity management, risk management, and incident management. They are measures taken to protect computer or computer systems (as on the Internet) against unauthorized access or risk referred to as cybersecurity. The Internet allows users to gather, store, process, and transfer vast amounts of data, including proprietary and sensitive business, transactional, and personal data.

Unfortunately, when businesses and consumers rely more and more on such capabilities, cybersecurity threats continue to plague the Internet economy. Cybersecurity threats evolve as rapidly as the Internet expands, and the associated risks are becoming increasingly global. Staying protected against cybersecurity threats requires all users, even the most sophisticated ones, to be aware of the threats and to improve their security practices on an ongoing basis. Creating incentives to motivate all parties in the Internet economy to make appropriate security investments requires technical and public policy measures that are carefully balanced to heighten cybersecurity without creating barriers to innovation, economic growth, and the free flow of information. As leaders of our organization, we are responsible for protecting the information in our care. Cybersecurity is a business function and technology tool that can be used to protect information assets more securely.

Augmented Reality and Virtual Reality

Virtual Reality is an entirely artificial digital environment that uses computer hardware and software to create the appearance of a real environment to the user. For a user to "enter" a Virtual Reality environment, they must first put on special gloves, earphones, and goggles, all of which receive their input from the computer system. By doing this, at least three of the five senses are controlled by the computer. In addition, the computer monitors the user's actions. The goggles, for example, track how the eyes move and respond accordingly by sending new video input. Virtual Reality enjoyed a lot of hype in the 1990s but fizzled out rather quickly by the end of that decade (Kipper & Rampolla, 2013. Augmented Reality (AR) is a variation of a Virtual Environment (VE), or Virtual Reality (VR) as it is more commonly called. Virtual Reality technologies completely immerse a user inside a synthetic environment, and while immersed, the user cannot see the real world around him. In contrast, Augmented Reality takes digital or computer-generated information, whether images, audio, video, touch, or haptic sensations, and overlays them over in a real-time environment. Augmented Reality technically can be used to enhance all five senses, but its most common present-day use is visual. Unlike Virtual Reality, Augmented Reality allows the user to see the real world, with virtual objects superimposed upon or composited with the real world.

Augmented Reality can also be used to remove real-world information, not just add to it. A basic example is the Vulcan Tourism Transporter App that creates the transporter "beaming" effect from the Star Trek series. A person sitting or object put in front of the transporter pad can be dematerialized or rematerialized using Augmented Reality. Building on the basic definition and descriptions of AR's capabilities, let us expand a bit further and outline the three characteristics that need to be present for true Augmented Reality: AR combines real and virtual information; AR is interactive in real-time and; AR operates and is used in a 3D environment.

Empirical Overview

Virtual Reality is the complete immersion into a digital world either based on a real model or completely fabricated. Augmented Reality is the blending of digital information within a real-world environment. The similarities between the two are that they both use various sources of information and programming to create visual, or other sensory simulations to create an experience. Despite the similarities in feel to the user, there are more differences between AR and VR than there are similarities, with the most significant difference being that one takes place in the real world and the other does not.

Application of AR

Education

Information technology is changing education in a number of ways. Beginning simply with the amount of information that is now available to everyone with access to the Internet, to online learning methods, and interactive interfaces such as the Promethean Board, which lets students interact with a digital "chalkboard" in ways that the old chalkboard couldnot.

Social Networking

With the ever-growing use of social networking sites and the quickly growing popularity of mobile social networking it's no real surprise that Augmented Reality is being used to create richer social networking experiences. An example of this is a mobile app prototype called "Recognizr" that allows you to use your phone in order to "see" who a person is and what Web services and social networks they are connected to.

Advertising

Today more and more brands are leveraging the ubiquity of the mobile phone to begin integrating Augmented Reality within their campaigns. Companies such as Nissan, Toyota, BMW, and Mini are using magazine advertisements and AR to give the viewer a full 3D view of the car being advertised. Lego stores use an AR system to provide kids an animated version of the completed Lego set inside the box they are holding. The motion picture industry has also taken advantage of Augmented Reality to promote movies such as Transformers, Iron Man, and Star Trek (Kipper & Rampolla, 2013).

Sightseeing

Since sightseeing is just that, AR is perfect for an enhanced sightseeing experience. By unlocking hidden, and interesting, information that is all around, the tourist, sightseer, or academic will have the chance to explore the unique details of a place. There are currently a couple of AR applications specifically designed for tourism. One of them is called "Tuscany + Augmented Reality" which brings up points of interest for the traveler in Tuscany. Another example is the Virtual Sightseeing scenic viewer located at the Environmental Interpretation Center at Ponta do Sal. This non-mobile AR experience offers visitors the chance to explore the uniqueness of the Cascais coastal biodiversity and man-made landmarks.

Cloud Computing

To provide cloud computing services requires a process of abstracting the computing through the process of virtualization. A new layer of software sits between each operating system (OS), its supported applications, and the computer hardware. That new software is called a hypervisor which allows multiple applications and the OSs that run them to be placed on a shared-use computer. That set of applications and their OS are packaged as a unit which is termed a Virtual Machine (VM). Each VM's applications and their OS have access to the hosting computer's hardware by means of the overall manager of this environment, the hypervisor, which acts as the overall OS for the hardware. All hosted VMs must execute through the hypervisor's Kernel to use the physical computer's hardware that hosts them (Groom & Jones, 2018). Cloud computing offers a number of advantages to a customer when compared to the cost of operating their own data center or data centers, staffing the operation, purchasing and deploying the equipment, maintaining that equipment, and then powering, cooling, and protecting it. In contrast, contracting for cloud computing services provides a number of advantages including;

Reduced IT Cost: Cloud services can be purchased on an as-used basis and consumers can avoid the large amount of up-front capital costs and associated operating expenses with no capital expenditure for equipment required. Consumers of cloud services can leverage the cloud service provider's infrastructure while avoiding the ongoing expenses for running a data center; these include the cost of power, cooling, management, construction of buildings, and purchasing of real estate. Consumers pay only for that portion of the costs that they actually consume.

Business Agility Support: The speed at which new computing capacity can be provisioned is a vital element of cloud computing. These providers can reduce the time required to provision equipment and deploy new applications and services from months to minutes for the consumer. Cloud computing allows organizations to react more quickly to market conditions and enables the cloud operators to scale up and scale down the provided resources as required by individual customers.

Flexible Scaling: A cloud can be easily and quickly scaled up and scaled-down based on individual customer demand. This appears to the customers as if the cloud computing resources are infinitely expandable. Consequently, cloud service users can independently and automatically scale their computing capabilities without any interaction with the cloud service providers.

Increased Availability: Cloud computing can provide a variety of application availability levels that depends on individual customer policy and the priority of each application. Redundant servers, network resources, and storage equipment, coupled with clustered and redundant software, enable fault tolerance for the entire cloud infrastructure. In addition, the technique of spreading processing over multiple data centers in different geographic regions with identical resource configurations and applications diminishes the potential for data unavailability due to individual data center or regional failures.

Less Energy Consumption: For those organizations concerned with energy and environmental issues, cloud computing enables organizations to reduce power consumption and space usage. Cloud computing further provides services from areas where power outages, tornados and hurricanes, and water shortages are minimized, and energy costs are at the lowest possible levels (Groom & Jones, 2018).

Blockchain Technology:In January 2009, the world witnessed the birth of bitcoin. It is a digital currency, a currency without the need for the traditional banking system. Bitcoin runs on blockchains technology, the blockchain stores, validates, authorizes, and wires digital transactions across the internet. Another name for a blockchain is a “distributed ledger” publicly available for the public to download on the internet. Blockchain transforms the way we trust and exchange value (Darlington, 2021). Blockchain transactions or recorded files cannot alter distributed digital ledgers on the internet. Therefore, each record of transaction stored on the ledger is a “block.”

Theoretical Review

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) was initially proposed by Davis (1989). It comprises two beliefs, the perceived utilities and the perceived ease of application, which determine attitudes to adopt new technologies. The attitude toward adoption will decide about the adopter’s positive or negative behavior in the future concerning new technology. The TAM underpins the study because it predicts and explains ICT usage behaviour, which causes potential adopters to accept or reject ICT use.

METHODOLOGY

Vector autoregression model (VAR) was employed because it makes each variable in the model an endogenous variable, which could impact itself and every other without imposing a theoretical structure on the estimates. Also, the model will afford the study opportunityto analyze the impact of the variables individually.

FTS_t = f(MCTS, AMBS, FBS, IUI)…………………………………(1)

$$FTS_t = a_2 + \sum_{i=1}^{k} b_2 FTS_{t-1} + \sum_{i=1}^{k} d_2 MCTS_{t-1} + \sum_{i-0}^{k} c_2 AMBS_{t-1} + \sum_{i-0}^{k} e_2 FBS_{t-1} ++ \sum_{i-0}^{k} f_2 IUI_{t-1} + U_{t2}$$
…………………(2)

$$MCTS_t = a_2 + \sum_{i=1}^{k} b_2 MCTS_{t-1} + \sum_{i=1}^{k} d_2 FTS_{t-1} + \sum_{i-0}^{k} c_2 AMBS_{t-1} + \sum_{i-0}^{k} e_2 FBS_{t-1} ++ \sum_{i-0}^{k} f_2 IUI_{t-1} + U_{t2}$$
…………………(3)

$$AMBS_t = a_2 + \sum_{i=1}^{k} b_2 AMB\,S_{t-1} + \sum_{i=1}^{k} d_2 MCTS_{t-1} + \sum_{i-0}^{k} c_2 FTS_{t-1} + \sum_{i-0}^{k} e_2 FBS_{t-1} ++ \sum_{i-0}^{k} f_2 IUI_{t-1} + U_{t2}$$
…………………(4)

$$FBS_t = a_2 + \sum_{i=1}^{k} b_2 FBS_{t-1} + \sum_{i=1}^{k} d_2 MCTS_{t-1} + \sum_{i-0}^{k} c_2 AMBS_{t-1} + \sum_{i-0}^{k} e_2 FTS_{t-1} ++ \sum_{i-0}^{k} f_2 IUI_{t-1} + U_{t2}$$

…………………(5)

$$IUI_t = a_2 + \sum_{i=1}^{k} b_2 IUI_{t-1} + \sum_{i=1}^{k} d_2 MCTS_{t-1} + \sum_{i-0}^{k} c_2 AMBS_{t-1} + \sum_{i-0}^{k} e_2 FBS_{t-1} ++ \sum_{i-0}^{k} f_2 FTS_{t-1} + U_{t2}$$

…………………(6)

Where:
FTS = Fixed Telephone Subscriptions
MCTS = Mobile-Cellular Telephone Subscriptions
AMBS = Fixed Broadband Subscriptions
IUI = Individuals Using the Internet

RESULTS AND DISCUSSION

Table 1: Descriptive Statistics

	FTS	MCTS	AMBS	FBS	IUI
Mean	1060.188	5928.188	2384.250	691.6875	2299.750
Median	1160.500	6461.500	1754.500	670.5000	2357.500
Maximum	1261.000	8283.000	5826.000	1178.000	3969.000
Minimum	0.000000	2205.000	0.000000	220.0000	0.000000
Std. Dev.	308.4581	1996.859	2120.552	308.1242	1090.885
Skewness	-2.702489	-0.555787	0.451505	0.116739	-0.298144
Kurtosis	9.994768	1.996548	1.708889	1.805806	2.405112
Jarque-Bera	52.09372	1.495007	1.654930	0.987074	0.472967
Probability	0.000000	0.473547	0.437156	0.610463	0.789399
Sum	16963.00	94851.00	38148.00	11067.00	36796.00
Sum Sq. Dev.	1427196.	59811660	67451121	1424107.	17850467
Observations	16	16	16	16	16

Source: Researchers Analysis using E-View Software 9.0 Version

Table 1 above presented the descriptive statistics for Fixed Telephone Subscriptions (FTS), Mobile-Cellular Telephone Subscriptions (MCTS), Active Mobile Broadband Subscriptions (AMBS), Fixed Broadband Subscriptions (FBS) and Individuals Using the Internet (IUI).The total number of observations is 16 with standard deviations of the variables from the mean ranging from 308.12 to 2120.55. The FBS has the lowest standard deviation of 308.12, while AMBS has the highest with the value of 2120.55. The Table also showed an average of 1060.18 for FTS with minimum and maximum values of 0.00 and 1261.00, respectively. MCTS has a mean of 5928.25 with a standard deviation of 1996.85; the maximum MCTS is 8283.00 and a minimum value of 2205.00. The AMBS for the period has an average of 2384.25 with a standard deviation of 2120.55. The highest value for AMBS is 5826. and the least value of 0.00. The FBS average 691.68 with a standard deviation of 308.12; the maximum and minimum values of FBS for the period are 1178.00 and 220.00 respectively.IUI has a mean of 2299.75 with a standard deviation of 1090.88; the maximum IUI is 3969.00 and a minimum value of 0.00 respectively.

Table 2 Unit Root Results

Variable	ADF Value/P-Value	Critical Values		Order of Integration	
FTS	4.756649/0.0163	1%	5.124875	I(1)	**Stationary at 1st difference**
		5%	3.933364		
		10%	3.420030		
MCTS	4.081697/0.0409	1%	5.1248	I(1)	**Stationary at 1st difference**
		5%	3.9333		
		10%	3.4200		
AMBS	3.5589/0.0438	1%	4.9923	I(0)	**Stationary at level**
		5%	3.8752		
		10%	3.3865		
FBS	3.6289/0.0375	1%	4.9923	I(1)	**Stationary at 1st difference**
		5%	3.8753		
		10%	3.3863		
IUI	4.3232/0.0459	1%	-4.8864	I(2)	**Stationary at 2st difference**
		5%	-3.8289		
		10%	-3.3629		

Source: Author's computation using E-Views Software, Version 9.0

Table 2 above presents the unit root test results using the Augmented Dickey-Fuller (ADF) Test. The variables (FTS, MCTS, AMBS, FBS, and IUI) are stationary at thefirst and second levels as the critical value is significant at 5% and 10% levels of significance, respectively. This showed that the variables are integrated of order zero, one, and two, respectively.

Trend Analysis

The trend analysis revealed that, Fixed Telephone Subscriptions (FTS) slopes downward from the year 2005 to 2018 but sharply declined from 1,000,000,000 to zero in 2020. The Mobile-Cellular Telephone Subscriptions (MCTS) shows that the use of mobile 2,000,000,000 in year 2005 to 8,000,000 in year 2020.It implies that globally the demand for mobile-cellular telephones is on the increase. There is an inverse relationship between the Fixed Telephone Subscriptions (FTS) and Mobile-Cellular Telephone Subscriptions (MCTS). The Active Mobile Broadband Subscriptions (AMBS) and Fixed Broadband Subscriptions (FBS)steadily rise from the year 2005 to 2020. In 2005, ABMS rose from zero subscribers to 6billion in 2020. Also, FBS risen from 200 million subscriptions to 1.2 billion subscriptions in the year 2020.The Individuals Using Internet rises from 1 billion subscriptions in 2005 to 4 billion in 2019.

Cointegration Results

From the result of **Trace Statistic**, the none* and At most 4 *was rejected since trace statistic is greater than the critical value at 5% with p/value lesser than 0.05. Thus, it shows that there is a long-run relationship with variables in the model. From the result of Max-Eigen, it was also observed that the none* and At most 4 * was rejected since Max-Eigen is greater than critical value at 5% with p/value lesser than 0.05, it shows that there is a long run relationship with variables in the model. That is, the variables are cointegrated and have a long-run equilibrium relationship. The cointegration test result is very insightful as it reveals that the variables are cointegrated. Both Trace and Maximum Eigenvalue test results showed evidence of one cointegrating vector. The evidence of cointegration in the series is very welcoming. It, therefore, follows that the variables have a long-run relationship. Overall, the null hypothesis of no cointegration is rejected. Model Estimation Before the estimation of the VAR model, the optimal lag order was determined automatically using various lag selection criteria as shown in the table below:

Table 3 LAG STRUCTURE

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-500.0088	NA	1.21e+23	67.33450	67.57052	67.33199
1	-397.8630	122.5749*	5.20e+18*	57.04840*	58.46450*	57.03332*

Source: Author's computation using E-Views Software, Version 9.0

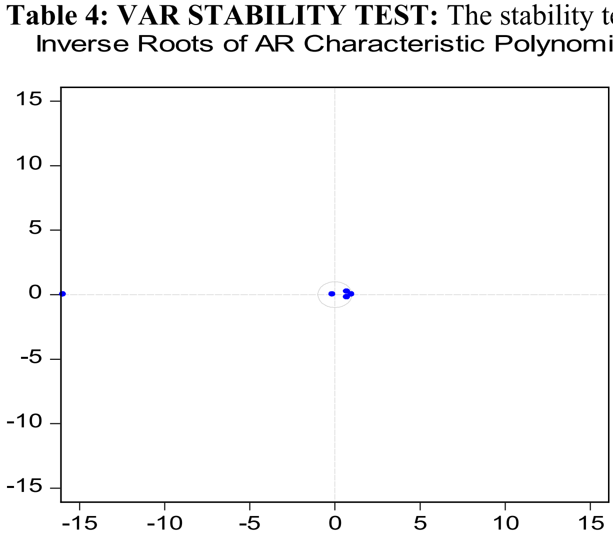
From the result of Trace Statistic and the result of Max-Eigen, the suitable and robust lag structure as selected by the lag length is one. This further indicates the long-run equilibrium relationship among the variables, and optimum lag criteria is selected for the analysis. The result reveals that lag 1 is accepted as the optimal lag for the VAR model. Furthermore, all the criteria such as sequential modified LR test statistic (LR), Final prediction error (FPE), Akaike information criterion (AIC), Schwarz information criterion (SC), and Hannan-Quinn information criterion (HQ) all identified lag 1 as the appropriate lag order. This forms the basis for the estimation of the VAR model.

Vector Autoregression (Var) Analysis

As observed from the VAR estimates (Appendix V refers), the lagged value of the fixed-telephone subscription significantly influences its current value. This indicates that previous fixed-telephone subscriptions can be relied upon in predicting its current value.

The F-statistic (743.1712) maximum indicates that all the regressors are jointly significant in influencing changes in the ICT indicators over the study period. Again, the coefficient of determination (0.997584) reveals that regressors jointly possess high explanatory power as they collectively account for 99.57percent of the overall systematic variations in ICT indicators. This provides appreciable empirical evidence that the model is well-fitted.

Table 4: VAR STABILITY TEST: The stability test for the model is provided in the figure below.



Source: Author's computation using E-Views Software, Version 9.0

As observed from diagram above, all the scatter points are within the circle. This indicates that the coefficients are stable over the study sample. This finding is very impressive as it shows that the model can be relied upon for long tern forecast and policy purposes.

CONCLUSION AND RECOMMENDATION

With a world population of 7.875 billion people and 5.168 billion internet users globally, the human race is confronted daily with changes in technologies and innovation. To need to analyze global ICT indicators and disruptive technologies such as Artificial Intelligence (AI), Big Data Analytics, Robotics, Blockchain Technologies, Cybersecurity, and Cloud Computing that shapes human life and activities worldwide.
ICT indicators are the way to go globally and aligns with schumperian effects of 1936 with the power to eradicate poverty and it affiliates, as linkage for integration and sustainability of the United Nations agenda, expansion of MSMEs, and other financial assistance to the developing ad third world countries with seamless monitoring with the help of ICT related indicators.

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