

ICT Policy Implementation as Correlate for Achieving Educational Sustainability: Approaching Development in Multi ICT Dimensions

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Abstract

The advancement in the national policy with regard to Information Communication Technologies (ICTs) in education has been updated by the demand for consistent and corresponding implementation of national policy on ICT for tertiary education in Nigeria. The policy identified the criticality of ICTs in the fulfillment of the national technology aspirations in the perspective of attaining sustainable development goals. The current research surveyed the level of ICT deployment in Hussaini Adamu Federal Polytechnic in relation to core ICT policy implementation framework and provided justification for the adoption of top ICT infrastructure in the digital-centric academic environment. The survey adopted quantitative research methodology to obtain information from four hundred and twenty respondents randomly selected from four units in the institution. The result of the research indicated that ICTs implementation within the educational management is fundamental to students' academic accomplishment, job satisfaction, productivity, and globalization, becoming unmistakably obligatory for governments, teachers, and management of institutions in the contemporary time to prioritize ICTs and incorporate electronic changes for opportunities in the digital age.

Keywords: ICT Policy Implementation, ICT Infrastructure, Information System, Educational Management, Sustainable Development, E-Learning Education

1. Introduction

The establishment of National Research and Education Networks (NRENs) was to improve education and research quality in the tertiary institutions, through the implementation of the topmost Information Communication Technology (ICT) strategic and action plan (Azene, 2019), which also had led to the formation of Nigerian Research and Education Network (NgREN), like every other Research and Education Networks (RENs) world-wide (Okewu and Daramola, 2017). The necessity for an enterprise network within every institution exists to connect education and research institutions directly using high-speed fiber optics, switches, servers, routers, and high-capacity radios to establish connectivity, using cutting-edge monitoring software with the purpose of integrating all of the country's research and educational institutions through an innovative digital hub in order to respond to education and research resourcefulness (Chohan and Hu, 2022). As a matter of fact, the NgREN will provide a nationwide framework for interconnected campuses, interconnecting additional Regional Research and Education Network (RRENs) backbones, which will further connect on a global knowledge repository (Bankole and Assefa, 2017). Over 100 nations have developed RENs, with more than 20 in Africa, and NgREN is the first operating REN in West and Central Africa (Chergarova, 2020).

The achievement of the country's aspirations for the Sustainable Development Goals (SDGs) is dependent on education fueled by ICT innovation and Science and Technology Education (Hoang, Nguyen, and Le, 2022). The ICT is a branch of Information Technology (IT) which emphasizes the need of integrated data transmissions via telecommunication media such as telephone lines, wireless signals and computers, together with all the necessary enterprise software platforms, middleware, storage and audiovisual contents, that enable users to access, collect, communicate (Githinji, 2022). The 21st century pedagogical skills concentrated primarily on making information sharing and knowledge networking available and ensuring that ideals, digital consumables and knowledge are used in the smartest way possible, because the current generation of digital natives have access to an infinite amount of digital information at the tip of their fingers (Gómez-Poyato et al., 2022).

In the current study, the assessments of ICT policy implementation in education were measured in the four areas of Hussaini Adamu Federal Polytechnic which include Academic Division, Centre for Information Communication Technology otherwise referred to as ICT Directorate, Library Information Service Unit (LISU) and Central Administrative Command (CAC), in accordance with the Ministerial Strategy Plan for the Education Sector, the

National Information and Communication Technology Policy, the National Information Technology Education Framework and the National Policy on Education (2016-2019). The level of ICT implementation and its overall achievements in Hussaini Adamu Federal Polytechnic was assessed in a manner to recommend the degree of support demanded to compel the top ICT initiatives for sustainable development in the institution. As a matter of fact, the ICT policy implementation as correlate for achieving educational development in Hussaini Adamu Federal Polytechnic was evaluated.

The research is thematically organized into an introduction, literature review, institutional ICT democratization, proposed ICT theory, objectives of the study, research questions, research design & methodology, research implementation, discussion of findings, factors affecting ICT policy integration, benefits of the REN, NRENs, and NgREN, recommendations, and conclusion.

2. Literature Review

The national policy on ICT in education is a development towards attainment of SDGs as the deployment of ICT in education symbolized an infrastructural adjustment and gateway to globalization (Sarangi and Pradhan, 2020). The establishment of essential ICT infrastructures and services such as NgREN that interconnected 27 universities in Nigeria with a hub at the NUC symbolized the opportunity for ICT ascendancy in education (Faborode, 2016). The campus networks, the functional websites, email facilities and portals for the ministry and schools, data centers in the ministry and in schools, the computers and other multimedia facilities, the internet connectivity through Very Small Aperture Terminal (VSAT) and fiber optic in all institutions, the alternative power supply such as solar panels, generators, inverters and renewables, Closed-Circuit Television (CCTV) cameras for security and safety of the education environment are all aspects of ICT policy mechanism (Mwiinga, 2017). Among the primary ICT policy achievement were the introduction of electronic learning (e-learning) and the use of ICT to remote education and massive open online learning at all levels. The contemporary information revolution, combined with the growing impact of ICT, has reshaped education and research practice across higher education institutions, providing hardware and software support that have allowed the society to create, collect, consolidate and communicate information in multi-modal formats for various purposes.

The Nigerian Education Management Information System (NEMIS) was established at the federal level to meet the need for a data repository for the entire education sector in Nigeria (Ekpoh and Asuquo, 2020). The digital connotation transcended into the creation of the State Education Management Information System (SEMIS) and the Local Government Education Management Information System (LEMIS) for data collection, storage, integration, processing, maintenance, and dissemination (Acharya et al., 2022). The enterprise data warehouse technology integration that promoted REMITA generation, account notification, validation, admission and backend authentications for national examinations (JAMB, NECO and NABTEB) have added to the mix of the ICT governance in the Nigeria educational automation. The government's efforts to establish ICT infrastructure through the national virtual digital library initiative and the NgREN are noteworthy, as they have resulted in the promotion of Nigerian librarians' ICT potency (Salau et al., 2020), (JONES and ESQ, 2022).

3. Institutional ICT Democratization

ICT democratization refers to the process by which a wide range of technical and non-technical citizens get access to innovations through communication technology gateways as infrastructure (Singh, Kumar, and Kumar, 2022). In order to facilitate effective educational involvement, ICTs are integrated into networks and services that have an impact on the accumulation and flow of public and private information and knowledge on a local and worldwide scale. The Internet service provision, telecommunications equipment and services, information technology equipment and services, media and broadcasting, libraries and documentation centers, commercial information providers, network-based information services, and other related information and communication activities are all covered by ICTs in accordance with the “United Nations Economic Commission for Africa” (Rothe, Van Audenhove, and Loisen, 2022), (Jambal and Jambal, 2022). The terms ICTs and IT are used interchangeably and broadly, though ICT is associated with the field of education while IT is associated with the field of computers, software and telecommunication networks (Akpan-Obong et al., 2022). The IT automation refers to information processing interactions between information suppliers and users, as well as the development and implementation of information-processing technologies that aren't necessarily related to educational development.

It is noteworthy that the majority of nations in the world now offer ICT teacher training in a range of formats and levels after realizing how crucial ICT is to both teaching

and learning in the twenty first century digital electronic society. It has always been, and will continue to be, of utmost importance to all humanity that ICT-based development ought to be pursued. The relationship between education and technology is currently changing dramatically, especially in the areas of the IoT , Information Centric Networking (ICN) for universal Internet access for education, big data, ubiquitous learning, and emerging technology for educational pedagogies (Barakabitze et al., 2019). In this study, ICTs primarily refer to the internet infrastructures and mobile electronic devices, but they may also refer to hybrid solutions, such as the use of traditional media such as newspapers, radio, digital media, and television in conjunction with technologies merely providing novel approaches of dealing with an already existing resource, namely information, whether codified or untapped for public consumption and societal enlightenment. The establishment of NRENs offers endless opportunities for boosting learning quality and promoting sound research outputs within the academic institution in attainment of corporate developmental goals (Manhibi, 2019). In a similar development, in order to connect Europe's national research and education networks with a high-bandwidth, high-speed, and highly resilient pan-European backbone, connecting Europe's researchers, academics, and students to each other and to the global community, the Gigabit European Academic Network (GEANT) was created (Ricart et al., 2020).

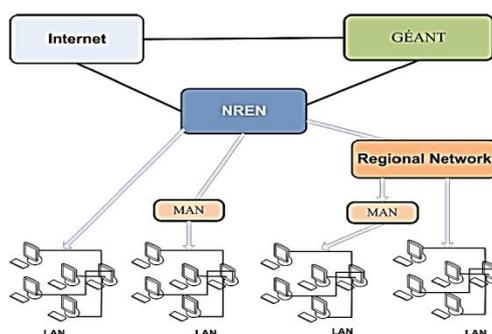


Figure 1. Development of National Research and Education Networks (NRENs) for networked academic and educational institutions (Zennaro et al., 2020)

With reference to Fig. 1, the establishment of NRENs or networks of academic and educational institutions, have fueled the global expansion of the Internet infrastructures, which had necessitated the implementation of top ICT policy, being established in Africa (Zennaro et al., 2020). On the African continent, successful and sustainable NRENs have enabled a number of educational and research institutions to benefit from enhanced Internet connections, collaborate globally and access essential e-resources for teaching and research (Mwale and Chita, 2020). The current efforts are to enable creation of long-term NREN that

concentrated on the offering of technical and services-oriented solutions while focusing on the business model and financial plan. The strategies that have succeeded elsewhere on the continent should be reinforced in order to advance NRENs into being dynamic and sustainable.

4. Proposed ICT Theory

The Actor-Network Theory (ANT) was used to evaluate the existing ICT policy implementation in education infrastructure in line with NRENs services and NgREN in order to establish whether a reliable network reinforcement as ICT policy instrument has increased the quality of education and research output in Hussaini Adamu Federal Polytechnic (Azene, 2019). The premise that everything in the social and natural worlds is related through dynamic networks of links that have aided in the evolution of organizations and individuals in multi-user environments forms the basis of the theoretical and methodological approach to social theory known as ANT (Mifsud, 2020). The world, according to ANT, is made up of networks that comprise of things, ideas and people. Actors within the network are terms used to describe all these networks and its activities (Matthews, 2021).

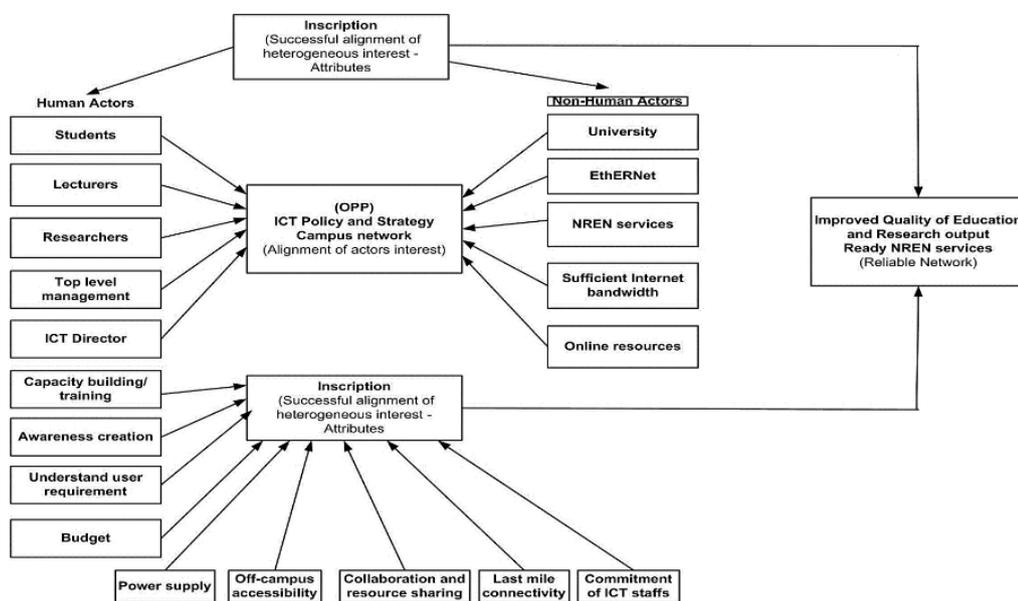


Figure 2. The Proposed ANT Model for ICT Adoption (Azene, 2019)

The proposed ANT model is shown in Fig. 2. As a matter of fact, more actors should be involved in developing the service portfolio and roadmap. The ANT approach does not place a premium on social or technological factors, which is similar to the situation in the case study, where social structures and technological issues are linked. The ANT will

constantly highlight the interpretative flexibility of information technology and systems, in the sense that seemingly similar systems create significantly different outputs in different neighborhoods as a result of specialized translation and network-building processes (Matthews, 2021). In general, the findings of the study revealed a wide range of needs for numerous technologies and services utilized in education and research that Hussaini Adamu Federal Polytechnic can adopt.

5. Objectives of the Study

- To investigate the amount of ICT educational infrastructure support required by the institutions, as well as the manpower requirements within Hussaini Adamu Federal Polytechnic education system.
- To determine the factors that militate against ICT policy adoption in Hussaini Adamu Federal Polytechnic educational institution.
- To evaluate the influence of ICT policy implementation on the quality of education at Hussaini Adamu Federal Polytechnic.
- To look into both positive and negative aspects that influence the implementation of the ICT policy framework in Hussaini Adamu Federal Polytechnic, in order to improve educational quality and research output.
- To assess how the ICT policy framework can be used to integrate the effectiveness of the science and technology education at Hussaini Adamu Federal Polytechnic.
- To learn how the ICT policy initiative can be used to deliver services in addressing challenges of quality education and research output in Nigeria, with a focus on Hussaini Adamu Federal Polytechnic.

6. Research Questions

- a. What are Nigeria's visions for implementing ICT policies in tertiary education for teaching and learning?
- b. Are those visions expressed in policy guidelines?
- c. In terms of access, infrastructure, and human resource development, what steps has the government suggested and undertaken to integrate ICT in tertiary education?

- d. What ICT tools are accessible in Hussaini Adamu Federal Polytechnic for teaching and learning and further infrastructure development?
- e. What are the educator's ICT background, as well as the ICT dispositions of the teachers?
- f. What are the barriers to ICT integration in teaching and learning in Hussaini Adamu Federal Polytechnic's tertiary education?

7. Research Design & Methodology for the ICT Policy Framework

The current research analyzed various ICT championed educational infrastructures that are implementable along innovative technology paradigm. The widespread use of Platforms as a Service (PaaS), Infrastructures as a Service (IaaS), and Software as a Service (SaaS) has brought attention to the importance of organizational automation for 21st century business automation. The members of the academic community, which include professors, lecturers, students, teachers, and researchers, have benefited greatly from the adoption of cloud technology infrastructures. The virtual infrastructure required for deploying and operating software applications and operating systems on cloud platforms was made available to educational institutions through these technology-mediated infrastructures as a service.

The current study used a quantitative research approach with a random sample population of workers from the Hussaini Adamu Federal Polytechnic's Centre for Information Technology (CIT) Directorate, Academic Division, Central Administrative Block, and Library Information Service Unit. The data were collected by handing out a set of questionnaires to 500 randomly selected employees from the institution's aforementioned four units. There were two portions in the questionnaire, each with single and multiple-choice questions. The first component was about demography, which were used to gather personal data from the respondents. Section two questions focused on the basic ICT policy framework, ICT infrastructures, mobile computing technology devices, and Cloud Internet of Things (CIoT) implementation, as well as the types of activities they were employed for in the academic environment and to achieve educational goals. The survey collected information on the proposed Management Information System (MIS) implementation, e-learning instructional design, organizational ICT infrastructure development and IoT infrastructure for educational activities aimed at increasing students' learning skills and academic achievement. Out of the 500 questionnaires issued, 420 were returned to the researchers, representing an 84

percent response rate, a very positive figure for this type of survey. The data were meticulously analyzed and presented using descriptive statistics.

Table 1. Questionnaire distribution on the ICT Infrastructure Development in the four Units of the Institution (Survey 2021)

Institutional Unit	No. of Questionnaires Distributed	No. of Questionnaires Retrieved	% of Questioners Returned
ICT Directorate	115	90	78.3 %
Academic Directorate	140	125	89.3 %
Central Administrative Unit	122	105	86.1 %
Library & Information Services	123	100	81.3 %
Total	500	420	84 %

The distribution of questionnaires and the proportion of each category recovered are shown in Table 1. Although more questionnaires were delivered to some unit depending on the extent of digital characterization and personnel population of the institution, the Directorate of Academics received the greatest percentage of the questionnaires. With an average proportion of 89.3%, Directorate of Academics eminently received the most responses. This demonstrated the respondents' readiness and enthusiasm for achieving an advanced digital future for education, including innovative teaching and cloud infrastructure investment. Central Administrative Unit comes second with an 86.1% proportionate response rate, followed by Library & Information Services (81.3%) and ICT Directorate (78.3%).

Table 2. Institutional ICT Infrastructure Development (Survey 2021)

Institutional ICT Infrastructure	Mean Distribution	Categorization
Cloud Data Warehouse/ Server Systems /MIS	3.85	1
Campus Inter-networking	3.89	2
Centre for Information Technology (CIT)	3.45	4
Wireless Digital Access Solutions	3.44	5
Internet Broadband Data Communication	3.74	3
Electronic Learning Platforms (Learning Management Systems-LMS)	3.11	6
Digital Library automation	3.85	1

Table 2 display the availability of IT infrastructures to be implemented in the institution as investigated in the current study to enable top ICT policy diffusion. Computers and servers in the CIT Centre, as well as multimedia digital library, are the mostly prioritized

instructional ICT tools, with a high-pitched mean of 3.91. Campus Networking and Internet Broadband Communication are the next highest ranking Institutional ICT capacity development infrastructures, with mean values of 3.69 and 3.65, respectively.

8. Research Implementation

Multi-dimensional ICT policy reinforcement were considered in incremental business decision rule that entails making minor changes to the existing infrastructures and services through improving specific recommendations. Nowadays, a lot of academic institutions and businesses don't have to own or manage their own servers; they can instead host their services on external cloud infrastructures. The workload is connected to the cloud destination by transferring the company's or institution's apps and data from local data storage to cloud services like Equinix hub via a dedicated confidential line inside the account set up for Equinix cloud exchange server. The necessity for the cloud Internet of Things (CIoT), real-time analytics, data collecting, data security, data protection, data compliance, and efficient usage of business indispensable data wherever users are situated around the globe, will normally be authorized by the data hub (Refer Fig.3 and Fig.4). Customers will always have access to business identity management features via the Equinix Cloud Exchange portal, an IoT web-based solution, via the Equinix Cloud Exchange Application Programming Interface (API). Customers can easily set up third-party cloud facilities for their automated multi-cloud connectivity and utility services to achieve business computing performance even if they lack the internal capacity or technical know-how to create cloud APIs (Bhardwaj et al., 2021).

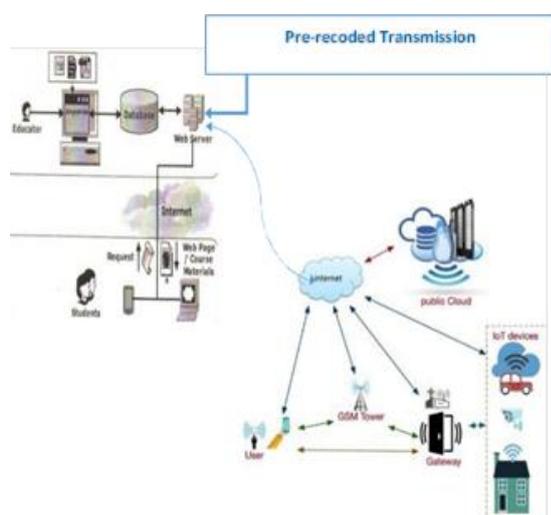


Figure 3. Enterprise E-Learning Education Environment on Cloud IoT Infrastructure (Matthew, Kazaure, and Okafor, 2021)

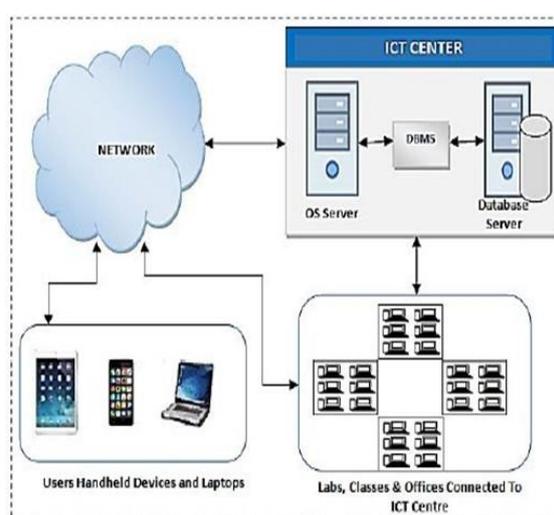


Figure 4. Management Information System (MIS) Infrastructure Development (Gumel, Abdullahi, and O, 2019)

9. Discussion of Findings

Table 2 indicates the existence of multi-dimensional IT infrastructures requirements in the various capacities within the institution as studied. The cloud data warehouse servers in the CIT Centre that hosted the Management Information System (MIS), as well as the Digital Library server generated the high-pitched mean of 3.91. With reference to Fig.5, the institutional ICT capacity development facilities that rank second and third highest, with mean values of 3.69 and 3.65, respectively, are campus networking and broadband internet communication. Organizational system wireless digital solutions and digital e-learning platform (LMS) are the least considered IT infrastructures, with mean values of 3.34, and 3.10, respectively. The entire respondents' cumulative mean for IT infrastructure investment was calculated to be 25.01.

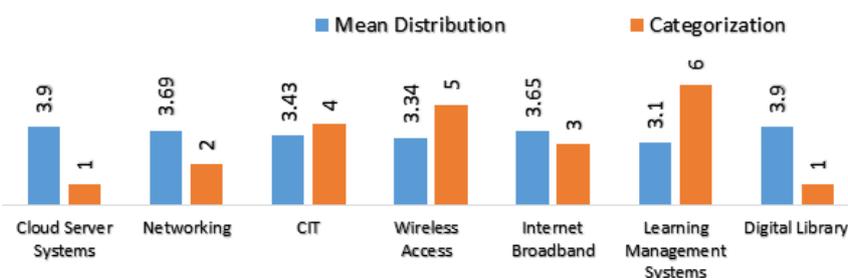


Figure 5. Institution ICT Infrastructure Development

The current research findings not only backed up the original framework's determinations, but also added additional ones, such as management support, classroom setup, course-related characteristics, and students' ICT competency and infrastructure access. When instructors decide to integrate technology into the classroom, the current research found that they seek support, reinforcement, and assistances from the management organ of the institution (St-Onge et al., 2022). Above all, the managerial organs are expected to organize training, set aside adequate funding, and provide users with proper ICT resources such as computers and broadband internet access. Without managerial support, end users may face too many obstacles, because management helps to mandate the ICT policy road-map for the institution's digital development. The usage of ICT policies vary by class, by academic subject, and even between academic disciplines. The recent study conducted by Mercader and Gairín in 2020, specified that impediments are constantly observed in the technology mediated classroom management which might lead to low levels of ICT adoption. The findings of this study also showed that instructors value students' perspectives as factors of consideration in ICT policy adoption. Despite the fact that the primary focus of this work was

on instructors' ICT use, instructors stressed the importance of considering students' circumstances and digital learning peculiarities. If there is no conducive environment for students to use ICT for learning, instructors will find it difficult to integrate ICT into their teaching in a meaningful way. Students, like instructors, require the appropriate level of knowledge, attitude, support, and ICT infrastructures for meaningful academic engagement (Ferede et al., 2022).

10. Factors Affecting Integration of ICT in the Institution

Having consulted from wide perspectives, the current research articulated the following challenges as the impediments in the implementation of the ICT policy framework within the educational institutions.

Cloud Server Service Charges: The cost of hosting the organizational data warehouse server, LMS for online education hosted on cloud servers, as well as infrastructures for ubiquitous computing and education, are considerably significant. The cloud service providers bill institutions, schools, and people based on their service use capacity which in most cases are considerable.

Bandwidth Subscription: Cloud data-based warehouse server systems and e-learning management system activities will necessitate Cloud internet servers to be able to access data services linked to the availability of internet service and bandwidth subscription.

Digital Security: ICT enabled infrastructure, LMS, e-learning material, and cloud data warehouse infrastructures all require security mechanisms. User identification, digital signatures, privacy policy setups, and confidentiality determining apparatus are all included in the e-learning system. The confidential data properties, on the other hand, are packaged and encrypted during deployment and stored on the data warehouse cloud servers, although they can be penetrated in most circumstances.

User idea and digital competency (digital & knowledge divide): Enterprise Cloud data warehousing technologies, as well as its accompanying infrastructures, IT service delivery usage patterns, and digital learning platforms, have all strayed significantly from traditional classroom computer technology usage scenario (Alexander, 2020). As a result, this new configuration will have an impact on end-user attitude and acceptability of future cloud-based digital learning implementation. The main solution to this type of challenge is to develop

effective case models for cloud-based e-learning and to promote wide application adoption in order to reach a larger user population.

Educational Dynamics: The persistence of traditional educational systems and their management is one of the major challenges faced by e-learning education technology. The advent of e-learning educational technology does not entirely undermine the value of teachers' commitments to traditional classroom management; rather, it gives teachers the flexibility and freedom to design a new electronic smart digital environment for student interaction. The management and operations of cloud-based e-learning systems will require teachers' involvement in the smart electronic classroom of the twenty-first century.

Resources Development and Capacity Building: All parties concerned must work together to construct, install, and set up the educational environment. Teachers and other educational experts will need to get involved in the resource development process in order to make sure that learning resources combine scientific dynamism with social engagement and synergy.

11. Benefits of NRENS, REN, NgREN and Multi-ICT Dimension

On the account of numerous benefits of the REN, NRENS, and NgREN to the universities and tertiary institutions in general, and the library in particular, every ICT driven institution is expected to be at the vanguard of the determination for complete integration of the REN in their respective institutions.

- To begin with, having a fully operational research and education network in the tertiary institution would imply that the library and its users would have access to the collective resources of all other institutions connected to the REN. All digital contents and e-books in each member institution's library, as well as all published works (including multimedia instructional content, project reports, thesis, dissertations, journals, and other articles) in those institutions, are accessible.
- As a disaster recovery mitigation, the e-contents of the library might be backed up to an offsite location using the NgREN's storage area network technology.
- Subscriptions to other e-resources are also available for the library through the REN, which might be bought at a significantly lower cost if resources are pooled together by connected institutions.

- Another significant benefit of the REN to connected institutions and libraries is the availability of low-cost, long-term Internet bandwidth obtained through resource pooling. This is due to the benefit of purchasing in bulk and pooling resources once again. As a result, better bargains at unbelievable prices are available.

12. Recommendations

The recommendations are summarized as follows:

- According to recommendations from the United Nations Development Programme (UNDP) and the United Nations Educational, Scientific and Cultural Organization (UNESCO), the Nigerian government should increase its budgetary contribution to education from less than 15% to approximately 26% (Obadahun, Kadir, and Abu Bakar, 2022).
- There should be a commitment to closely monitor funds allocated to the educational ministry in order to prevent mismanagement, embezzlement, and diversion.
- For the educational sector, a rating performance indicator should be devised to aid in monitoring progress as needed.
- Better working environment for teachers is required. This would aid in reducing the present brain drain in the educational sector and attracting more qualified personnel to assist boost the sector's productivity and the overall economy.
- Creation of an internet infrastructure using the digital grid to permit connectivity and radio frequency transmission throughout every tertiary institution environment is needed.
- When using mobile computing devices, students and lecturers should use suitable phones and software that allows them to access a wide range of online resources.
- Today's students are primarily young and active on social media; they have a lot to achieve through the use of social media in communication updates; librarians can easily pass along announcements of new acquisitions and even send remote login credentials for students both within and outside the library.
- There should be ICT democratization that will enable all teaching staff to own a laptop computer system to enable educational oriented service improvement.

13. Conclusion

In this study, evidence on the implementation of ICT policies as correlate for achieving educational sustainability in higher education in Nigeria has been gathered. The paper developed a conceptual framework based on multi-dimensional ICT policy implementation and categories: institutional, infrastructure, and individuals based on the literature review and survey. The findings from the investigation largely supported this proposed conceptual framework in the hypothesis, objectives, and research questions. The findings suggested that the factors influencing academic ICT use are not solely related to the instructors and their institutions, rather a top-down policy reinforcement and developmental approach. This work covers a wide range of topics, including government policies on technology and infrastructure, institutional ICT policy framework and dispositions, student, and course management. One among the very important keynotes from the current study is that understanding the causes of educational ICT use in higher education requires looking at it from the perspectives of management, academia, and student's engagement. Another takeaway from this study is that ICT determinants are complex, and educational ICT used programs and initiatives in Nigerian higher education must be personalized, holistic, and methodical in order to meet the identifiable aspiration. The current study has ramifications for future research as prerequisite to understanding institutional ICT policy peculiarities across organizational settings. This concept means that, in order to have a good predictive capacity for academic advancement, it is necessary to identify the ICT infrastructure usage with the most determinants in an organizational environment. In order to calculate the impacts of each of the discovered determinants, it seems appropriate to undertake a follow-up quantitative analysis of the determinants using statistical techniques. Future research should include a larger sample of tertiary institutions and supplement teachers' perceptions with evidence gained through longitudinal observation.

Conflict of Interest: There is no conflict of interest regarding this research work.

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