

An Evaluation of ICT Infrastructure and Application in Nigeria Universities

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Abstract: The need for adequate ICT infrastructure/facility in higher education institutions cannot be overemphasized, even as availability and utilization of these facilities are at times the indices for rating universities. In this descriptive survey study, ICT infrastructure and the extent of usage in Nigeria universities were investigated. Questionnaire was the instrument used for gathering information and based on related literature. A total of 452 respondents comprised of students, lecturers and administrators randomly selected from a total of 15 universities from different regions of Nigeria participated. Data collected were analyzed using mean statistic analysis and analysis of variance (ANOVA).

Keywords: ICT; Infrastructure/facility; Nigerian Universities; Application

1 Introduction

Information and communication technology (ICT) is the convergence of communication, information and media technologies, which are based on the common digital technology [1]. ICT infrastructure/facility can be described as electronic device, equipment, or tool used for collection, processing, storage, retrieval or transfer of information, and its associated services. ICT infrastructure

refers to the hardware or equipment, software applications, and services associated with ICTs, including telecom networks. Akinsola *et al.* [2] stated that, ICT infrastructure could be categorized into hardware, which comprises telephone, computer, LAN network, hub, printer, scanner, television, fax, codec camera, projector, radio, Video CD, audio tape players and microphone, software that includes windows, Ms Office and others. ICT infrastructures comprise even the earlier technologies such as radio and television.

The principal device for processing, storage or retrieval of information is the computer. When two or more of these computers are interconnected, they form a network, and can intercommunicate and exchange information. The value of these computers to business, researchers, government and individuals actually increases greatly when they are so connected into networks. Networked computers can transmit voice messages, alphabetical and numerical data, and video over communication media.

Connections of computers into networks are of different categories depending on the needs of an organization. Local area networks join computer at a particular site, or within a small geographical spread, such as an office building or an academic campus. On the other hand, wide area networks interconnect computers and small networks to larger networks over greater geographic area, including different continents. In this category of networks, the computers, or smaller networks are linked by means of communication medium such as cables, optical fibres, wireless links, or satellites. Access to the networks is via a modem, a device that allows computers to communicate over telephone lines.

The largest wide area network in the world is the internet, a collection of networks and devices linking millions of computer users all over the world. This is a product of merged technologies of computer, computer networks and communication, and also the basis of modern day ICT infrastructures. Communication technologies include cable, satellite, fiber optics and wireless links. Network technologies include personal area network (PAN), campus area network (CAN), intranets, Extranets, LAN, WAN, and the internet. Computer technologies include disks, flash memories, multimedia projectors, interactive electronic boards, and personal computers [3]. Services and resources associated with both modern and the earlier technologies include distance/E-learning, videoconferencing, E-library, E-mailing, the web etc.

Computer provides easy and efficient means of information processing, storage and retrieval making clerical and general administrative duties interesting. In higher education institutions, common ICT infrastructure and services are usually computers, the internet, and services related to the internet. Computer networks interconnect computers in the university for easy communication, sharing of resources, and collaboration among students and lectures. E-learning makes education available even to remote positions and teleconferencing/videoconferencing enables transfer of services of experts from

other universities. Additionally, the internet makes information search and access to variety of information easy. All these mean that in higher education institutions, common ICT infrastructure and services are usually computers, the internet, and services related to the internet and they have obviously important impact on the activities conducted. Additionally, the extents to which an institution can provide all the necessary ICT facilities are a measure of the status of the institution.

Unfortunately, Nigeria universities are still grappling with the problem of inadequate ICT infrastructure. According to Philip [4], tertiary institutions in Nigeria lack adequate infrastructure to effectively tap into the opportunities offered by the cyberspace. Computers are not enough for students use in most Nigeria universities very few of which have campus-wide network. The internet facilities are non-existent in many campuses. Moreover, where they are available, they are plagued by one problem or another, including low access speed, insufficient computers for users, poor power supply etc. Under these circumstances, it could be necessary to examine ICT infrastructure issues in Nigeria higher education institutions. This study is therefore undertaken to evaluate the ICT infrastructure/facilities and applications in Nigeria universities.

The remainder of this paper is organized as follows: the study on the existing literature is given in Section 2. The methodology used for this study and the results are summarized in Section 3 and 4. A discussion on findings of the results is in Section 5. Lastly, the conclusions drawn are the last section of the paper.

2 Literature Survey

According to Adomi and Kpangban [5], the new partnership for African Development (NEPAD) launched e-schools initiative, intended to equip all African schools with ICT facilities, including computers, radio and television sets, phones and fax machines, scanners, digital cameras and copiers among others and to connect the students to the internet. He stated that the aim of the initiative was to impart ICT skills to young Africans in schools and noted that although efforts have been made to ensure that ICTs are available and used in Nigeria schools, the level of uptake is still low.

Philip [4] observed that tertiary institutions in Nigeria lack adequate ICT infrastructure to effectively tap into the opportunities offered by the cyberspace. He stated that personal computers are available in most Nigeria tertiary institutions, but they are not readily accessible to students because of the low computer to student ratio, put at about 1 to 40. In addition, the basic software needed for practical works are not available and where they are available, they are not accessible because of the low ratio. It was remarked that for internet connectivity in most tertiary institutions in Nigeria, the bandwidth subscribed is

too small to support any meaningful activity during peak period. He also noted that, where ICT infrastructures like multimedia projectors are available, other infrastructures like interactive whiteboards are lacking.

Anunobi and Edoka [3] examined the use of ICT facilities in Nigeria University Libraries and discovered that personal computer, photocopiers and CD-Rom were the ICT facilities mostly used in serial units of the universities. Other facilities identified were printers, LAN, scanner, fax machine and the internet. It was identified that none of the libraries used E-mail or WAN facilities in the serials unit. But noted, however, that many serials operations are performed with ICT facilities outside the serials units.

Osofisan and Osunade [6] evaluated the ICT services available in educational and research institutes in Nigeria. It was observed that, in most of the educational and research institutes surveyed, ICT infrastructure had just been put in place. Although, there were computer systems available for many years, but their use was limited to only word processing. The authors stated that the drive in most of the institutions was on internet service. The study revealed equipment and services available in the institutes and universities to include printers, scanners, LAN, Email, the internet, websites, intranet, telephone. It was found that there was no WAN connectivity between any two educational or research institutes in Nigeria. The study also revealed that not all the institutes had websites, and those who had did not update them regularly and the content present on most of the websites were not useful to researchers.

Akomolafe [7] investigated the strategies and challenges of ICT infrastructure development for university education in Nigeria. He stated that available infrastructure for ICT in most Nigeria universities were grossly inadequate. He identified that most university students still visit the internet off campus because of too much demand on the internet on-campus. Respondents indicated that computers available for internet browsing were inadequate to meet the demand for its usage. He observed that much attention was given to computers and the internet while other ICT infrastructures such as CD-ROM, radio, tape, television, mobile phones and others were lacking and that the level of awareness on the extent to which ICT could be useful in education was still low, noting that many lecturers were not conversant with ICT usage in classroom situations.

Kumah and Tanye [8] sought the views of tertiary institution students on ICT usage in Ghana. He stated that Ghana's public universities' ICT growth was lagging in comparison to the country's business usage. It is worth noting here that the use of ICTs, such as the interactive whiteboards, was increasing in a number of lecture halls. Email was used by most students, but it was limited to their personal communication with friends and family members. It was stated that most lecturers do not engage their students in the use of ICT for academic purposes.

Cheah et al [9] examined the key aspects of ICT infrastructure in three selected universities in Singapore. And discovered among others that,

- The universities were linked up and fully networked within the campus using wired and wireless LAN. All computers in the universities are networked and the campus-wide network extends to halls of residence, graduate housing, laboratories, libraries, tutorial rooms, staff offices etc.
- All the campuses have internet access with improved bandwidth.
- E-mail accounts were provided to their students for communications amongst staff and students.
- Each faculty staff or administration staffs is provided a computer.
- Many computer laboratories were provided within the campus with the computers normally equipped with specialized software for teaching and learning purposes.
- Every tutorial room and lecture theatre was equipped with proper audio-visual facilities, a computer connected to the internet, a projection system, videoconferencing facility used to connect to international organizations for collaboration, research and meetings, etc.

The findings of Cheah et al [9] are from a well-developed country. The findings of the others [3-8] represent the reports from developing countries and in particular Nigeria [3-7] and Ghana [8]. Studies and views on ICT in Nigeria education mostly dwelt on the aspects of availability/use of modern ICT tools. No study found in literature covered the general area of ICT facilities and their associated services/resources. There were also no efforts to determine the exact extent to which these facilities, services or resources are applied in Nigeria universities. The present study therefore seeks to fill these gaps located in literature, and possibly broaden the views on ICT.

3 Methodology

The major purpose of this study is to evaluate the ICT infrastructure and applications in Nigeria higher education. For this purpose, this study will first attempt to answer the following research questions.

- 1) What are the ICT infrastructure/facilities utilized in Nigeria universities?
- 2) What is the extent of ICT application in Nigeria universities?
- 3) What are the most utilized ICT facilities in Nigeria universities?

The results are expected to guide policy makers and provoke the university administrators and stakeholders on ensuring adequate provision of ICT facilities.

It will then investigate the statistical relationship in the mean responses of respondents in the study using the following null hypotheses.

Ho₁: *There is no statistical difference in the mean responses of students, lectures and administrators on the ICT infrastructure utilized in Nigeria universities.*

Ho₂: *There is no significant difference in the mean responses of students, lecturers and administrators on the extent of ICT application in Nigeria universities.*

A descriptive survey approach is more appropriate for this study since it focuses on people, facts about people, their benefits, opinions, attitudes, motivation and behaviour and seeks the opinions of the respondents. A descriptive survey was considered most appropriate for this study because it sought the relationship among factors regarding use of ICT in Nigeria universities.

The study was carried out in the North Central, South East and South-South regions of Nigeria. These areas were chosen because they have a good number of universities for such study. The population of the study comprised students, lecturers and administrators in these universities. The students, lecturers and administrators of the universities were chosen because they are in the best position to provide the required information on ICT infrastructure/facilities and application in Nigeria universities.

A total of 480 respondents were randomly selected from a total of 15 universities. Each university is represented by 20 students, 10 lecturers and 2 administrators in the sample.

A questionnaire was developed based on a review of related literature and used as the research instrument for this study. The questionnaire has three sections. Section A was used to collect general information about the respondents. Section B has 17 items (1-17) intended to elicit information on the ICT infrastructure/facilities utilized in the universities (Research Question 1). The items were structured on a two point rating scale with response options of; Utilized, Not utilized. Section C has 17 items (18-34) which sought information on the extent of ICT application in the universities (Research Question 2). The items were structured on a five-point likert rating scale with response options of: Always, Oftentimes, Sometimes, Rarely, Never.

The instrument (questionnaire) was validated by three experts from the Computer Science Department of a university in Enugu State of Nigeria. They were to examine the questionnaire items for clarity and suitability for use in collecting data for the study. The observations and suggestions of these experts improved the instrument.

The reliability of the instrument was determined by a pilot test for the instrument administered on 20 respondents comprised of 12 students, 6 lectures, 2 administrators from university outside the zones used for the study. Cronbach alpha reliability was computed for testing the internal reliability from the responses using statistical package for social sciences (SPSS). The reliability coefficient was 0.86 indicating that the instrument was reliable for the study.

The instrument was administered during visits to the universities and 452 copies of the questionnaire, out of 480 copies administered were retrieved and used for the study. That represented 94.2% return rate. They were all found useful.

The research questions were analyzed using mean statistics. This means in each of the response items, the mean score of the item is computed and interpreted based on its boundary limits Table 1 and Table 2).

In other words, for research question 1, a mean score on an item statement that was equal to or greater than 1.50 (≥ 1.50) was accepted as utilized, while a mean that was equal to or less than 1.49 (≤ 1.49) was accepted as not utilized (Table 1).

Table 1
Response options with points and boundary limit

<u>Response option</u>	<u>Points</u>	<u>Boundary limit</u>
Utilized	2	1.50 - 2.00
Not utilized	1	0.50 - 1.49

Similarly, the decision rule for the research question 2 is: a mean score on the item statements that was equal to, or greater than 3.50 (≥ 3.50) was taken as often times applied while a mean that was equal to, or less than 3.49 (≤ 3.49) was taken as rarely applied (Table 2).

Table 2
Response categories with points and boundary limit

<u>Response options</u>	<u>Points</u>	<u>Boundary Limit</u>
Always Applied	5	4.50 – 5.00
Often times Applied	4	3.50 – 4.49
Sometimes	3	2.50 – 3.49
Rarely	2	1.50 – 2.49
Never	1	0.50 – 1.49

The relationships were investigated based on research hypotheses. In other words, one-way analysis of variance (ANOVA) test was used to determine if the students, lecturers and administrators differed significantly in their mean responses at 0.05 level of significance. The decision rule in this case is that if the calculated F-ratio value is equal to, or greater than the given critical F-ratio value ($F_{cal} \geq F_{tab}$) at 0.05 level of significance, the hypothesis is rejected. However, if the calculated F-ratio is less than the given critical value ($F_{cal} < F_{tab}$) the hypothesis is accepted.

4 Results

Frequency Results

Regarding research question 1, namely, “what are the ICT infrastructure/facilities utilized in Nigeria universities?” responses and results are presented in Table 3.

Table 3 showed the frequency distribution and the mean of the response of students, lecturers and administrators on ICT infrastructure and services in Nigeria universities. Among these, the lowest frequencies were observed for Teleconferencing, Campus Area Network, Wide area network, Online/E-learning course delivery, E-library and Intranet. This means, universities encounter problems in distant learning activities.

Table 3
ICT infrastructure/facilities & services utilized in Nigeria Universities

S/No	Infrastructure & services	Utilized 2	Not Utilized 1	Mean \bar{x}	Decision
1.	Computers (with printers)	437	15	1.97	Utilized
2.	Peripherals: scanner, webcam digital camera	134	318	1.30	Not Utilized
3.	LAN	93	359	1.21	Not Utilized
4.	Campus Area Network	37	415	1.08	Not Utilized
5.	Wide area network	-	450	0.99	Not Utilized
6.	Internet facilities/cyber café	371	81	1.82	Utilized
7.	Email services	367	85	1.81	Utilized
8.	World wide web	359	93	1.79	Utilized
9.	Intranet	-	447	0.98	Not Utilized
10.	Website	343	109	1.76	Utilized
11.	E-library	13	439	1.03	Not Utilized
12.	Online/E-learning course delivery	11	435	1.04	Not Utilized
13.	Teleconferencing (videoconferencing)	-	449	0.99	Not Utilized
14.	Telephone services (mobile/fixed)	451	-	1.99	Utilized
15.	Radio/Television broadcast lecture delivery	115	337	1.25	Not Utilized
16.	Projectors	164	288	1.36	Not Utilized
17.	Interactive whiteboard	77	375	1.17	Not Utilized

Research Question 2 was presented as “What is the extent/level of ICT application in Nigeria universities?” and data relevant to this question 2 is given in Table 4.

Table 4
Extent/Level of ICT application in Nigeria Universities

S/No	Item Statements	Always 5	Often 4	Some times 3	Rarely 2	Never 1	Mean \bar{x}	Decision
1	Computers + printer networked, or standalone for processing information	321	78	41	12	-	4.57	Often times
2	Peripheral such as scanners, webcam, digital camera	16	18	31	201	186	0.96	Rare
3	Use of LAN for interconnecting all computers within a department/centre	21	29	37	34	331	1.62	Rare
4	Use of Campus area network interconnecting LANs in the entire university	48	15	8	11	370	1.58	Rare
5	Use of wide area network (WAN) interconnecting the university to other institution or linking various campuses	-	-	6	-	446	1.03	Rare
6	Use of Internet facilities/cyber café in the university	258	62	61	92	19	4.08	Often
7	E-mail services on the internet or intranet.	252	65	64	57	14	4.07	Often
8	Use of Intranet; LAN, CAN connected to the internet for private internet access by the university	-	-	12	16	424	1.09	Rare
9	Use of world wide web (WWW) to obtain information on the internet.	243	71	75	53	10	4.07	Often
10	Use of University website for information and online access to the university	248	61	68	53	10	4.07	Often

11	E-library for online access to the university library resources.	17	8	7	31	389	1.30	Rare
12	Use of online/E-learning service in the University	25	31	37	53	306	1.71	Rare
13	Use of teleconferencing for interactive communication for lectures, seminars, meetings etc.	-	-	-	-	448	0.99	Rare
14	Use of telephone (fixed, mobile) service for communication in the university	328	75	37	12	-	4.59	Often
15	Recorded radio/television broadcast lecture delivery.	-	-	43	68	341	.34	Rare
16	Use of Projectors for class room lecture and presentations	78	58	103	61	152	2.68	Rare
17	Interactive whiteboard in place of chalk board for lecture and presentations.	51	49	77	84	191	2.30	Rare

Table 4 shows the frequency distribution and the mean of the responses of students, lecturers and administrators on the extent/level of ICT application in Nigeria universities. It is observed in general that, usage of peripheral such as scanners, webcam, digital camera, use of wide area network (WAN) interconnecting the university to other institutions or linking various campuses, LAN, CAN connected to the internet for private internet access by the university, E-library for online access to the university library resources, use of teleconferencing for interactive communication for lectures, seminars, meetings etc. and radio/television broadcast lecture delivery are at the lowest level. This finding is parallel to what was observed for Research Question 1. Interestingly, the frequency of the use of telephone (fixed, mobile) service for communication in the university has been found to be the highest.

Test Results

Regarding hypothesis 1, it is found that $F_{cal} < F_{tab}$ with 1 and 33 degrees of freedom at 0.05 significance level (Table 5) and we reject the hypothesis. This may also be interpreted, as there is no significant difference in the mean responses

of students, lecturers and administrators on the ICT infrastructure utilized in Nigeria universities (Table 5). This shows that the students, lecturers and administrators have similar responses on the question examined.

Table 5
Summary of Analysis of variance (ANOVA)

Source of variation	Sum of squares (ss)	Degree of freedom (df)	Mean squares (ms)	F-cal	Critical value (F-tab)	Level of significance	Decision
Between groups SS_B	5512.5	1	5512.5	0.201	4.14	0.05	Accept
Within groups SS_N	906160.47	32	27459.4				
Total		33					

The results for hypothesis 2 indicated that $F_{cal} < F_{tab}$ with 4 and 80 degree of freedom at 0.05 significance level (Table 6). Therefore, the hypothesis of no significant difference in the mean responses of students, lecturers and administrators on the extent of ICT application in Nigeria universities is accepted. In other words, the students, lecturers and administrators had similar responses on the extent of ICT application in Nigeria universities.

Table 6
Summary of Analysis of variance (ANOVA) on the mean responses of students, lecturers and administrators on the extent of ICT application in Nigeria Universities

Sources of variation	Sum of squares (ss)	Degree of squares (ms)	Mean squares (ms)	F-cal	Critical value (F-tab)	Level of significance	Decision
Between groups SS_B	23089.43	4	5772.4	0.236	2.533	0.05	Accept
Within groups SS_W	1956952.9	80	24461.9				
Total		84					

5 Discussion of Findings

Analysis of findings on Research Question 1 has revealed that, ICT infrastructure utilized in most Nigeria universities are computers, the internet and telephone and that the internet resources of Email, the web and websites are the ICT services utilized in most Nigeria Universities. This is an indication that Nigeria universities are still low in provision and utilization of ICT facilities. The finding has

substantiated that of Akomolafe [7] that, in Nigeria universities more attention is given to computers and the internet while other infrastructures are lacking. Osofisan and Osunade [6] had also observed that, the ICT drive in most educational institution in Nigeria is on internet service provision. She had also identified Email and websites as ICT services in Nigeria institutions.

The findings on Research Question 2 also reflected that of Question 1. It was found that computers networked or standalone are used oftentimes in Nigeria universities. Computers promote efficiency in the school and are therefore extensively used for record keeping, processing examination, students' records, word processing of students' works, and general administration. The finding is consistent with Ahmed [10] which reported that almost all the respondents in his study used computers for their research works. Adeyemi and Olaleye[11] also discovered in his study that computers for typing, processing and storage of data were frequently used in effective management of schools.

It was also found that internet facilities are utilized oftentimes in most Nigeria universities. This could be attributed to the numerous benefits in using the internet. As a result, the internet has become a tool, which students, lecturers and researches cannot overlook. This finding is in consonance with Livingstone and Bober [12] in which most of the respondents indicated that they used the internet and the use was mainly for obtaining academic – related information. Ojedokun and Owolabi [13] observed that the internet has become an invaluable tool for learning, teaching and research.

The study also revealed that Email services and the web are used oftentimes in Nigeria universities. These are obviously the most popular resources on the internet, with wide usage due to the numerous benefits offered. Other researchers have confirmed the popularity of these services. Nweze [14] reported that e-mail is the most frequently used internet resource by staff and students. Ahmed [10] stated that the most frequently used services on the internet are e-mail and the web. Kumah [8] observed that most students frequently used e-mail, especially for personal communication with friends and family members. Adelsberger *et al.* [15] found that respondents used the web frequently for searching for information on their studies.

Also indicated in the study was the use of websites by most Nigeria Universities. This could be due to the increasing use of websites to provide information about the universities, and for easy online access, especially to prospective students.

The finding that telephone was used oftentimes in Nigeria universities would be expected, considering that almost all students and staff use and communicate with telephone, especially the mobile phones. Osofisan and Osunade [4] had noted that telephones (fixed or mobile) are utilized at all the educational institutions in Nigeria. The finding agreed also with that of Ongori and Mburu [16], which identified telephone as one of the main ICT tools always used by his respondents.

Analysis on the null hypothesis 1 revealed that there is no significant difference in the mean responses of students, lecturers and administrators on ICT infrastructure/facilities in Nigeria universities. This implied that there was a significant relationship in mean responses of the students, lecturers and administrators in identifying the ICT infrastructure/facilities utilized in Nigeria universities such as computers, the internet, telephone, Email, the web, and website. This is in consonance with Osofisan and Osunade [6] who discovered ICT services in educational and research institutes to include computers, the internet, Email, website, and telephone.

Analysis on the null hypothesis 2 also revealed that there was a significant relationship in the mean responses of the students, lecturers and administrators in identifying the ICT infrastructure/facilities oftentimes applied in Nigeria Universities as use of computer, use of internet, use of telephone, Email service, use of the web, and use of university websites.

In all, the study has actually proved that the extent of ICT application in Nigeria universities is poor and that ICT infrastructure is yet not adequately provided in the universities. Omotayo [17] found that mostly students don't have access in the university campus and they use internet in cyber cafes. Oyelaran-Oyeyinka and Adeya [18] reported that the most serious constraint to Internet adoption in Nigeria is due to improper and insufficient networking. Although both of the studies were carried out in 2004 and 2006 but still in the situation is not changed to much. Our findings reflect the same.

Conclusion and Future Work

The benefits of ICT infrastructure in the university are quite enormous and the extents to which an institution can provide and utilize these ICT equipments define the status of the institution. Unfortunately, there is indication that ICT infrastructure is lacking in Nigeria universities and the utilization is low. The main ICT infrastructure and services utilized in Nigeria universities were identified to include the computer, the internet, E-mail services, the World Wide Web, website, and telephone. In the same way, ICT infrastructure and services oftentimes/frequently applied in Nigeria universities include the use of computers, use of the internet, E-mail services for online communication, use of the web to obtain information, use of university website for information and online access to the university, and the use of telephone.

It is recommended that necessary actions be taken for adequate provision of other important ICT facilities identified to be lacking including:

- Use of LAN and campus- wide network to interconnect computers and other workstations within departments and the entire university for easy sharing of resources and information.
- Use of WAN to connect the universities to other institutions for collaborations especially in research.

- Provision of E-library for easy online access to university library resources.
- Establishment of E-learning and teleconferencing services for classroom lectures and presentations etc.

These infrastructures will definitely change and improve the face of Nigeria universities.

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