Summer 5-1-2019

Evaluation of the Level of Adoption of Information and Communication Technology Resources and the Usage of Alternative Sources in Obtaining Information by Researchers of a Federal Research Institute in Nigeria

Olayinka Babayemi Makinde Dr
University of South Africa, babayemimakinde@gmail.com

Glenrose Velile Jiyane Prof
University of South Africa, gvjiyane@gmail.com

Tinashe Mugwisi Dr
University of South Africa, tmugwisi@gmail.com

Evaluation of the Level of Adoption of Information and Communication Technology Resources and the Usage of Alternative Sources in Obtaining Information by Researchers of a Federal Research Institute in Nigeria

Abstract

There is an increasing interest in studying the level of adoption of information and communication technology (ICT) resources by researchers of various disciplines with the effective adoption of ICTs having a proven record of significant academic, social, economic and environmental benefits. The aim of the study was to evaluate the level of adoption of ICT resources and the usage of alternatives in obtaining research information by researchers of a federal research institute in Nigeria. The research was carried out at the Federal Institute of Industrial Research Oshodi (FIIRO) Nigeria. A questionnaire was distributed to 165 researchers of the institute but usable returns totaled 114 (67%). This study revealed that FIIRO researchers utilized varying ICT resources and they had a good level of ICT competency in adopting ICT resources available to them as they carry out their work. Additionally, the institute lacked the ICT infrastructure for FIIRO researchers to fully adopt ICTs. The institute did not have internet connectivity. Considering this gap, researchers used alternative sources in the form of mobile devices, personally-provided laptops/desktops (with personal internet subscription) and internet-providing business centers (cybercafés) outside the institution's premises to access information for their research. The study recommended that FIIRO management should provide adequate number of computers for researchers and unhindered internet connectivity for easy access to research information. This paper emanates from the doctoral thesis submitted at the University of South Africa, titled Information Needs and Information Seeking Behavior of Researchers in an industrial research institute in Nigeria.

Keywords

information and communication technologies, alternative sources, researchers, information needs, Federal Institute of Industrial Research Oshodi, Nigeria.

Introduction

Information and communication technology (ICT) has been a foremost resource and tool through which researchers obtain information for their work. Qureshi (2011:249) maintained that the utilization of ICTs can enable development to take place through access to knowledge and skills

if applied to address local conditions and individual challenges. ICT resources have been established to be very helpful to researchers in finding needed information quickly and easily, promptness in the research process, improvement in job performance and have also helped in information access, management and communication. Beñat, Soumitra and Bruno (2013) observed that ICT tools, services and models have the potential to bring about development in research. Therefore, it is not surprising that there is some consensus that ICTs are a key factor in the socioeconomic development of the society since the 21st century is driven by a knowledge economy (Alderete, 2017:42). However, the paucity of ICTs has led to employment of viable alternative sources (especially when the ICT resources are not provided by the organization) by researchers of research institutions in obtaining much needed information for their projects.

Atiso and Adkins (2015) define ICTs to encompass mostly communication devices or applications including radio, television, cellular phones, computers and its networks such as the internet, satellite system and many more services associated with them. Likewise, Kim and Crowston (2011) describe ICTs to be information technology artifacts that enable people's communications and information access. They also highlight that ICTs can include any physical devices (such as cell phones and cyber infrastructure), any computer applications (such as Microsoft Office), or any internet or web services. In its simplest form, ICTs are a combination of complementary technologies through which the dissemination of essential information is made possible (Bankole, Shirazi & Brown, 2011; ITU, 2007). More inclusively, Gunday, Ulusoy, Kilic and Alpkan (2011) and Modimogale and Kroeze (2011) situate information communication technology to be technology systems used to transmit, store, process, display, create, and automate information dissemination. Ali, Jabeen and Nikhitha (2016) indicate that these technologies consist of items such as television; fixed telephone lines; mobile phones; radio; satellite systems; video; computers; network software and hardware; and the equipment and services related to these technologies, such as emails, video-conferencing, blogs, and social media.

Currently, there are several commercial and non-commercial organizations with a wide range of ICT tools that can be used for various research projects with the benefits from the adoption of these ICTs being related to the quantity and quality of research (Arcila-Calderon, Calderin & Aguaded, 2015). ICTs are synonymous with research and the adoption of ICTs by researchers in the course of projects is a known fact. Kim and Crowston (2011) define adoption as a user's

initial acceptance of an object. The object here refers to different ICT tools available to researchers and that they make use of in their research routines. Kusumaningtyasa and Suwarto (2015) express ICT adoption as the willingness to take for usage the innovation related to computer and the Internet. Given the consensus about the impact of the adoption of ICT resources on scientific methods and practices (Dutton, 2010; Nielsen, 2012), there is an increasing interest in studying the level of adoption and use of ICTs by researchers in various disciplines (Pearce, 2010; Procter, Williams, Stewart, Proschen, Snee, Voss & Asgari-Targhi, 2010; Ponte & Simon, 2011). Knowing this will go a long way in making sure that the ICT requirements in meeting the information needs of researchers are spelt out and adequately provided for.

As seen in the various definitions of ICT, mobile or cell phones are also included as part of ICT resources that when adopted will make the process of obtaining information for research by researchers easy. However, in this paper, the mobile or cell phone is considered an alternative source. This is because the management of FIIRO did not provide mobile or cell phones as ICT tools made available for sourcing information by researchers. In addition, Ricardo (2014:274) recalls that despite the incredible growth of the mobile or cell phone in the past few years, it is rarely used as a tool to access the Internet as most mobile or cell phone users tend to use it for traditional phone calls. In the context of this paper, mobile or cell phones are used as viable alternative sources used by researchers to access the Internet for research information.

Statement of the problem

Despite the considerable contributions of existing research in this sphere of influence, there is lack of significant and adaptable research about the usage of alternative sources by researchers of a federal research institution in Nigeria. This is discussed in the present study as it relates to use of mobile devices, personally-provided laptops/desktops (with personal Internet subscription) and Internet-providing business centers (cybercafés) outside the premises of the research institution. It is practical and productive to view this issue from this angle because the factor of obtaining community's symbolic acceptance (in this case, FIIRO researcher's community) is a key process necessary for the institutionalization of digital inclusion projects (Walsham & Sahay, 2006). Additionally, an institution-focus approach is employed which considers local context relating to the institution being studied with the problems and solutions being easily highlighted (McGrath & Maiye, 2010). This paper is an attempt to fill this gap by using a

methodology that captures these progressions. Findings would serve as ways to develop strategies for digital society in developing nation's context. The results obtained will be useful in influencing ICT policies as the results would provide new information for public servants' policy skills and help governments obtain the research inputs needed to inform their policy decisions.

Contextual setting

The Federal Institute of Industrial Research Oshodi (FIIRO), Nigeria, was established in 1956 (Adeboye, 1988; Onilude & Apampa, 2010). It is a parastatal organization under the agency of the Federal Ministry of Science and Technology. The broad mandate of FIIRO is to assist in accelerating industrialization of Nigeria through finding utilization for the country's raw materials and upgrading of indigenous production techniques (Adeboye, 1988; Onilude & Apampa, 2010). There are a total of 171 multidisciplinary researchers at FIIRO who include microbiologists, biochemists, agriculturists, food technologists, breeders, textile technologists and engineers (According to Federal Institute of Industrial Research Oshodi (letter, 19 May 2016); Adeboye, 1988). All 171 researchers are located at FIIRO office in Lagos (According to Federal Institute of Industrial Research Oshodi (letter, 19 May 2016). The number of researchers and areas of specialization are shown in Table 1.

Table 1: Departments and number of researchers in FIIRO (According to Federal Institute of Industrial Research Oshodi (letter, 19 May 2016)

Department	**Number of researchers**
Food Technology	45
Project Development & Design	31
Biotechnology	37
Chemical Fibre & Environmental Technology	35
Production, Analytical & Laboratory Management	19
Planning, Technology Transfer & Information Management	4
Total	**171**

FIIRO as a research institute stands out and its uniqueness informs this study emanating from its broad mandate of accelerating industrialization in Nigeria. Over the years, it has developed technologies that have promoted the ideals of entrepreneurship development. This by inference means that FIIRO have excellent researchers from which information can be obtained and consequently help in no small measure in addressing the gaps that this paper seeks to address.

The Federal Institute of Industrial Research Oshodi has a special library which was established in 1957 out of the necessity to provide information support to research and development activities

of the institute (FIIRO, 2016). Olaifa and Oyeniyi (2014) state that special libraries (research libraries) in Nigeria are found in research institutes with the number of research libraries being the same as the number of research institutes in Nigeria. Therefore, FIIRO library is among the special libraries of many research institutes operating under the auspices of the Federal Ministry of Science and Technology in Nigeria. The library has some ICTs which include six computers, three printers, two photocopiers and one server (non-functional as at the time of this study). One computer is originally designed for circulation but it is not being used for this function due to a lack of automation, one is for the audio-visual unit and the remaining four are for library users. The computers have no internet access. There is also no Wi-Fi networks provision by either the institute or its library.

Literature review

Several decades have witnessed numerous attempts to understand the mechanisms of adoption of technological innovation with the adoption of ICT in research for this information age being a response to quest for knowledge. With research and development centers having to deal with complex repositories, where they store, compute and retrieve data, ICTs have become invaluable (Arcila-Calderon et al., 2015). Gelb, Maru, Brodgen, Dodsworth, Samii and Pesce (2008) opine that the effective adoption of ICTs has a proven record in many parts of the world and a demonstrated potential to attain significant economic, social and environmental benefits at local, national and global levels. Walsham, Robey and Sahay (2007) explain that governments in developing countries of the world are increasingly adopting ICTs because there is an underlying belief in their potential to bring benefits to different sectors within a society including science and technology sector.

Many developing countries are typified by poor ICT infrastructure, and low level of focus on the same (Harle, 2009). UN (2015) shows that the digital divide is particularly pronounced with respect to Internet use and quality of access with just over one third of the population in developing countries using the Internet, compared to 82 percent in developed countries. In addition, there are also major inequalities across countries in terms of costs of ICT services, availability of ICT skills and availability of relevant and local content with the global mobile-cellular penetration rate being 97 percent in 2015 but reaching only 64 percent in least developing countries (UN, 2015). Oxford Business Group (2019) reports that the number of internet subscribers in Nigeria has increased rapidly in recent years but significant gaps remain.

They state that 154 million Nigerians still lack high-speed broadband access and broadband penetration rates stand at just 22 percent. In addition, the group also reports that in 2017, the International Telecommunication Unit ranked Nigeria 143rd globally in its ICT Development Index, down from 137th in 2016 and was placed 15th in Africa. All these go a long way to affect Internet experience at the institutional level and will invariably affect how ICTs are used for research purposes.

Dzandu and Dadzie (2012) state that research scientists are expected to undertake research as part of their work and the ability to perform this task effectively is dependent on the availability and adoption of some ICT facilities and services. The incorporation of ICTs into scientific routines has affected the way in which scientists do their works (Borgman, 2007; Dutton, 2010). Hey, Tansley and Tolle (2009) put forward that ICTs allow the production, analysis, curation and sharing of huge amounts of information that may configure the entire scientific process and activity. Obviously, the rationale for ICT resources usage for academic and research purposes stems from the benefits derived, such as free access to online journals, magazines and other information resources (Apuke & Iyendo, 2018). Contrariwise, in the midst of non-availability of ICTs, researchers are bound to seek for alternative sources in order to forge ahead with their research.

Obioha (2005) shows that all the researchers in her study know what ICTs are and the tools that make up ICTs with the way they are exposed to ICTs. She noted that all researchers use ICT tools. These results demonstrate that ICT awareness, use and application are not new to these researchers. In relation to ICTs adopted for information seeking and use, many of the respondents make use of the Internet/www/email, computer systems, peripherals, CD-ROM and telephone while few of them utilized radio and cable TV. The majority of researchers utilized the Internet, electronic mail and telephone in seeking for information in the office while they rely on cable TV and radio at home. Similarly, Dzandu and Dadzie (2012) demonstrate the impact of ICTs on information provision in six selected Institutes of Council for Scientific and Industrial Research (CSIR). They established that most of the researchers are aware of and make use of computers, Internet service and databases as they seek for research information. Osofisan and Osunade (2007) report that research institutes in Nigeria have ICT facilities such as computers, local area network and Internet provision equipment, but their use is limited. Most of the information systems available are mostly in paper format, are segmented and are kept by the

library and individuals. The computer-to-researcher ratio is very low in most institutes about one to two.

Agwu, Uche-Mba and Akinnagbe (2008) in their study of the adoption and use of ICTs by science researchers indicate that out of 24 ICT facilities listed, 14 facilities are frequently used by the researchers and these facilities include Internet, television set, voltage stabilizer, radio set, printer, flash drive, diskette, computers, uninterrupted power supply (UPS), mobile phone, photocopier, CD-ROMs, fixed telephone and e-mail. With respect to their mean scores, mobile phone, Internet, e-mail and radio set are ranked as ICT facilities that are well adopted by researchers, while fixed telephone, CD-ROMs and photocopier were the least adopted ICT facilities. However, Dzandu and Dadzie (2012) submit that some ICT facilities and services that are made available to CSIR researchers in their libraries include computers, Internet access, local area networks, compact disc-read only memory (CD-ROM) databases, online databases, online public access catalogues (OPACs), fax machines, photocopiers, inter-library lending and document delivery services, computer laboratories, scanners, printers, microfiche readers and telephones, and many others.

Atiso and Adkins (2015) show that ICTs are completely integrated into the work life of scientists. Scientists are keenly aware of ICT technologies, although they are not taking full advantage of most or all of them. Atiso and Adkins (2015) posit that ICTs could augment traditional library functions such as those of the online public access catalogue, reference and bibliographic services, document delivery, current awareness services, and audio-visual services, which may in turn affect users' access and ability to use information. When compared to Obioha (2005), scientists in the study of Atiso and Adkins (2015) also make use of the Internet which they use to access databases (both foreign and local ones) with most scientists having home Internet access in addition to work access. These have become a routine part of scientists' works, although their use of ICTs could be expanded. Atiso and Adkins (2015) further observe that the most used ICT is the electronic mail, which recorded 100 percent for researchers. The investigations conducted in the study confirmed the usefulness and adoption of ICT among researchers in selected research organizations, which help further the understanding of online information behavior of research scientists (Atiso & Adkins, 2015).

The results of various studies indicate that most researchers are conversant with the role of ICTs and thus the adoption of ICTs as they seek for research information on a day-to-day basis.

However, there have been a number of instances judged to be partial or complete ICT introduction failures (Walsham, Robey & Sahay, 2007) in developing countries invariably affecting ICT adoption due to lack of political will associated with inadequate funding by both private and public players. With the concept of digital divide, where a considerable number of people in the developing countries like Nigeria does not own computers or have affordable access to the Internet, they are left with no other choice but the usage of alternative sources in obtaining research information. In environments with constrained ICT resources, past studies show that support infrastructure play a significant role in decisions of which technology to use and sustained usage (Duque, Ynalvez, Sooryamoorthy, Mbatia & Shrum, 2005; Harle, 2009; Ynalvez & Shrum, 2011). Gomez (2014) pinpoints that digital divide concept is being slowly bridged by alternative sources in the form of initiatives such as public libraries and Internet cafes or cybercafés, all of which offer public access to computers and the Internet. In addition, Bresnahan and Yin (2017) elucidate that a collection of technologies has surfaced (functioning as alternative sources to obtaining research information) and it is associated with mobile devices adoption. They describe these alternative sources as new wave of recent technology of innovative ICTs that are moving into the institutions replacing and complementing existing technologies. The employment of these alternative technologies by researchers creates the question of what valuable influence will come from their application as they are utilized by researchers in getting research information.

In the context of the current study, these alternative sources involve use of mobile devices and its various applications, personally provided laptops/desktops (with Internet provided by the researcher in the form of personal subscription) and external Internet facilities (cybercafés). Wei (2013) describes mobile devices to encompass a range of hand-held devices from mobile phones, tablets, and e-readers to game consoles primarily as a personal, interactive, internet-enabled and user-controlled portable platform that provides for the exchange of and sharing of personal and non-personal information among users who are inter-connected. Stoop (2017) maintains that mobile or cell phones are being used more extensively for scientific purposes with them being used by scientists to prepare, conduct and analyze experiments. Stoop (2017) further stresses that mobile or cell phones are rapidly getting a central spot in the evolution of social networks and virtual reality and also open science (a broad term that reflects how technology is changing the future of science, making research more openly collaborative, transparent and efficient).

Purpose of the study

The purpose of this study was to evaluate the level of adoption of information and communication technology resources and the usage of alternative sources in obtaining research information by researchers of a federal research institute in Nigeria. This was achieved by ascertaining the ICT resources, the available infrastructure for research at the institute and the competencies of the researchers. This paper sought to answer the following research questions:

a. What are the ICT resources that researchers have access to in the office/organisation?
b. What is the level of adoption of ICTs by the researchers?
c. What are the alternative sources used by researchers to get research information?

Research methodology

A survey method was adopted in which a questionnaire was employed as the data collection instrument. The questionnaire was used to collect data from researchers from the six departments of the Federal Institute of Industrial Research Oshodi, Nigeria. The questionnaire included both closed-ended and open-ended questions with the purpose of making researchers to provide additional remarks, thus generating quantitative responses. Descriptive statistics provided general profiles of the researchers. The target population consisted of all the 171 researchers including 6 Directors. The six Directors were excluded from the study largely due to the sensitivity of their position with respect to the federal civil service. Out of 165 copies of the questionnaire that were administered to researchers, there were usable returns of 114 (67%) that were analyzed using SPSS.

Results

General description of respondents

The respondents were from six departments, namely - Food Technology Department (FT), Project Development and Design Department (PDD), Biotechnology Department (BD), Chemical, Fiber and Environmental Technology Department (CFET), Production, Analytical and Laboratory Management Department (PALM) and Planning, Technology Transfer and Information Management Department (PTTIM). The distribution of the respondents by their departments indicated that 30 (26%) were from FT, while 20 (18%) were from PDD. Twenty-five (22%) were from BD, 21(18%) were from CFET, 14 (12%) were from PALM and 4 (4%) were from PTTIM.

In terms of qualifications, out of 114 respondents in the study, 40 (35.1%) had a bachelor's degree, 21 (18.4%) had a post-graduate diploma, 35 (30.7%) had a master's degree and 18

(15.8%) had a doctoral degree. The greater percentage of the respondents had a bachelor's degree, while a doctoral degree was the qualification that the lower percentage of the respondents had. In terms of gender, out of 114 respondents in the study, 60 (52.6%) were males and 54 (47.4%) were females. The result showed that male respondents were more than female respondents by a percentage difference of 5.2%. This also showed a close range between the number of male and female respondents in relation to gender. In terms of age range, the majority (49; 43.0%) were between 30 and 39 years of age, whereas 16 (14.0%) were 50 years and older. Twenty-four (21.1%) were between the ages of 20 and 29 years and 25 (21.9%) were between 40 and 49 years of age. In terms of the number of years that respondents had worked in FIIRO as researchers, 39 (34.2%) had worked as researchers in FIIRO for 1 to 5 years, followed by 26 (22.8%) for 6 to 10 years, 18 (15.8%) for 16 to 20 years, 17 (14.9%) for 11 to 15 years, 8 (7.0%) for 26 years and above and 6 (5.3%) for 21 to 25 years. Seventy two percent of the respondents were found in the lower categories of 1 to 5 years, 6 to 10 years and 11 to 15 years.

ICT resources access in the office or organization

The quantitative results indicated that majority of the respondents had a reasonable access to essential ICT resources. The majority of the respondents (95; 83.3%) had access to electronic mail (ranked first), seventy four (64.9%) had access to the Internet (ranked second) while seventy two of the respondents (63.2%) had access to computer systems at the office/organization. This response was not just limited to office access but also access from elsewhere by the respondents within the organization. A summary of the response is seen in Table 2. However, the results show that ICT services attached to the availability of computer systems were highly ranked than the ICT device itself in terms of accessibility. CFET respondents had the highest access to computer systems (17; 81%) while FT respondents had the least access to computer systems (11; 36.7%). On the contrary, twenty eight (93.3%) of FT respondents had access to email (the highest) while PALM respondent had the lowest access to email (10; 71.4%).

Table 2: ICT resources accessed in the office or organization

ICT resources	FT		PDD		BT		CFET		PALM		PTTIM		ΣF & %
	F	%	F	%	F	%	F	%	F	%	F	%	
Computers	11	36.7	16	80.0	19	76.0	17	81.0	7	50.0	2	50.0	72 (63.2)
Printers	7	23.3	5	25.0	4	16.0	12	57.1	3	21.4	2	50.0	33 (28.9)

Fixed telephone	1	3.3	1	5.0	0	0.0	0	0.0	0	0.0	0	0.0	2 (1.8)
Fax	0	0.0	0	0.0	2	8.0	0	0.0	0	0.0	0	0.0	2 (1.8)
Television	1	3.3	2	10.0	2	8.0	8	38.1	0	0	0	0	13 (11.4)
Radio	3	10.0	7	35.0	4	16.0	4	19.0	1	7.0	1	25.0	20 (17.5)
Video recorder	2	6.7	3	15.0	2	8.0	0	0.0	0	0.0	1	25.0	8 (7.0)
Internet	22	73.3	16	80.0	16	64.0	10	47.6	7	50.0	3	75.0	74 (64.9)
Email	28	93.3	18	90.0	18	72.0	18	85.7	10	71.4	3	75.0	95 (83.3)

Note: Table denotes multiple responses.

None of the respondents in BT, CFET, PALM and PTTIM departments had access to fixed telephone. None of the respondents in FT, PDD, CFET, PALM and PTTIM had access to fax. None of the respondents in PALM and PTTIM departments had access to television. None of the respondents of CFET and PALM departments had access to video recorder.

Rating the ICT infrastructure of the office/department

Generally, a majority (74; 64.9%) of the respondents indicated that ICT infrastructure of the institute was poor. In descending order in terms of poor status, FT respondents (24; 80%), CFET respondents (16; 76.2%) and PALM respondents (10; 71.4%). The least in terms of poor status was PDD with 8 respondents (40%). Largely, 39 respondents (34.2%) pointed out that ICT infrastructure was good. The PDD respondents have the highest in terms of good status with 12 respondents (60%). Only 1 (0.9%) of the respondents indicated that the ICT infrastructure in the office/department was very good. One (25%) of the PTTIM respondents, which was the highest indicated ICT infrastructure of the institute to be very good.

Table 3: Rating ICT infrastructure of office/organization N=114

Rating	**FT**		**PDD**		**BT**		**CFET**		**PALM**		**PTTIM**		**ΣF & %**
	F	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	
Very good	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	25.0	1 (0.9)
Good	6	20.0	12	60.0	11	440	5	23.8	4	28.6	1	25.0	39 (34.2)
poor	24	80.0	8	40.0	14	56.0	16	76.2	10	71.4	2	50.0	74 (64.9)
Total	30	100.0	20	100.0	25	100.0	21	100.0	14	100.0	4	100.0	114 (100.0)

ICT competencies of respondents

This question was aimed at assessing the levels of ICT competence among the respondents. Essentially, this question was important because ICT competence of respondents would

influence how the available ICT resources would be used. Generally, only twenty six (22.8%) of the respondents indicated having a very good level of ICT competency. CFET respondents indicated the highest in terms of their skills being very good with 9 respondents (42.9%) while FT respondents was the lowest with 5 respondents (7%). Seventy two respondents (63.2%) showed a good level in terms of their skills. The BT respondents indicated the highest in terms of good status with 20 respondents (80%) while PTTIM respondents indicated the lowest with 2 respondents (50%). Sixteen (14.0%) of the respondents showed a fair level of ICT skills. The FT respondents was the highest in terms of fair level of ICT skills with 8 (26.7%) respondents while the lowest in terms of fair level was BT respondents with 1 respondent (4%). None of the respondents indicated that they had a poor level of ICT skill. However, it should be noted that the question attracted multiple responses (see Table 4).

Table 4: ICT competencies of researchers N=114

ICT competencies	FT		PDD		BT		CFET		PALM		PTTIM		ΣF
	F	%	F	%	F	%	F	%	F	%	F	%	
Very good	5	7	4	20.0	4	16.0	9	42.9	3	21.4	1	25.0	26 (22.8)
Good	17	56.7	14	70.0	20	80.0	11	52.4	8	57.1	2	50.0	72 (63.2)
Fair	8	26.7	2	10.0	1	4.0	1	4.8	3	21.4	1	25.0	16 (14.0)
Poor	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0 (0)
	30	100.0	20	100.0	25	100.0	21	100.0	14	100.0	4	100.0	114 (100.0)

Obtaining journal articles

The importance of this question was to know the level at which respondents use ICT resources in obtaining journal articles for their research. Journal articles are essential information sources utilized by researchers in getting research information. The majority (82; 71.0%) of the respondents reported that they obtained their journal articles mainly from the Internet by the use of search engines such as Google and Yahoo to retrieve uploaded journals. Others in descending order are personal subscription to online versions (51; 44.7%), personal subscription to print journals (45; 39.5%), e-archive (17; 14.9%) and document delivery (1; 0.9%). None of the respondents obtained journal articles via the library's online/electronic version, library's print subscription and interlibrary loan. Detailed information on how respondents obtained journal articles can be seen in Table 5.

Table 5: Ways of obtaining journal articles N=114

Ways of obtaining journal titles	FT		PDD		BT		CFET		PALM		PTTIM		ΣF & %
	F	%	F	%	F	%	F	%	F	%	F	%	
Personal subscription to print journals	11	36.7	9	45.0	12	48.0	10	47.6	1	7.1	2	50.0	45 (39.5)
Personal subscription to online version	9	30.0	12	60.0	14	56.0	9	42.9	4	28.6	3	75.0	51 (44.7)
Library online/electronic version	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0 (0.0)
Library print subscription	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0 (0.0)
E- archive	0	0.0	14	70.0	0	0.0	0	0.0	3	21.4	0	0.0	17 (14.9)
Inter library loan	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0 (0.0)
Document delivery	0	0.0	1	5.0	0	0.0	0	0.0	0	0.0	0	0.0	1 (0.9)
Internet using Google, yahoo e.t.c	20	66.7	13	65.0	19	76.0	16	76.2	10	71.4	4	100.0	82 (71.9)

Note: Table denotes multiple responses.

Frequency of accessing online journals outside the institute

Having known how respondents utilize ICT resources in obtaining journal articles, it is also important to know how the availability or non-availability of ICT resources will also affect the frequency of accessing journals outside the institute. The majority (92; 80.7%) of the respondents often access online journals outside the institute while seventeen (17.9%) sometimes access online journals outside the institute. Only 5 (4.4%) of the respondents never access online journals outside the institute. Remarkably, 23 (92%) of BT respondent, 19 (90.5%) of CFET respondents and 16 (80%) of PDD respondents often access online journals outside the institute's library. None of the respondents in PDD, BT, CFET, PALM, and PTTIM departments indicated that they never access online journals outside the institute's library while 5 (16.7%) of FT respondents never access online journals outside the institute's library. The summary of responses on frequency of accessing online journals outside the institute is seen in Table 6.

Table 6: Accessing online journals outside the institute N=114

Frequency of access	FT		PDD		BT		CFET		PALM		PTTIM		ΣF & %
	F	%	F	%	F	%	F	%	F	%	F	%	
Often	20	66.6	16	80.0	23	92.0	19	90.5	11	78.6	3	75.0	92 (80.7%)
Sometimes	5	16.7	4	20.0	2	8.0	2	9.5	3	21.4	1	25.0	17 (14.9%)
Never	5	16.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	5 (4.4%)
Total	30	100.0	20	100.0	25	100.0	21	100.0	14	100.0	4	100.0	114 (100.0)

Location of accessing the databases/archives/indexes

This question was also important in evaluating ICT resources utilization by respondents and the location where ICT resources usage were engaged pointing to ICT resources availability. The majority (74; 64.9%) of the respondents accessed databases/archives/indexes from home, followed by twenty one (18.4%) accessing from the office. Ten (8.8%) of the respondents accessed databases/archives/indexes from another library outside the FIIRO library and seven (6.1%) of the respondents accessed from the FIIRO library. None of BT respondents accessed databases/archives/indexes from FIIRO library and none of PTTIM respondents accessed databases/archives/indexes from another library outside FIIRO library. Detailed information on location of accessing databases/archives/indexes is seen in Table 7.

Table 7: Location where the databases/archives/indexes selected were accessed N=114

Location	FT		PDD		BT		CFET		PALM		PTTIM		ΣF & %
	F	%	F	%	F	%	F	%	F	%	F	%	
FIIRO library	2	6.7	2	10.0	0	0	1	4.8	1	7.1	1	25.0	7 (6.1)
Office	7	23.3	3	15.0	4	16.0	3	14.3	3	21.4	1	25.0	21 (18.4)
Home	16	53.3	13	65.0	19	76.0	15	71.4	9	64.3	2	50.0	74 (64.9)
Another library outside FIIRO library	3	10.0	2	10.0	2	8.0	2	9.5	1	7.1	0	0.0	10 (8.8)

Factors aiding accessibility of research information

This question was important in order to know the factors impeding researchers from accessing research information. The respondents revealed that the provision of more recent books in different fields (45; 39.5%) was a major factor that will aid accessibility of research information. Other factors in descending order included the adoption of electronic services (43; 37.7%), improved computer availability for online searching (29; 25.4%), adequate shelving (24; 21.1%), well-catalogued books (22; 19.3%), improved indexing (11; 9.6%) and well-trained library staff (9; 7.9%). Detailed information on factors aiding accessibility is seen in Table 8.

Table 8: Factors aiding accessibility of research information N=114

Factors	FT		PDD		BT		CFET		PALM		PTTIM		ΣF & %
	F	%	F	%	F	%	F	%	F	%	F	%	
Provision of more recent book in different fields	11	36.7	5	25.0	5	20.0	11	52.4	11	78.6	2	50.0	45 (39.5)
Adequate shelving	3	10.0	3	15.0	2	8.0	3	14.3	12	85.7	1	25.0	24 (21.1)
Electronic services adoption	1	3.3	5	25.0	4	16.0	10	47.6	12	85.7	2	25.0	43 (37.7)
Well trained library staff	1	3.3	3	15.0	1	4.0	2	9.5	2	14.3	0	0.0	9 (7.9)
Improved computer available for online search	9	30.0	0	0.0	4	16.0	8	38.1	8	57.1	0	0.0	29 (25.4)
Well catalogued books	2	6.7	4	20.0	2	8.0	5	23.8	8	57.1	1	25.0	22 (19.3)
Improved indexing	2	6.7	5	25.0	0	0.0	2	9.5	0	0.0	2	50.0	11 (9.6)

Note: Table denotes multiple responses.

Usage of alternative sources by respondents

The essence of this question was to know the alternative sources respondents adopted in getting research information in the absence of ICT resources at the institute. The majority (103; 90.4%) of the respondents used the alternative source of mobile phone/iPad in getting research information while eighty eight (77.2%) utilized personal laptop/desktop with own subscription to Internet data. Fifteen (13.2%) of the respondents obtained research information by patronizing external internet facilities (that is, business centers outside the institute). From the quantitative data, all the respondents from all departments showed that they preferred the usage of the alternative source (mobile phone or iPad) to the alternative sources of personal laptop/desktop with personal subscription to internet data and external internet facilities. Detailed information on usage of alternative sources by the respondents is seen in Table 8. Within this research in terms of the usage of mobile phones/iPads in getting research information, the respondents indicated the frequency with which they used mobile phones/iPads in obtaining research information. In concurrence with Table 9, 110 (96.5%) of the respondents indicated that they often use mobile phones/iPads and 4 (3.5%) of the respondents indicated that they sometimes use mobile phones/iPads, with no respondent indicating never.

Table 9: Alternatives sources used by researchers N=114

Alternative	FT		PDD		BT		CFET		PALM		PTTIM		ΣF
	F	%	F	%	F	%	F	%	F	%	F	%	
Use of personal	24	80.0	15	75.0	19	76.0	17	81.0	10	71.4	3	75.0	88

laptop/desktop with personal subscription to internet data													(77.2)
Use of mobile phone/ipad	26	86.7	19	95.0	23	92.0	20	95.2	11	78.6	4	100.0	103 (90.4)
External internet facilities (internet provided by business centres)	2	6.7	6	30.0	3	12.0	3	14.3	1	7.1	0	0.0	15 (13.2)

Note: Table denotes multiple responses.

DISCUSSION

The present study assesses the self-reported level of adoption of ICT resources and the alternative sources that researchers of a federal research institute in a developing country use in obtaining information as they engage in research. The respondents had a reasonable access to email, Internet and computers as seen in Table 2 but Tables 5, 6 and 7 further indicated that these ICT resources were personally provided based on the facts that there was high subscription to online version of journal articles by the respondents, online journals were accessed outside the institute's library often and the databases/archives/indexes used by the respondents were majorly accessed from home. In this light, The ICT resources available at the Federal Institute of Industrial Research Oshodi were not encouraging and acceptable for thorough research to take place that will positively affect national scientific and technological growth that the institute craves for. This finding contradicts the results found by Obioha (2005) and Osofisan and Osunade (2007) in their studies on research institutes in Nigeria. They found out that most ICT resources are available in Nigerian research institutes. Notwithstanding the stated assertion, Osofisan and Osunade (2007) also affirmed that the number of laptops in most institutes was limited and the computer-to-researcher ratio was very low. They further indicated that the computing needs of the administrative staff had priority over that of researchers. This, they indicate, might be due to low priority of computing facilities on the institute's lists of needs. Credence is also given to the finding of poor ICT resources and infrastructure in the current study by Harle (2009) declaring that many developing countries are typified by poor and low level of focus on ICT infrastructure. Also this finding agrees with the results of Egoeze, Sanjay-Misra and Colomo-Palacios (2014) who observed that ICT provision and utilization are still

rated low in Nigerian research environment because more attention is given to computer systems and the Internet while other ICT infrastructures are grossly inadequate.

The respondents in the current study had least access to land phone and fax with both being indicated by 2 (1.8%) of the respondents. This agrees with Obioha (2005) who indicated that fixed telephone lines were for the Directors only (showing low access to land telephone in this study for researchers). In addition, reduced usage of land telephone and fax can be attributed to the widespread usage of mobile phone and the Internet in Nigeria (Business Insider, 2019; Nigerian Communications Commission, 2017). In addition, as observed in the study, email is the most commonly accessed ICT resource by researchers. This observation suggests a positive pointer to collaborative tendency amongst researchers if Internet connectivity is provided. This concurs with Muriithi (2013), Muriithi, Horner and Pemberton (2014), Muriithi, Horner and Pemberton (2016) and Egoeze, et al. (2014) who pointed email as the most commonly used ICT resource for communication among researchers.

Quantitative results in the current study showed that researchers in terms of their skill, attitude and knowledge of ICTs have a good level of ICT competency. As a result of this, they were competent in adopting and using information and communication systems. This finding gives credence to the results of Obioha (2005), Salau and Saingbe (2008) and Dzandu and Dadzie (2012) who indicated that most researchers were highly skilled and competent in terms of the usage of ICTs tools. The tolerable level that researchers adopted information and communication technology resources could be seen in the frequency of the use of Internet (use of search engines like Google and Yahoo), the accessing of online journals outside the institute since the institute's library does not meet their requirements for the provision of online journals (80.7% of the respondents had to settle for accessing online journals outside the institute), and the majority of the respondents (64.9%) accessing databases/archives/indexes from home despite access challenges at the institute. The respondents used the Internet to retrieve research journal articles. As seen in Table 5, the majority of the respondents (71%) reported that they obtain their journal articles mainly from the Internet compared to personal subscription to online versions (44.7%), personal subscription to print journals (39.5%), e-archive (14.9%) and document delivery (0.9%). This finding gives credence to the result of Acheampong and Dzandu (2012) who revealed that researchers preferred to access most of the information they need for their research using their own computers by accessing electronic resources using the Internet.

The finding on the factors aiding accessibility to research information agrees with the results of Okonoko, Njideka and Mazah (2015:87). They revealed that factors such as provision of recent books, orientation on the importance and use of catalogue, training and retraining of library staff and researchers, improved Internet connection, automation of the library and provision of electronic resources will aid accessibility of information. Tables 2, 3, 5, 6, and 7 assented to the fact that the lack of Internet connectivity makes it difficult for researchers to access information. This was because the researchers cited the adoption of electronic services and improved computer availability for online searching among the factors for information accessibility. However, other factors such as the provision of more recent books in different fields, adequate shelving, well-catalogued books, improved indexing and well-trained library staff should be considered holistically in terms of solving the problem of research information availability and access.

The Federal Institute of Industrial Research Oshodi as an organization did not provide internet access either in its library or the institution as a whole. Internet was not provided through any Internet Service Provider by way of dial-up or analogue system, satellite broadband, fiber optic broadband or Wi-Fi broadband. This would have enabled the researchers to connect to other devices such as desktop computers, laptop computers, mobile phones, iPads and so on. The lack of provision of Internet has made researchers to make use of alternative sources to obtain information for research. The respondents used the alternatives of mobile phone or iPad (connected to the Internet by way of mobile operator company), personal laptop/desktop with own subscription for Internet data (by way of using privately owned mobile broadband modems) and external internet facilities (business centers with Internet provision outside the institute) in getting research information. By the way of the usage of the alternative sources by researchers, the mobile phone or iPad is ranked first, personal laptop/desktop with own subscription for Internet data is ranked second while external internet facilities is ranked third (Table 9). The finding in this current study, where mobile phone or iPad is ranked first for the alternative sources concurs with the results of Obioha (2005), Agwu et al. (2008), Isabona (2013) and Eruvwe, Sambo and Salami (2014) who indicated the mobile phone as an alternative source due to the lack of ICT resources for finding information to satisfy the information needs of researchers. Obioha (2005) also indicated that researchers used the alternative of mobile phones because of inadequate ICT infrastructure of the research institution and its library. Agwu et al.

(2008) revealed that researchers used mobile phone alternative because of the lack of adequate information technology infrastructure to access information. Likewise, Eruvwe et al. (2014) stated that the frequent use of cell phones for research was as a result of the library not being able to satisfy users' information needs due to poor internet connection and lack of current library materials for research. In addition, Agwu et al. (2008) also revealed that the frequent use of cell phones by researchers could be due to lack of internet access on desktop and laptop computers but also uncovered that factors such as poor finance for ICT infrastructures, complexity in using ICTs, nature of information provided, high cost of ICT software and hardware are also contributory to frequent mobile phone usage by researchers. In the case of the current study, researchers used the alternative of mobile phone because of the lack of ICT infrastructure at the institute and its library. Mobile phone usage as an alternative is connected with the ICT revolution and penetration in Nigeria in relation to the spread in the use of mobile or cell phones. The number of Nigeria's mobile subscribers has reached 150 million, and the number of its Internet users has climbed to 97.2 million at penetration rates of 81% and 53%, respectively (Business Insider, 2019; Nigerian Communications Commission, 2017). Related to this, Isabona (2013) reported that cell phones were transforming the Nigerian society in so many ways including research. This finding agrees with Eruvwe, et al. (2014) who revealed that the majority of researchers in their study indicated that cell phones helped to solve their problems and in meeting their information needs.

The finding in this study of researchers using the alternative of personal laptop/desktop with own subscription for Internet data (by way of using privately owned mobile broadband modems) is in agreement with the results of Muriithi, et al. (2016). They put forward that researchers in their study resorted to using privately owned mobile broadband modems in order to deal with unreliable Internet connectivity at their institution. The finding relating to researchers using external internet facilities (cybercafés) also concurs with the results of Muriithi, et al. (2016). They submit that it not uncommon for researchers to use a place where there is a public access to ICT resources. In agreement, Gomez (2014) also noted that it has become usual for researchers in developing countries to use the alternative of getting information as they utilize ICT resources at cybercafés. This they attributed to accessible ICT resources favored due to good customer service and connection speed to the Internet at these cybercafés.

However, it should be noted that the usage of cell phones or iPads (with Internet connection), usage of privately owned modems and cybercafés services can attract some costs to the researchers and the problems in Internet access will further affect use of diverse range of technologies. Researchers are left in the hands of market-driven and profit-oriented operators in order to access ICT resources. Therefore, the all-important question to be asked is, will this not further make worse the present social and economic disparities that exist among researchers at federal research institutions in a developing country like Nigeria?

Conclusions

FIIRO researchers were skillful in relation to the self-reported ICT resources available and that they utilize at the institute and outside the institute. However, the institute lacked the ICT infrastructure for FIIRO researchers to fully adopt ICTs – the institute did not have internet connection with ICT equipment not also sufficiently provided. Considering this gap, the study found out that the researchers have been using alternative sources to obtain their much needed research information. They used the alternatives of mobile phones or iPad (with Internet connection), personal laptop/desktop with personal subscription to Internet data and external Internet facilities (cybercafés). This showed that alternative sources have positively influenced researchers' information behavior towards information communications technology adoption in getting research information aimed at solving their information needs issues.

The results of the study contribute to the growing literature on ICTs for science and technology research and its adoption in a developing country environment. They also highlight the need to embrace ICT adoption and the use of alternative sources by researchers to get research information in order to boost national growth and development. The study has demonstrated the level of adoption of ICT resources at the institute and at the homes of researchers as they search for information for their projects. It also showed some of the challenges they face and the alternative sources they employ to get information.

This study brings to focus the assertion of UN (2015) that says that it is by addressing the widening digital divide that can make the transformative power of ICTs to come to fruition, and with this data revolution, harnessing excellent solution to deliver sustainable development for all will be made easy.

Recommendation

Based on the findings of the study, the following recommendations are made:

a. It is recommended that FIIRO management should provide adequate number of desktop and laptop computers for researchers in their offices and the library.
b. FIIRO management should drastically work towards unhindered provision of Internet at the library of the institute and the institute as a whole and by extension the provision of electronic version of journals by subscribing to them and provision of e-archive. This stresses the finding in the study that the retrieval of uploaded journals using search engines such as Google or Yahoo is not the best but the subscription to databases by FIIRO management will ensure access to recent and peer reviewed journals.
c. Further, it is recommended that successive governments should demonstrate the political will in addressing the age-long issue of improving information access, management and communication in their various federal research departments.
d. The study also brought to light the fact that the usage of mobile phones or iPads (with Internet connectivity) has become a very reliable research tool used by researchers due to its widespread usage in Nigeria. Therefore, the study recommends the encouragement of their utilization for research and for more investment in such resources.

References

Acheampong LD and Dzandu MD (2012) Access to and use of information centres among scientist at Council for Scientific and Industrial Research Crops Research Institute, Kumasi Ghana. *Library Philosophy and Practice*. Available at: http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1996&context=libphilprac (accessed 1 February 2018).

Adeboye T (1988) Diffusion of precommercial inventions developed in government-funded research institutions in Nigeria. Available at: http://eprints.icrisat.ac.in/12281/1/RP-05136.pdf (accessed 12 August 2017).

Agwu EA Uche-Mba UC and Akinnagbe OM (2008) Use of information communication technologies (ICTs) among researchers, extension workers and farmers in Abia and Enugu states: implications for a National Agricultural Extension Policy on ICTs. *Journal of Agricultural Extension* 12(1): 37-49.

Alderete MV (2017) Examining the ICT access effect on socioeconomic development: the moderating role of ICT use and skills. *Information Technology for Development* 23(1): 42-58.

Alis S, Jabeen UA and Nikhitha M (2016) Impact of ICTs on agricultural productivity. *European Journal of Business Economics and Accountancy* 4(5): 82-92.

Apuke OD and Iyendo TO (2018) University students' usage of the internet resources for research and learning: forms of access and perceptions of utility. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6299120/ (accessed January 23 2018).

Arcila-Calderon C, Calderin M and Aguaded I (2015) Adoption of ICTs by communication researchers for scientific diffusion and data analysis. Available at: https://www.researchgate.net/publication/282151056_Adoption_of_ICTs_by_communication_researchers_for_scientific_diffusion_and_data_analysis (accessed May 12 2017).

Atiso K and Adkins D (2015) Librarians, research scientists and ICT adoption in research institutes in Ghana. Available at: https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=3427&context=libphilprac (accessed 22 February 2018).

Bankole F, Shirazi F and Brown I (2011). Investigating the impact of ICT investments on human development. *The Electronic Journal on Information Systems in Developing Countries* 48(8): 1-19.

Beñat B, Soumitra D and Bruno L (2013) The global information technology report 2013: growth and jobs in a hyperconnected world. Available at: http://www3.weforum.org/docs/WEF_GITR_Report_2013.pdf (accessed 21 May 2017).

Borgman C (2007) "Data: input and output of scholarship". In Borgman (ed.). *Scholarship in the digital age. Information, infrastructure, and the internet*. Cambridge, Massachusetts: MIT Press. 115-148.

Bresnahan T and Yin P (2017) Adoption of new information and communications technologies in the workplace today. Available at: https://marshall.usc.edu/sites/default/files/pailingy/intellcont/final%20nber%20ipe-1.pdf (accessed 17 July 2018).

Business Insider (2019) Smartphone adoption on the upswing in Nigeria. https://www.businessinsider.com/smartphone-adoption-on-the-upswing-in-nigeria-2017-4?IR=T (accessed 2 February 2019).

Duque B, Ynalvez M Sooryamoorthy R Mbatia P and Shrum W (2005). Collaboration paradox: scientific productivity, the Internet, and problems of research in developing areas. *Social Studies of Science* 3595: 755-785.

Dutton W (2010) Reconfiguring access in research: information, expertise, and experience. In: Dutton W and Jeffreys P (eds) *World-wide research. Reshaping the sciences and humanities*. Cambridge, Massachusetts: MIT, pp.1-19.

Dzandu L and Dadzie P (2012) Facilitating ICT Adoption among Research Scientists in Ghana. Available at: http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1778&context=libphilprac (accessed 7 May 2017).

Egoeze F, Sanjay-Misra IA and Colomo-Palacios R (2014) An evaluation of ICT infrastructure and application in Nigeria universities. *Acta Polythecnica Hungarica* 11(9): 115-129.

Eruvwe U, Sambo AS and Salami R (2014) Utilization of cell phone for research among postgraduate students in the University of Nigeria Nsukka: the study. Available at: http://iiste.org/Journals/index.php/RHSS/article/viewFile/14892/15697 (accessed 24 December 2017).

FIIRO (2016) Library and documentation division. Library, documentation and intellectual property (IPTTO) division**.** Available at: http://www.fiiro.org/index.php/departments/planning-technology-transfer-information-management/library-documentation (accessed 20 February 2017).

Gelb E, Maru A Brodgen J Dodsworth E Samii R and Pesce V (2008) Adoption of ICT enabled information systems for agricultural development and rural viability. Available at: http://www.fao.org/docs/eims/upload/258775/workshop_summary_final.pdf (accessed 30 May 2017).

Gomez R (2014). When you do not have a computer: Public-access computing in developing countries. *Information Technology for Development* 20(3): 274-291.

Gunday G, Ulusay G Kilic K and Alpkan L (2011). Effects of innovation types on firm performance. *International Journal of Production Economics* 133(101): 662-676.

Harle J (2009). The Nairobi report: frameworks for Africa-UK research collaboration in the social sciences and humanities. London: British Academy/The Association of Commonwealth Universities.

Hey T, Tansley S and Tolle K (2009) The fourth paradigm: data-intensive scientific discovery. Washington: Microsoft Research.

Isabona J (2013) Harnessing telecommunications revolution in Nigeria: a case study. *Wireless and Mobile Technologies* 1(1): 20-24.

ITU (2007) Measuring the information society (Telecommunication Development Bureau Report). Geneva: International Telecommunication Union.

Kim Y and Crowston K (2011) Technology adoption and use theory review for studying scientists' continued use of cyber-infrastructure. *Proceedings of the American Society for Information Science and Technology* 48(1): 1-10.

Kusumaningtyasa N and Suwarto DH (2015) ICT adoption, skill and use differences among small and medium enterprises managers based on demographic factors. *Procedia - Social and Behavioral Sciences* 169: 296-302.

McGrath K and Maiye A (2010) The role of institutions in ICT innovation: learning from interventions in a Nigerian e-government initiative. *Information Technology for Development* 16(4): 260-278.

Modimogale L and Kroeze JH (2011). The role of ICT within small and medium enterprises in Gauteng. *IBIMA Publishing* 2011(1): 1–12.

Muriithi P (2013) ICT supported collaboration among the academic research community in Kenya. Doctoral Consortium paper presented at the Research Challenges in Information Science (RCIS) conference, Paris, France.

Muriithi P, Horner D and Pemberton L (2014) Understanding factors influencing the effect of scientific collaboration on productivity in a developing country: Kenya. *Proceedings of the American Society for Information Science and Technology, Montreal, Canada* 50: 1-10.

Muriithi P, Horner D and Pemberton L (2016) Factors contributing to adoption and use of information and communication technologies within research collaborations in Kenya. *Information Technology for Development* 22: 84-100.

Nielsen M (2012) Reinventing discovery: the new era of networked science. New Jersey: Princeton University Press.

Nigerian Communications Commission (2017) Nigeria's Internet users rise to 91.6million. https://www.ncc.gov.ng/thecommunicator/index.php?option=com_content&view=article&id=1572:nigeria-s-internet-users-rise-to-91-6m&catid=20&Itemid=141 (accessed 2 February 2019).

Obioha J (2005) The role of ICT in information seeking and use amongst research officers in research institutes in Nigeria: the Nigerian Institute of Oceanography & Marine Research Institute experience. *The International Information & Library Review* 37: 303-314.

Okonoko V, Njideka NO and Mazah D (2015) A comparative study of information seeking behaviour of researchers in Nigeria libraries: librarians' perspective. Available at: http://www.idpublications.org/wp-content/uploads/2015/05/A-COMPARATIVE-STUDY-OF-INFORMATION-SEEKING-BEHAVIOUR-OF-RESEARCHERS-IN-NIGERIA-LIBRARIES.pdf (accessed 15 August 2018).

Olaifa TP and Oyeniyi JO (2014) Research library development in Nigeria: the role of information communication and technology (ICT). *International Journal of Science and Research* 3(3): 256-259.

Onilude OO and Apampa OR (2010) Effects of information and communication technology on research and development activities: the FIIRO experience. Available at: https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1424&context=libphilprac (accessed 23 May 2018).

Osofisan AO and Osunade O (2007) ICT infrastructures available in Nigerian Educational and Research Institutes. Available at: http://sci.ui.edu.ng/sites/default/files/ICT%20Infrastructures%20Available%20in%20Nigerian%20Educational%20and%20Research.pdf (accessed 26 January 2018).

Oxford Business Group (2019) Steady progress made to expand broadband in Nigeria. Available at: https://oxfordbusinessgroup.com/analysis/closing-digital-divide-steady-progress-broadband-expansion-despite-challenges (accessed 11 February 2019).

Pearce N (2010) A study of technology adoption by researchers: web and e-science infrastructures to enhance research. *Information, Communication & Society* 13(8): 1191-1206.

Ponte D and Simon J (2011) Scholarly communication 2.0: exploring researchers' opinions on web 2.0 for scientific knowledge creation, evaluation and dissemination. *Serials review* 37(3): 149-156.

Procter R, Williams R Stewart J Proschen M Snee H Voss A and Asgari-Targhi M (2010) Adoption and use of web 2.0 in scholarly communications. *Philosophical Transactions of the Royal Society A-Mathematical Physical* 368: 4029-4056.

Qureshi S (2011) Globalization in development: do information and communication technologies really matter? *Information Technology for Development* 17(4): 249-252.

Ricardo G (2014) When you do not have a computer: public-access computing in developing countries. *Information Technology for Development* 20(3): 274-291.

Salau ES and Saingbe ND (2008) Access and utilisation of information and communication technologies (ICTs) among agricultural researchers and extension workers in selected institutions in Nasarawa state of Nigeria. *Production Agriculture and Technology* 4(2): 1-11.

Stoop J (2017) New ways to use smartphones for science. Available at: https://www.elsevier.com/connect/new-ways-to-use-smartphones-for-science (accessed 17 July 2018).

UN (2015) The millennium development goals report. New York: United Nations.

Walsham G, Robey D and Sahay S (2007) Foreword: special issue on information systems in developing countries. *MMIS Quarterly* 31(2): 317-326.

Walsham G and Sahay S (2006) Research on information systems in developing countries: current landscape and future prospects. *Information Technology for Development* 12(1): 7-24.

Wei R (2013) Mobile media: coming of age with a big splash. *Mobile Media and Communication* 1(1): 50–56.

Ynalvez M and Shrum W (2011) Professional networks, scientific collaboration, and publication productivity in resource-constrained research institutions in a developing country. Research Policy 4092: 204-216.