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**THE USE OF ICT APPLICATIONS IN RESEARCH BY POSTGRADUATE
STUDENTS IN GHANA**

By

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ABSTRACT

ICT has influenced the conduct of research with the emergence of advanced technologies that have enabled researchers to work with larger datasets and to improve the outcome of their research. Despite these benefits, it was revealed that some postgraduate students were not computer literate hence their inability to use the ICT applications in their research activities. This problem has led to huge financial losses to the universities since they have invested in ICT facilities, yet little use is being made. The study sought to examine the use of ICT in research by postgraduate students in public universities. The survey design was adopted for the study. The Stratified and Convenience sampling techniques were adopted to select 346 respondents out of 4907 postgraduate students from the University of Ghana and University of Cape Coast. The questionnaire was the sole instrument used for data collection. The responses were analyzed using SPSS. The finding of the study revealed that most students frequently accessed ICT facilities such as e-resources, communication and collaboration applications, citation and compiling bibliography applications, data analysis applications and sharing and/or publishing in their conduct of research. Thus, it is recommended that the ICT facilities should be marketed to students and promoted extensively through social networks; the universities' administration should also ensure that there are adequate ICT facilities for each research process or activity.

Keywords: ICT, Research, TAM 3, Postgraduate students, Public Universities, Ghana.

INTRODUCTION

Innovations in Information and Communication Technologies (ICTs) are enhancing the techniques in which faculty members, academics and researchers in all disciplines varying between pure and applied sciences, social sciences, and law to the humanities and education approach their study or work. These advances in techniques have brought about ICT applications to satisfy these eclectic needs of students and researchers.

In this study, these different types of ICT applications are classified into Basic ICT applications and Advanced ICT applications. The former are applications that are more general and ubiquitous across disciplines. Additionally, these applications are perceived as inevitable in 21st-century research. They include communication and scientific collaboration applications like email, videoconference with commercial providers (Skype) or with advanced networks (Internet Academics); data collection analysis and processing such as reference management software (RefWorks, Mendeley etc.); spreadsheets and databases; preservation and dissemination of data for instance digital storage sites with open access, restricted access; digital scientific journals and blogs. Other examples of these applications include library catalogues; research databases; internet search engines (like Google); directories (like Yahoo); research data capture; wikis, VPN; Qualtrics; desk phones, Synplicity, The semantic web (Web 2.0), links from trusted sites and virtual research environment (Arcila-Calderón, Piñuel-Raigada, & Calderín-Cruz, 2013; Bloomsburg University of Pennsylvania, 2016; Dutton & Meyer, 2009; ECU, 2017; Hall, Roue, & Shadbolt, 2009; Meyer & Dutton, 2009; Southern Cross University, 2017; University of Otago, 2017; University of Rhode Island, 2017). For example, Arcila-Calderón et al. (2013) found out in their online survey of 316 respondents that most ICT applications used by researchers are the basic ICT applications such as email, commercial videoconferencing, office software, and social networks.

On the other hand, advanced ICT applications are task-specific applications that are specially made to solve distinct research problems or take advantage of an opportunity. These applications are less used or diffused among researchers. They include The Quadrant tool for managing research projects; My Tardis to provide a repository for characterization and bioscience data; Federated Archaeological Information Management System; The ARCHER – eResearch tools (Research Repository Scientific Dataset Managers); e-Health Software Systems for health data management and processing/analysis, telehealth and medical device operations. Others include High Speed Network for sharing accessing services and large datasets; Access to Wireless Network across universities through Eduroam; High Performance Computing for Climate Change Research; use of Supercomputers for hosting and data storage; Moodle for dissemination of reliable scientific information and data and collaborative research (Androulakis et al., 2009; eRSA, 2017; Gerber, Osborne, & Hunter, 2012; Maeder, 2008; Robey, 2008; UNSW, 2016; van Deventer & Pienaar, 2012). For example, Meyer and Dutton (2009) identified some advanced or task-specific ICT applications such as Transana; The Observer; Wordstat; Concordance; Webtrends; Netlogo; Repast; UCINet; Atlas.ti, etc. in their web-based survey research which targeted mostly social scientists. However, they noted that these categories of ICT applications are less common, with only 13% of respondents (n=526) reported using visualization software like UCINet and dropping to a low of only 4% reported using video analysis software (such as Transana). Arcila-Calderón et al. (2013) reported congruent less use of advanced technologies among researchers.

Problem Statement

In recent times, a lot of emphases has been placed on the use of ICT in research in both academia and industry world over. This has compelled institutions and industries to invest in these technologies to enhance their input, output, and usage by researchers.

Despite the value of ICT in research in the provision of effective and efficient research, available literature shows that research into the awareness, usage, and support of ICT in research is not up to the level expected. This problem is more peculiar to developing countries. For example, Borgman (2006) stated that there is relatively little research on the use of ICT in research especially in determining how and whether these technologies will facilitate easy communication or enable access to new forms of knowledge. Similarly, Meyer and Dutton (2009) pointed out that there are relatively little knowledge and awareness on the use of ICT in research and its impact on actual research practices and outcome. Again, Adeagbo et al., (2016) found out a similar low awareness and usage of ICT in research by researchers.

Even though some scholars in Ghana have conducted research on related topics especially the use of electronic resources by researchers (Acheampong, 2016; Ankamah, Akussah, & Adams, 2018; Atuase, 2016; Boakye, 2015; Budu, 2015; Dadzie, 2005; Kwafoa, Osman, & Afful-Arthur, 2014), no empirical study has been conducted on the frequency of use of ICT in research. This has necessitated research to dissect into the usage of ICT in research by postgraduate students in public universities in Ghana and to give necessary recommendations.

Background of the Postgraduate students of both Universities

The postgraduate students of the University of Ghana (UG) are being supported by ICT tools and facilities that can be used in their research and learning. These include but not limited to remote access to academic databases, online catalog, reference management software, institutional repository, and electronic books. The rest include research commons, LiveChat with a librarian and library instructions. These tools and services are provided to advance the research and learning activities of UG postgraduate students (University of Ghana, 2014).

Comparatively, postgraduate students of the University of Cape Coast are provided with electronic resources, reference management software and other ICT related training by the Graduate School in collaboration with the Library. These services are provided to enhance postgraduate students' research as part of their education (University of Cape Coast, 2017).

Significance of the Study

The study examined the use of ICT in research by postgraduate students; the results could serve as a reference point in addressing the issue of usage of ICT in research by students. Thus, the universities' management would be in the position to acquire more relevant ICT facilities for research purposes and improve on the existing e-resources and services and as well strategize for future research services to meet the emerging information requirements of its students.

It would be useful to researchers and scholars, as it would add to the scholarly research and fill the gap in the literature in the field of ICT use.

The study would also be useful to information professionals in the field as it will reveal issues concerning the use of ICT in enhancing research among postgraduate students in Ghana, Africa and the world at large can learn from and provide relevant ICT facilities, infrastructure, and services to users.

Finally, the results of the study would provide policy and decision-makers with considerable knowledge on contemporary issues of using ICT in research so that appropriate measures and decisions can be taken.

LITERATURE REVIEW

Access is the right or opportunity to use or benefit from something (Oxford University Press, 2017). In this study, access to ICTs use in research is the right or opportunity to use ICT facilities for research purposes. The use of diffusion of ICT among users is grounded in its usefulness and ease of use in their research. Thus, researchers will frequently or intensively use ICT facilities to collect and analyze and share research data. Again, the usefulness and ease of use of ICT facilities in various research methods and techniques will increase its adoption among researchers (Adeagbo et al., 2016; Arcila-Calderón et al., 2013; Bradbury & Borchert, 2010; Dutton & Meyer, 2009; Hellmers, 2009; Meyer & Dutton, 2009). For example, Arcila-Calderón et al. (2013) stated that 70.25% of researchers said ICT applications are ‘useful’ in research activities.

Research into the access to ICT applications used for research has been based on its usage in research process or activity, research techniques or methods and access to specialized

applications that are used to support research activities. The first addressed processes and activities such as communication and scientific collaboration; data collection, analysis and processing; and preservation and dissemination of data. For instance, Arcila-Calderón et al. (2013) noted that researchers used at least one ICT applications for scientific communication and collaboration, especially email (81.33%), archives and document sharing (62.97%) and social networks (62.34%). With the use of ICT applications in data collection, analysis and process more than half of the respondents (57.91%) stated they use database whilst (44.62%) used spreadsheets and software for data visualization. Last but not the least, in the area of preserving and disseminating data most of the respondents chose digital scientific journals (72.47%), a significant number of them also use online data storage (53.16%) and a few of respondents use restricted access storage and blogs (48.10%).

Similarly, Hellmers (2009) in her research to find out how researchers provided access to their data, noted that out of 826 respondents, 100 published data online, 62 deposited data in repositories, 75 submitted data for publishing, 200 allowed privately negotiated access, 30 provide via 3rd party and 25 of them indicated 'other'.

Likewise in Nigeria, Adeagbo et al. (2016) confirmed that 90% of the researchers made use of emails and 60% use Skype to communicate and collaborate with each other. Again, most (80%) of the respondents do not use reference management software however, less than 20% of the respondents use Mendeley. In addition, respondents revealed that they use shared calendars, emails, Wikispace and regular online meetings to keep members abreast of deadlines of deliverables. Moreover, researchers use ICT applications such as email (75%), SharePoint

(40%), Online Forum (30%), Wikispace (25%), Dropbox (20%) and dedicated websites (5%) to share relevant information among team members.

Furthermore, research into the access to ICTs use in research is based on research techniques or methods used by researchers who employ ICT applications in qualitative, quantitative, database, video analysis, integrating and content analysis. Others include simulation, visualizing, geographic and web metrics (Dutton & Meyer, 2009; Meyer & Dutton, 2009). For example, Meyer and Dutton (2009) found that out of 526 respondents, 205 (39%) of them use ICT applications for quantitative research, 179 (34%) use database ICT applications, 96 (18%) use ICT applications for qualitative research and 69 (13%) use visualization ICT applications in their research. However, the least were web metrics and video analysis where their usages were 44 (8%) and 22 (4%) respectively.

Another important access to ICTs use in research is to support research technologies or activities. This includes the use of programming languages or scripts and open source software to support research. They are specialized applications that some researchers use in a specific research investigation. For example, Bradbury and Borchert (2010) opined that 27.2% of respondents indicated they write computer programs or scripts to help them carry out their research. These respondents (n=254) use programming languages or scripts such as MATLAB (22), FORTRAN (20) and SQL (15) were the most selected response. With the open-source software, 29.1% of the respondents revealed that they use open-source software in their research activities whilst 48.4% and 22.4% indicated that 'they do not' and 'they do not know' respectively. They were further asked to give the names of the open-source software/applications they use in their research. The answers include R, LaTeX, GIMP, ImageJ,

Open Office, Firefox, OpenCV and GNU. The rest include Inkscape, MikTek, MySQL, Ubuntu, VLC player, and Zotero.

Objectives of the Study

The specific objectives of the study were:

1. To find out the frequency of usage of ICT applications in research by postgraduate students.
2. To find out the ICT applications use by postgraduate students for their research.
3. To determine the way postgraduate students access ICT facilities, use in research.

METHODOLOGY

The study employed the survey design to select 346 respondents out of 4907 total population using the stratified and convenience sampling techniques. The questionnaire was the main instrument used to collect data from the postgraduate students from the University of Ghana and University of Cape Coast. The data was analyzed using SPSS.

Theoretical framework

The study incorporated the Technology Acceptance Model 3 posits that the behavior intention to use a system is determined by two main factors that are, perceived usefulness (PU) and perceived ease of use (PEOU). Therefore, using or adopting ICT in research is comparable to accepting to use technology.

FINDINGS

Frequency of Use of ICT Facilities in Research

The frequency of accessibility and usage of ICT facilities in research is an indicative tool used to measure and determine how these resources are utilized by students. Students have preferences in their effort to use ICT applications or resources to satisfy their research needs. These preferences could be due to differences in research methodologies, study programs, student's interest or the ease of use of electronic resources. In line with this, respondents were asked to indicate how frequently they accessed information communication technologies such as electronic resources; communication and collaboration applications; citation and compiling bibliography applications; research data management applications; data analysis applications and sharing and/or publishing in their conduct of research.

Electronic resources

The respondents were asked to indicate electronic resources they often used to search for information during their research activities. Table 1 illustrates the responses;

Table 1 Electronic resources

Electronic resources		UG	UCC	All	UG	UCC	All	UG	UCC	All	UG	UCC	All	UG	UCC	All
		E	E	E	M	M	M	O	O	O	R	R	R	N	N	N
CD-ROM databases	No.	6	1	7	0	1	1	0	1	1	0	0	0	0	-	0
	%	2.9	1.0	2.3	0.0	1.0	0.3	0.0	1.0	0.3	0.0	0.0	0.0	0.0	-	0.0
E-newspapers	No.	33	21	54	2	7	9	1	2	3	1	0	1	2	-	2
	%	16.2	21.2	17.8	1.0	7.1	3.0	0.5	2.0	1.0	0.5	0.0	0.3	1.0	-	0.7
Online databases	No.	115	35	150	28	14	42	9	2	11	2	0	2	1	-	1
	%	56.4	35.4	49.3	13.7	14.1	13.8	4.4	2.0	3.6	1.0	0.0	0.7	0.5	-	0.3
E-conference papers	No.	30	11	41	2	7	9	1	2	3	2	0	2	1	-	1
	%	14.7	11.1	13.5	1.0	7.1	3.0	0.5	2.0	1.0	1.0	0.0	0.7	0.5	-	0.3
E-journals	No.	128	47	175	33	25	58	8	5	13	3	3	6	3	-	3
	%	62.7	47.5	57.6	16.2	25.3	19.1	3.9	5.1	4.3	1.5	3.0	2.0	1.5	-	1.0
E-thesis	No.	73	29	102	14	15	29	4	2	6	1	0	1	1	-	1
	%	35.8	29.3	33.6	6.9	15.2	9.5	2.0	2.0	2.0	0.5	0.0	0.3	0.5	-	0.3
E-books	No.	99	43	142	21	15	36	7	5	12	3	3	6	2	-	2
	%	48.5	43.4	46.7	10.3	15.2	11.8	3.4	5.1	3.9	1.5	3.0	2.0	1.0	-	0.7
E-magazine	No.	27	13	40	2	3	5	0	1	1	1	0	1	1	-	1
	%	13.2	13.1	13.2	1.0	3.0	1.6	0.0	1.0	0.3	0.5	0.0	0.3	0.5	-	0.3
Internet resources	No.	138	50	188	35	20	55	8	7	15	2	3	5	2	-	2
	%	67.6	50.5	61.8	17.2	20.2	18.1	3.9	7.1	4.9	1.0	3.0	1.6	1.0	-	0.7
Key:	Everyday = E More than once a week = M Once a week = O Rarely = R No response = N															

From Table 1, it can be seen that most of the respondents that are 188(61.8%) generally indicated they preferred to retrieve information using internet resources every day whereas the least of the respondents that are 7(2.3%) preferred to access CD-ROM databases on daily basis. Again, 58(19.1%) respondents stated that they retrieved information from e-journals more than once a week while the lowest 1(0.3%) pointed out that they accessed CD-ROM more than once a week. Moreover, 15(4.9%) respondents intimated that they retrieved information from internet resources once a week whilst the least that is 1(0.3%) of them identified that they accessed CD-ROM databases and e-magazine once a week. Furthermore, the respondents who indicated that they rarely accessed electronic resources had the highest patronage of 6(2.0%) use of e-journals and e-books as opposed to 0(0.0%) for CD-ROM databases which were the lowest patronage. Last but not least, 3(1.0%) respondents stated that they retrieved information from e-journals however they did not indicate how frequently they do. On the other hand, the least 0(0.0%) respondent was for CD-ROM databases with no response. The emerging trend from the analysis is that awareness of ICT facilities by postgraduate students did not influence their access and use of them. This may be due to the perceived ease of use of some information retrieval systems to others.

Communication and Collaboration Applications

The researcher asked the respondents to indicate the technologies they often used for communication and collaboration during their research activities. Table 2 presents the results of their responses.

Communication and Collaboration Applications		UG	UCC	All	UG	UCC	All	UG	UCC	All	UG	UCC	All	UG	UCC	All
		E	E	E	M	M	M	O	O	O	R	R	R	N	N	N
Email	No.	140	53	193	39	23	62	10	5	15	3	4	7	2	-	2
	%	68.6	53.0	63.5	19.1	23.0	20.4	4.9	5.0	4.9	1.5	4.0	2.3	1.0	-	0.7
Google Docs	No.	43	16	59	13	8	21	2	1	3	3	0	3	2	-	2
	%	21.1	16.0	19.4	6.4	8.0	6.9	1.0	1.0	1.0	1.5	0.0	1.0	1.0	-	0.7
Videoconferencing	No.	13	7	20	2	3	5	0	1	1	0	0	0	1	-	1
	%	6.4	7.0	6.6	1.0	3.0	1.6	0.0	1.0	0.3	0.0	0.0	0.0	0.5	-	0.3
Google hangout	No.	8	10	18	3	4	7	0	0	0	1	0	1	1	-	1
	%	3.9	10.0	5.9	1.5	4.0	2.3	0.0	0.0	0.0	0.5	0.0	0.3	0.5	-	0.3
Skype	No.	44	14	58	6	7	13	2	3	5	2	0	2	1	-	1
	%	21.6	14.0	19.1	2.9	7.0	4.3	1.0	3.0	1.6	1.0	0.0	0.7	0.5	-	0.3
Google Plus	No.	13	20	33	5	5	10	1	3	4	2	1	3	1	-	1
	%	6.4	20.0	10.9	2.5	5.0	3.3	0.5	3.0	1.3	1.0	1.0	1.0	0.5	-	0.3
Dropbox	No.	50	23	73	6	11	17	4	1	5	0	1	1	1	-	1
	%	24.5	23.0	24.0	2.9	11.0	5.6	2.0	1.0	1.6	0.0	1.0	0.3	0.5	-	0.3
Facebook groups	No.	61	24	85	15	14	29	1	2	3	0	4	4	2	-	2
	%	29.9	24.0	28.0	7.4	14.0	9.5	0.5	2.0	1.0	0.0	4.0	1.3	1.0	-	0.7
Blogs	No.	14	5	19	1	4	5	0	2	2	0	0	0	0	-	0
	%	6.9	5.0	6.3	0.5	4.0	9.5	0.0	2.0	0.7	0.0	0.0	0.0	0.0	-	0.0
Phone call/SMS	No.	116	40	156	32	25	57	9	5	14	1	3	4	2	-	2
	%	56.9	40.0	51.3	15.7	25.0	18.8	4.4	5.0	4.6	0.5	3.0	1.3	1.0	-	0.7
ResearchGate	No.	48	21	69	8	9	17	2	1	3	2	0	2	1	-	1
	%	23.5	21.0	22.7	3.9	9.0	5.6	1.0	1.0	1.0	1.0	0.0	0.7	0.5	-	0.3
Wikis	No.	12	5	17	2	6	8	3	1	4	1	0	1	1	-	1
	%	5.9	5.0	5.6	1.0	6.0	2.6	1.5	1.0	1.3	0.5	0.0	0.3	0.5	-	0.3
Whatsapp	No.	129	56	185	36	27	63	10	7	17	3	4	7	3	-	3
	%	63.2	56.0	60.9	17.6	27.0	20.7	4.9	7.0	5.6	1.5	4.0	2.3	1.5	-	1.0
SnapChat	No.	8	6	14	3	1	4	0	2	2	0	0	0	1	-	1
	%	3.9	6.0	4.6	1.5	1.0	1.3	0.0	2.0	0.7	0.0	0.0	0.0	0.5	-	0.3
Key:	Everyday = E More than once a week = M Once a week = O Rarely = R No response = N															

Table 2 Communication and collaboration applications

Table 2 indicates that 193(63.5%) respondents in both UG and UCC use email compared to 14(4.6%) respondents who used SnapChat every day for communication and collaboration. In addition, 63(20.7%) respondents used Whatsapp more than once a week as opposed to 4(1.3%) respondents who used SnapChat. Again, Whatsapp had the highest patronage that is 17(5.6%) respondents who stated that they used it once a week compared to the lowest patronage of Google hangout with no usage. Lastly, 7(2.3%) respondents reported they rarely used selected email whilst Blog which is the least had no usage. This means that email and Whatsapp is the widely used communication and collaboration technology among students in both universities.

Citation and Compiling Bibliography Applications

The respondents were asked to indicate the technologies they used for citation and compiling bibliography. The responses are represented in Table 3;

Table 3 Citation and compiling bibliography applications

Citation and Compiling Bibliography Applications		UG	UCC	All	UG	UCC	All	UG	UCC	All	UG	UCC	All	UG	UCC	All
		E	E	E	M	M	M	O	O	O	R	R	R	N	N	N
Mendeley	No.	87	30	117	22	20	42	6	3	9	2	2	4	1	-	1
	%	45.3	30.6	38.5	11.5	20.4	13.8	3.1	3.1	3.0	1.0	2.0	1.3	0.5	-	0.3
RIS	No.	2	2	4	0	0	0	0	1	1	0	0	0	0	-	0
	%	1.0	2.0	1.3	0.0	0.0	0.0	0.0	1.0	0.3	0.0	0.0	0.0	0.0	-	0.0
Endnote	No.	59	29	88	10	11	21	3	2	5	1	2	3	0	-	0
	%	30.7	29.6	28.9	5.2	11.2	6.9	1.6	2.0	1.6	0.5	2.0	1.0	0.0	-	0.0
Refworks	No.	1	1	2	1	0	1	0	0	0	0	0	0	0	-	0
	%	0.5	1.0	0.7	0.5	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0
Institutional software	No.	5	6	11	3	3	6	0	0	0	0	0	0	0	-	0
	%	2.6	6.1	3.6	1.6	3.1	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0
Zotero	No.	2	5	7	2	1	3	0	0	0	0	0	0	0	-	0
	%	1.0	5.1	2.3	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0
MS Word	No.	87	41	128	24	19	43	5	6	11	2	4	6	1	-	1
	%	45.3	41.8	42.1	12.5	19.4	14.1	2.6	6.1	3.6	1.0	4.1	2.0	0.5	-	0.3
BibTex	No.	4	1	5	2	1	3	0	0	0	1	0	1	0	-	0
	%	2.1	1.0	1.6	1.0	1.0	1.0	0.0	0.0	0.0	0.5	0.0	0.3	0.0	-	0.0
MS Excel	No.	30	21	51	9	15	24	3	6	9	1	2	3	0	-	0
	%	15.6	21.4	16.8	4.7	15.3	7.9	1.6	6.1	3.0	0.5	2.0	1.0	0.0	-	0.0
No organised way	No.	5	3	8	1	0	1	1	0	1	0	0	0	0	-	0
	%	2.6	3.1	2.6	0.5	0.0	0.3	0.5	0.0	0.3	0.0	0.0	0.0	0.0	-	0.0
Key:	Everyday = E More than once a week = M Once a week = O Rarely = R No response = N															

In general Table 3 shows that the maximum number of respondents that is 128(42.1%) responded that they used MS Word for citation and compiling bibliography on daily basis as opposed to 2(0.7%) respondents who chose RefWorks. However, in UG there was an equal response of 87(45.3%) using MS Word and Mendeley respectively. Again, MS Word was used by the highest number of respondents that is 43(14.1%) who indicated more than once a week usage compared to the least RIS with 0(0.0%) response. Moreover, most of the respondents reported that they used MS Word 11(3.6%) once a week while a slightly higher number of them that is, 9(3.0%) respondents indicated Mendeley. Six (2.0%) respondents indicated that they used MS Word rarely. It is therefore clear that most of the respondents used MS word and Mendeley for citation and compiling bibliography.

Research Data Management Applications

Respondents were also asked to indicate the technologies they often used for managing their research data. Table 4 shows the results of their responses;

Table 4 Research data management applications

Research Data Management Applications		UG	UCC	All	UG	UCC	All	UG	UCC	All	UG	UCC	All	UG	UC	All
		E	E	E	M	M	M	O	O	O	R	R	R	N	N	N
MS Word	No.	99	46	145	26	25	51	6	7	13	3	3	6	3	-	3
	%	50.8	46.5	47.7	13.3	25.3	16.8	3.1	7.1	4.3	1.5	3.0	2.0	1.5	-	1.0
Mendeley	No.	70	20	90	15	13	28	6	3	9	2	2	4	1	-	1
	%	35.9	20.2	29.6	7.7	13.1	9.2	3.1	3.0	3.0	1.0	2.0	1.3	0.5	-	0.3
MS Excel	No.	69	31	100	20	16	36	5	4	9	1	2	3	3	-	3
	%	35.4	31.3	32.9	10.3	16.2	11.8	2.6	4.0	3.0	0.5	2.0	1.0	1.5	-	1.0
NVivo	No.	21	4	25	5	1	6	1	0	1	0	0	0	0	-	0
	%	10.8	4.0	8.2	2.6	1.0	2.0	0.5	0.0	0.3	0.0	0.0	0.0	0.0	-	0.0
MS Access	No.	13	6	19	3	4	7	2	3	5	0	0	0	0	-	0
	%	6.7	6.1	6.3	1.5	4.0	2.3	1.0	3.0	1.6	0.0	0.0	0.0	0.0	-	0.0
Google Drive	No.	33	22	55	9	8	17	3	3	6	3	0	3	0	-	0
	%	16.9	22.2	18.1	4.6	8.1	5.6	1.5	3.0	2.0	1.5	0.0	1.0	0.0	-	0.0
Cloud	No.	14	5	19	2	1	3	0	0	0	1	0	1	1	-	1
	%	7.2	5.1	6.3	1.0	1.0	1.0	0.0	0.0	0.0	0.5	0.0	0.3	0.5	-	0.3
Google Docs	No.	19	2	21	3	6	9	0	1	1	1	1	2	1	-	2
	%	9.7	2.0	6.9	1.5	6.1	3.0	0.0	1.0	0.3	0.5	1.0	0.7	0.5	-	0.7
SPSS	No.	76	43	119	20	20	40	6	6	12	2	1	3	3	-	3
	%	39.0	43.4	39.1	10.3	20.2	13.2	3.1	6.1	3.9	1.0	1.0	1.0	1.5	-	1.0
Key:	Everyday = E More than once a week = M Once a week = O Rarely = R No response = N															

From Table 4, it is generally evident that 145(47.7%) of the respondents used MS Word to manage their research data every day as opposed to 19(6.3%) of the respondents, representing the least who used MS Access and the Cloud. Similarly, the greatest number of respondents that is 51(16.8%) used MS Word more than once a week while the least number of respondents that is 3(1.0%) used the Cloud. The noticeable trend from the analysis is that MS Word was the most used software for managing research data.

Data Collection Applications

Respondents were asked to indicate the applications they used for collecting data. Table 5 illustrates their responses;

Table 5 Data collection applications

Data Collection Applications		UG	UCC	All	UG	UCC	All	UG	UCC	All	UG	UCC	All	UG	UC	All
		E	E	E	M	M	M	O	O	O	R	R	R	N	N	N
Key Survey	No.	41	13	54	11	14	25	2	3	5	2	0	2	1	-	1
	%	36.6	17.8	17.8	9.8	19.2	8.2	1.8	4.1	1.6	1.8	0.0	0.7	0.9	-	0.3
GenBank	No.	6	2	8	0	1	1	0	1	1	0	0	0	0	-	0
	%	5.4	2.7	2.6	0.0	1.4	0.3	0.0	1.4	0.3	0.0	0.0	0.0	0.0	-	0.0
Google Form	No.	40	25	65	14	15	29	5	7	12	1	4	5	1	-	1
	%	35.7	34.2	21.4	12.5	20.5	9.5	4.5	9.6	3.9	0.9	5.5	1.6	0.9	-	0.3
Telescope	No.	0	1	1	1	0	1	0	0	0	0	0	0	0	-	0
	%	0.0	1.4	0.3	0.9	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0
DNA scanner	No.	1	1	2	0	0	0	0	0	0	0	0	0	0	-	0
	%	0.9	1.4	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0
Microscope	No.	7	2	9	0	1	1	0	0	0	1	0	1	0	-	0
	%	6.2	2.7	3.0	0.0	1.4	0.3	0.0	0.0	0.0	0.9	0.0	0.3	0.0	-	0.0
Key:	Everyday = E More than once a week = M Once a week = O Rarely = R No response = N															

It is clear from Table 5 that, 65(21.4%) of the respondents employed Google Form for data collection daily while there was no response for Telescope. Similarly, 29(9.5%) respondents used Google Form for collecting data more than once a week. However, in UG 41(36.6%) of the respondents used Key Survey, compared to 25(34.2%) respondents who used Google Form in UCC. This means that the most patronized data collection applications employed by postgraduate students were Google Form and Key Survey.

Data Analysis Applications

The researcher sought to determine the packages respondents often used for analyzing data.

Table 6 illustrates the responses;

Table 6 Data analysis applications

Data Analysis Applications		UG	UCC	All	UG	UCC	All	UG	UCC	All	UG	UCC	All	UG	UC C	All
		E	E	E	M	M	M	O	O	O	R	R	R	N	N	N
SPSS	No.	108	50	158	29	29	58	8	6	14	4	4	8	2	-	2
	%	60.0	54.9	52.0	16.1	31.9	19.1	4.4	6.6	4.6	2.2	4.4	2.6	1.1	-	0.7
Netlogo	No.	1	0	1	0	2	2	0	0	0	0	0	0	0	-	0
	%	0.6	0.0	0.3	0.0	2.2	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0
STATA	No.	52	17	74	14	9	23	4	3	7	2	1	3	2	-	2
	%	28.9	18.7	24.3	7.8	9.9	7.6	2.2	3.3	2.3	1.1	1.1	1.0	1.1	-	0.7
Atlas	No.	2	2	4	1	0	1	0	0	0	0	0	0	0	-	0
	%	1.1	2.2	1.3	0.6	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0
NVivo	No.	22	4	26	8	1	9	1	0	1	0	0	0	0	-	0
	%	12.2	4.4	8.6	4.4	1.1	3.0	0.6	0.0	0.3	0.0	0.0	0.0	0.0	-	0.0
SAS Business Intelligence	No.	1	0	1	0	1	1	0	0	0	0	0	0	0	-	0
	%	0.6	0.0	0.3	0.0	1.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0
Leximancer	No.	-	1	1	-	0	0	-	0	0	-	0	0	-	-	0
	%	-	1.1	0.3	-	0.0	0.0	-	0.0	0.0	-	0.0	0.0	-	-	0.0
Enterprise Miner	No.	-	1	1	-	0	0	-	0	0	-	0	0	-	-	0
	%	-	1.1	0.3	-	0.0	0.0	-	0.0	0.0	-	0.0	0.0	-	-	0.0
Key:	Everyday = E More than once a week = M Once a week = O Rarely = R No response = N															

It is clearly evident from Table 6 that 158(52.0%) of the respondents confirmed that they used SPSS for data analysis every day compared to less than one percent of them that is 1(0.3%) who indicated that they used Netlogo, SAS Business Intelligence, Leximancer, and Enterprise Miner. Again, 74(24.3%) of the respondents reported that they made use of STATA, whilst 26(8.6%) of them confirmed utilizing NVivo for data analysis daily. The general trend from this is that SPSS was the most employed data analysis package.

Sharing and/or Publishing

The researcher asked the respondents to indicate the technologies they often used for sharing and/or publishing research findings. Table 7 shows the results of their responses;

Table 7 Sharing and/or publishing

Sharing and/or Publishing		UG	UCC	All	UG	UCC	All	UG	UCC	All	UG	UCC	All
		E	E	E	M	M	M	O	O	O	R	R	R
Open Access sites	No.	50	21	71	14	10	24	4	3	7	3	1	4
	%	38.5	28.0	23.4	10.8	13.3	7.9	3.1	4.0	2.3	2.3	1.3	1.3
Institutional repositories	No.	34	16	50	10	11	21	3	3	6	0	2	2
	%	26.2	21.3	16.4	7.7	14.7	6.9	2.3	4.0	2.0	0.0	2.7	0.7
Restricted access sites	No.	7	4	11	1	1	2	0	0	0	0	0	0
	%	5.4	5.3	3.6	0.8	1.3	0.7	0.0	0.0	0.0	0.0	0.0	0.0
Blogs	No.	14	10	24	4	6	10	0	3	3	0	2	2
	%	10.8	13.3	7.9	3.1	8.0	3.3	0.0	4.0	1.0	0.0	2.7	0.7
Digital journals	No.	37	14	51	10	6	16	1	3	4	1	1	2
	%	28.5	18.7	16.8	7.7	8.0	5.3	0.8	4.0	1.3	0.8	1.3	0.7
'Others'	No.	9	3	12	3	2	5	0	0	0	0	0	0
	%	6.9	4.0	3.9	2.3	2.7	1.6	0.0	0.0	0.0	0.0	0.0	0.0
Key:	Everyday = E More than once a week = M Once a week = O Rarely = R No response = N												

According to Table 7, the highest number of the respondents that is 71(23.4%) employed open-access sites for sharing and/or publishing their research report every day as opposed to 11(3.6%) respondents who stated that they used restricted access sites for this purpose. Again, more than fifteen percent of the respondents indicated that they used digital journals and institutional repositories for sharing and/or publishing their research reports every day. From the analysis, it could be deduced that most of the postgraduate students surveyed were using open-access sites for sharing and/or publishing because of their ease of accessibility compared to restricted-access sites.

Mode of Access to ICT Facilities Used for Research

The study inquired about the mode of access to ICT facilities used for research from the respondents. The results are displayed in Table 8;

Table 8 Mode of Access to ICT facilities used for research

Research Conduct	UG		UCC		All	
	No.	%	No.	%	No.	%
Myself	155	79.1	73	74.5	228	75.0
Assistance from librarian(s)	31	15.8	19	19.4	50	16.4
Assistance from my supervisor(s)	57	29.1	27	27.6	84	27.6
Assistance from expert(s)	17	8.7	22	22.4	39	12.8
Assistance from my colleagues/friends	89	45.4	57	58.2	146	48.0
Assistance from IT help desk	12	6.1	6	6.1	18	5.9

Generally, it can be seen from Table 8 that 228(75.0%) of the respondents reported that they conducted research by themselves. However, 18(5.9%) of them indicated that they accessed ICT facilities with assistance from the IT help desk. Again, 146(48.0%) respondents indicated that they accessed ICT facilities with assistance from their colleagues and friends. The analysis

makes it comprehensible that most of the respondents accessed on their own as one of their preferred ways to conduct their research.

Place of Use of ICT Facilities for Research

A very important aspect of the use of ICT facilities in research is that they provide unlimited user accessibility and usage. This means that regardless of physical locations, students or researchers can have access to ICT facilities such as electronic resources once they have access to the internet. This study found out from respondents about the different places that they get access to ICT facilities for their research activities. Respondents were permitted to select more than one response where applicable. The results are presented in Table 9;

Table 9 Place of use of ICT facilities for research

Place of use of ICT facilities	UG		UCC		All	
	No.	%	No.	%	No.	%
Library	173	84.8	47	47.0	220	72.4
Home	87	42.6	55	55.0	142	46.7
On-campus location	121	59.3	36	36.0	157	51.6
Department	84	41.2	29	29.0	113	37.2
Computer Centre	55	27.0	28	28.0	83	27.3
Hostel	61	29.9	22	22.0	83	27.3
Off-campus location	60	29.4	12	12.0	72	23.7
'Others'	2	1.0	3	3.0	5	1.6

In all, the responses in Table 9 show that postgraduate students accessed ICT facilities from different locations. The highest number of respondents, that is, 220(72.4%) reported that they accessed ICT facilities at the libraries of their institutions whilst the lowest number of respondents that is, 5(1.6%) indicated that they accessed ICT facilities off-campus. Moreover, 157(51.6%) respondents stated that they accessed ICT facilities on-campus whilst 142(46.7%) respondents stated that they accessed ICT facilities from home. However, most respondents

that are, 173(84.8%) from UG indicated that they accessed ICT facilities at the libraries of their institutions while in UCC, 55(55.0%) respondents stated they accessed ICT facilities from home. This means that most postgraduate students accessed ICT facilities at the libraries of their institutions and from home.

DISCUSSION OF FINDINGS

Frequency of Use of ICT Facilities in Research

The acceptance of the use of ICT in research by postgraduate students is usually influenced by the perceived usefulness and perceived ease of use. Thus, the regular use of specific or group of ICT facilities in research by students is important to their institutions so that they can invest more resources in such facilities. It also helps institutions to provide similar and complementary ICT facilities that students can use to equally enhance their research.

The objective was to find out the frequency of use of ICT applications in research by postgraduate students. The first ICT facilities considered were electronic resources. The findings of this study revealed that most postgraduate students rather preferred to access information from internet resources, online databases and electronic journals than CD-ROM databases. This is because the CD-ROM databases have limited access and their contents become obsolete by the time they are published as opposed to electronic databases which can be updated frequently. This finding corroborated the findings of Arcila-Calderón et al. (2013) in which most respondents stated that they accessed information from ICT applications like databases and digital scientific journals for their research activities.

Again, postgraduate students were asked to indicate the technologies they often used for communication and collaboration during their research activities. Most of the respondents

reported that they used email, Whatsapp, Skype, phone/SMS and Dropbox for communication and collaboration. This assertion was supported by Adeagbo et al. (2016) who posited that the researchers made use of email and Skype to communicate and collaborate with each other. Also, Arcila-Calderón et al. (2013) identified that researchers used email, archives sites and document sharing and social networks for scientific communication and collaboration.

In addition, postgraduate students were asked to indicate the technologies they used for citation and compiling bibliography. The finding shows that most respondents used Mendeley, Endnote, MS Word and MS Excel for citation and compiling a bibliography. This finding is consistent with the findings of Bradbury & Borchert (2010) who report that researchers mostly use Endnote and other software like Mendeley in their research. However, the finding contradicts Adeagbo et al.'s (2016) study in which they found out that most (80%) of the respondents do not use reference management software, however, only 20% of the respondents use Mendeley. It could be deduced that most students use Endnote and Mendeley in their research.

In addition, it emerged from the data analysis that most postgraduate students frequently used MS Word, MS Excel, SPSS, Mendeley and Google drive to manage their research data. These findings correspond with Bradbury and Borchert (2010) who stated that most researchers manage their research data using Microsoft Office Suite (MS Word, MS Access and MS Excel) and Endnote.

Further, postgraduate students indicated that they accessed the Google Form and Key Survey for collecting data. This finding is in line with that of Arcila-Calderón et al. (2013) who were of the view that most researchers use online survey software (Google Form and Key Survey)

for data collection. This can probably be explained by the fact that the use of digital survey is efficient and less expensive.

The analysis also showed that most postgraduate students often accessed SPSS, STATA, and NVivo for analyzing their research data. This result is supported by that of Bradbury and Borchert (2010) who found out that researchers used statistical analysis software (SPSS and STATA) and qualitative data analysis applications (NVivo) for data analysis. These ICT applications are used because they make it easier to code and manage huge data files successfully. This means that adequate expertise in the use of these ICT applications can enhance postgraduate students' research.

Last but not least, postgraduate students indicated that they often used open-access sites, digital journals and institutional repositories for sharing and/or publishing research findings. This result is supported by that of Adeagbo et al. (2016) who reported that researchers used applications like SharePoint, online forum and dedicated websites to share relevant information. Additionally, Arcila-Calderón et al. (2013) found out that most researchers use digital scientific journals, blogs, open-access sites and restricted access sites to disseminate their research data.

Again, the analysis of data showed that most postgraduate students mostly access ICT facilities to conduct research themselves. This finding compares favorably with the findings of Bradbury and Borchert (2010) who noted that most researchers prefer to use ICT facilities themselves. They further stated that this reflects the independent nature of research and researchers. This means that academics should invest more in providing training opportunities for postgraduate students so that they can have competent skills needed to use available ICT facilities. Also, the

provision of fast internet bandwidth to students can help them consult Google and other search engines when they ‘get stuck’.

The analysis of data showed that most postgraduate students access ICT facilities at their institution’s library. This finding affirms the findings of Bradbury and Borchert (2010) and Meyer & Dutton, (2009) who indicated that most students and researchers access the QUT library resources such as communication and collaboration applications, data analysis and data management applications for their research activities. It can be deduced that academic institutions should provide their libraries with adequate funds so that they can subscribe to quality electronic resources and provide training and instructional avenues for postgraduate students in order to increase usage.

CONCLUSION AND RECOMMENDATIONS

The key findings from this objective revealed that most postgraduate students frequently accessed information communication technologies in their conduct of research. ICT facilities such as e-resources, communication, and collaboration technologies, citation and bibliography applications, research data management applications, data collection applications, data analysis technologies and results dissemination technologies were considered. Most postgraduate students frequently accessed e-resources such as internet resources, emails, and MS Word daily. Additionally, most postgraduate students used MS Word for managing their research data; Google Form for data collection; SPSS for data analysis; and open-access sites for sharing and/or publishing their research reports every day. Most postgraduate students also reported that they accessed ICT facilities by themselves. Moreover, most of them accessed ICT at the libraries of their institutions.

The study found out that most postgraduate students frequently used ICT facilities such as e-resources, communication and collaboration technologies, citation and compiling bibliography applications, research data management applications, data collection applications, data analysis technologies and results in dissemination technologies for their research inquiries. Thus, it is recommended for universities to ensure that there are adequate ICT facilities for each research process or activity that postgraduate students engaged in to ensure maximum usage of ICT in their research.

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