Application of Cloud Computing in Public University Libraries in South- East, Nigeria for Effective Service Delivery

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Abstract
This study investigated the application of cloud computing services in public university libraries in South- East, Nigeria. Pointedly, the study explored the extent, benefits and challenges of application of cloud computing services by the staff of the libraries under study. The study adopted descriptive survey research design with a sample of 129 librarians drawn from ten public university libraries in South - East, Nigeria. Questionnaire was used to collect data that was analysed using descriptive parameters of mean and standard deviation. The findings revealed that respondents had applied cloud computing services in their libraries amidst challenges such as pricing, acceptance, security, sustainability and post adoption concerns. The study recommended that based on the enormous benefits of cloud computing services, more Information Technology (IT) infrastructure which can enhance the application of cloud computing services should be provided for enhanced services delivery in public university libraries.

Keyword: Cloud Computing, Application of Cloud Computing, Public University Libraries, Challenges of cloud computing, South-East, Nigeria

Introduction
The Library which is the hub of every academic institution has experienced numerous technological changes especially with regards to the application of Information and Communication Technology (ICT) in its services and operations. This has affected the methods and approaches adopted by the libraries in rendering its services and operations (Tella, Ukwoma & Kayode, 2020). The services in the library are continually driven by computer-enabled infrastructures such as cloud computing, artificial intelligence and robotics in the present technological era. Cloud computing describes an electronic service that can be rendered to clients through the internet. According to Ranger (2018), cloud computing is a conglomeration of computer and internet for the purpose of rendering computing services to clients in a "pay-as-you-use" basis and sometimes without fee. The services offered through cloud computing are categorized into the following: Software as Service (SaaS), Platform as Service (PaaS) and Infrastructure as Service (IaaS) (Breeding, 2018).

The libraries especially those in developed climes in the last few years, had engaged some cloud computing technology in most aspects of their services. This was necessitated by the fact that most library materials especially the digital content were required to be available

ubiquitously. The effect of this demand made libraries to seek for ways to outsource their infrastructure related services because of cost burden (Breeding, 2018). Moreover, the existence of internet based options in performing library routines such as online cataloguing, online circulation services are some of the factors that provoked the adoption of cloud computing services in libraries in Europe and America. In addition, the adoption of cloud computing services in the libraries in developed economy could be attributed to the stunning features of cloud computing which include: scalability, flexibility, cost effectiveness and service-oriented focus (Yousef, et al, 2020).Tuncay (2010) posited that most essential services in the library such as cataloguing a book require collaboration if one is to apply a designated standard.

The differences in services rendered in libraries of Europe and America when compared to poor service delivery in Africa occasioned by infrastructural gap, leave less to be desired (Carcary, Doherty, Conway, & McLaughli, 2014; Mate, 2016; Khayer, 2020). This infrastructural deficit can be bridged by the enormous benefits that can be derived from the adoption and application of cloud computing services in the libraries in line with international best practices obtainable in developed economies. Cloud computing providers focus mainly on providing services in accordance with the subscriptions made in different categories of cloud computing (SaaS, IaaS, PaaS) and this will benefit libraries in the developing regions. This is what prompted the researchers to embark on this study.

Public university libraries are established within federal and state government-owned universities to support the information and research needs of the university community, primarily serving faculty and students as well as non-teaching staff. The quality of library holdings and service rendered in any public university library is assumed to be the yardstick for measuring the quality of academic activities available in such institution. Significant investment in library resources and services reflects the institution's commitment to academic excellence (Oyeleye, Fagbola & Daramola, 2014). Libraries are integral to supporting the educational and research missions of universities and contributes to the success and advancement of their academic communities. Accrediting bodies of programmes such as the National Universities Commission (NUC), place significant importance on the quality of library resources and services. Libraries receive a special score during programme evaluations, which significantly impacts the approval status of academic programmes. A high score in library resources and services is essential for the approval of academic programmes. Conversely, low scores in library assessments can lead to the denial of programmes' approval or result in only interim approval, regardless of high scores in other evaluation areas. Libraries must maintain extensive and up-to-date collections of books, journals, and electronic resources to meet the academic and research needs of their users. Quality services indicators include reference assistance, research support, interlibrary loans, study spaces, access to technology and online databases.

Although researches are available on adoption of cloud computing services in academic libraries of advanced nations, it seemed that not much research was found on the application of cloud computing services in academic libraries particularly in South- East, Nigeria. It is based on this gap that this study seeks to explore the adoption and application of cloud computing services in public libraries of South- East, Nigeria. South- East, Nigeria comprises Abia State, Anambra State, Ebonyi State, Enugu State and Imo State.

Objectives of the Study

The general purpose of this study is to investigate the application of cloud computing in public university libraries in South-East, Nigeria. It specifically sought:

1. To find out the areas of application of cloud computing in the services of public university's libraries in South- East, Nigeria.
2. To identify the benefits of application of cloud computing in the services of public university's libraries in South- East, Nigeria.
3. To ascertain the challenges hampering the application of cloud computing in the services of public university's libraries in South- East, Nigeria.

Research Questions

1. What are the areas of application of cloud computing in the services of pubic university's libraries in South- East Nigeria?
2. What are the benefits of applying cloud computing in the services of public university's libraries in South- East, Nigeria?
3. What are the constraints confronting the application of cloud computing in the services of public university's libraries in South- East, Nigeria?

Review of Related Literature

Conceptual overview of cloud computing

Cloud computing can be likened to a coin with two sides: From the first side, it is described as a process of using a web browser on the internet to dynamically allocate or de-allocate the access of the remote computing resources based on the users' demands, and from the second side, it could be referred to as the process of paying for the real use of the computing resources and facilities (Hover and Martin, 2008). According to Romero (2012) cloud computing also referred to as "The cloud" is a highly scalable platform promising quick access to hardware and software infrastructures over the internet in addition, to easy management and access of resources by non-expert users. Ogbu and Lawal (2013) opined that cloud computing is a style of computing in which IT-based services are delivered externally to customers with the help of internet technologies. It is a technology which provides a shared pool of resources that people can access privately or corporately. Some services rendered via cloud computing includes e-mail services, onshore data backup, social networking, server hosting, etc. The satisfaction enjoyed by subscribers to cloud computing services is to a large extent dependent on the IT devices and its accompanying infrastructure available to such subscribers (Zubairu, Olugbenga & Abiola, 2021). A comprehensive definition given by National Institute of Standards and Technology (NIST) cited by Mell and Grance (2011) indicated that it is a model that enables ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources such as networks, servers, storage, applications and services that can be swiftly provisioned and released with minimal management effort or service provider interaction.

Several studies by Dhaka (2017), Swapna and Biradar (2017) and Khayer, Jahan,Hossain and Hossain (2020) showed three main cloud computing service models which include: Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). SaaS are delivered to users from any online devices. The burden of installation, upgrade and maintenance of the software are the sole responsibilities of the service providers. The clients' own responsibility is to pay for the subscription fee. For example, SaaS services such as G-mail, Skype, Hotmail, among others are of payment upon subscription. On the other hand, PaaS are

platforms which supply computing tools that enable companies to build, test and deploy web-based applications. Such platforms include social networking sites, wordpress while IaaS are platforms that offer infrastructure services such as data backup and server hosting to companies. A leading company in IaaS computing service model is Amazon's web services.

According to Mell and Grance (2011), cloud computing services can be deployed around private, public, and community and hybrid models. The private cloud model as the name suggests is the type that is used by one organization, not sharing with any organization. The infrastructure of this type can be self-managed by the organization or outsourced to third party but the distinctive feature is that it is used to service solely one organization. The choice of this type of model is informed by security being of great concern to the organization. However, the public cloud computing model is the type that is available to the general public and is made available by the service providers. This is the most common and popular because it is accessible to any person or organization by simply subscribing to the services which may be at little or no cost. The community model is the type where some organizations with common interest, pull resources together to procure infrastructures deployed through the cloud for the benefit of the organizations. For example, banks may pull their resources together to procure IT infrastructure for the benefit of all concerned instead of patronizing public cloud computing model with its attendant security challenges. The high point of this model is that organizations can pay less for premium service in such relationship. Lastly, the hybrid model is that which combines two or more models. Employing more than one model harnesses the merits of each model and aims to mitigate the disadvantages of one singular model. It also provides more flexibility and a wide range of opportunities to exploit (Qasim, Sadiq, Kamaludin & Al-Sharafi, 2017).

Application of Cloud computing in the library

The libraries just like in other sectors have experienced improved services delivery to her patrons with the integration of information and communication technology tools were in their operations (Sanchati, 2011). Hoy (2012) posited that many academic libraries had started using cloud computing services in the following areas:

a) *Online Public Access Catalogue (OPAC):* This is the provision of bibliographic details of library collections centrally where they can be accessed from any part of the globe. This has made cataloguing and search for resources a lot easier. A user can simply retrieve any document by supplying the bibliographic details of the materials such as the name of the author, title, call number (Suman &Singh, 2016).
b) *Library digitization*: Storage is a factor that provokes the conversion of hardcopies to electronic copies. The library had gone a step ahead to outsource the storage of their digital collections and cloud computing offers an unimaginable storage facility.
c) *Integrated Consulting Service*: The library provides extended services to her patrons outside working hours. Such services like interlibrary loan and discharge of borrowed materials. Some of these services have been outsourced to cloud computing providers.
d) *Bulletin Board Services and E-mail:* This is a kind of electronic information service similar to blank board hosted on the internet. All users can publish their knowledge on this board. E-mail is also electronic information services powered by the Internet. These two services require sustained availability of services all round the clock. Through BBS system, library patrons can consult librarians at any time. The cost of maintaining servers may be overwhelming and hence these services are at their best when outsourced to third party companies.

Benefits Of Application of Cloud Computing: The benefits of cloud computing include: scalable storage capacity, computing competencies, universal accessibility and overall cost reduction. Libraries leveraging on cloud computing technology can save themselves from some teething information technology problems such as computer cyber security issues, hardware breakdown, software update problems, network breakdown, staff training deficiency and loss of important data due to natural disasters.

Challenges Associated with Cloud Computing

The application of cloud computing in academic libraries are usually faced with some obstacles (Kayode, Tella & Akande 2020; Yousef, Quasem, Yusmandi ,Rodziah & Shahla. 2019). They include: security, pricing, acceptance and adoption, sustainability and post-adoption and privacy concerns.

*Security Concern***:** The most critical concern for application of cloud computing by any organization hinges on the concern of security associated with cloud computing. This is because no organization wants the confidentiality, integrity and availability of their data to be compromised. The major security issue pertaining to cloud services is ensuring that the right person receives the administrative password that is usually given remotely.

*Pricing Concern***:** Library management is a capital-intensive venture and funding is usually in short supply because there are numerous other projects in academic institutions competing for the available resources. The worrisome aspect of cloud computing pricing lies on the licence renewal which must be done at least at yearly intervals and with the tendency for scale up in pricing for the licensing agreement.

*Acceptance and Adoption Concern***:** The fear that any new technology meant to assist staff in performing their duties will likely displace some people from the job is still a source of worry that may hinder the acceptance ,adoption and application of cloud computing. The tendency that some librarians who are not information technology savvy will oppose the adoption of cloud computing in their library is very high (Tan & Kim, 2015).

*Sustainability and Post-adoption Concern***:** Sustenance is the hallmark of every project that is successful. Therefore, the way to keep cloud computing running after its application is a critical concern that must be considered before adoption. It could affect the zeal to accept adoption if not properly addressed. A new technology is prone to go into extinction if it has no elaborate plan and policy on the sustainability and post-adoption maintenance.

*Privacy Concern***:** The library has the responsibility to protect reading materials under their custody which are protected by copyright laws from copyright infringement. This concern is capable of standing in the way for the adoption of cloud computing technology because it involves a huge financial commitment for licensing agreements as well as high costs for litigation when there is a contravention of the provisions of the law and no library is willing to go through the litigation of infringement on copyright laws.

Methodology

Research design

This study adopted descriptive survey design. Research design is simply a plan or strategy adopted to solve a research problem specially to answer research questions (Brink, 2018). A survey was used in order to draw large sample and to generalize the findings on the entire

population of the study. Survey research has been revealed to be a vital and complex process used to ensure that research objectives are met (Zikmund, Babin, Carr, & Grin, 2013).

Population Size and Sampling Technique

The area of this study is public university libraries in South- East, Nigeria and a total of 10 public University libraries in the five states with at least each having one. A population of 129 academic librarians were used for the study. The total enumeration technique was used as sample for the study, hence all the librarians were involved because the number was manageable. The distribution of the sample in various schools is illustrated in Table 1.

Table 1: Sample distribution of the Respondents

S/N	Institution of Respondents	Study Population	Percentage
1	Abia State University	6	4.7
2	Anambra State University	4	3.1
3	Ebonyi State University	10	7.8
4	Enugu State University of Science and Technology	10	7.8
5	Imo State University	6	4.7
6	Federal University Ndufu Alike Ikwo	11	8.5
7	Federal University of Technology Owerri	8	6.2
8	Michael Okpara University of Agriculture Umudike	18	14.0
9	Nnamdi Azikiwe University, Awka	29	22.5
10	University of Nigeria, Nsukka	27	20.9
	Total	**129**	**100.0**

Source : Researchers' survey 2024

Method of data collection

A five-point Likert scale questionnaire was designed to collect data for the study. The Likert scale designated 5 as strongly agree, 4 as agree, 3 as undecided, 2 as disagree and 1 as strongly disagree. Each question item of the instrument was fashioned in line with the objectives of the study and the research questions. The questionnaire was compartmentalized into clusters A – D. Cluster A featured the demographic information such as gender, highest qualification, institution of the respondents and the cluster B – D contained items of the instrument which include application of cloud computing services, benefits of using cloud computing services and challenges of using cloud computing services respectively.

Validation and Reliability of the instrument

The validity of the instrument was determined by giving it to colleagues that are outside the catchment area of the study. The advice given by these colleagues led to modification of the instrument. To ensure construct reliability of the instrument, the questionnaire was administered to 40 librarians. Cronbach Alpha was used to compute reliability of the instrument based on the data collected from the respondents. A Cronbach Alpha value of 0.905 was obtained, which attest for high reliability and the internal consistency of the instrument as illustrated in Table 2.

Table 2: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.905	.906	25

Method of Data Analysis

The collected data were downloaded from the researchers' Google cloud account in spreadsheet format. The data were then exported to IBM Statistical Package for Social Sciences (SPSS) version 16. Percentage and frequency counts were used to analyse the data that was collected. The result obtained from the analysis were presented as follows:

Cluster A: Demographic Information of respondents.

The demographic information on the qualifications of the librarians as indicated in Table 3 showed that 29.5% (38) had PhD, 45.7%(59) had M.Sc and 24.8%(32) had B.Sc in library and information science. This goes to show that majority of the respondents were well rounded in the field of librarianship.

Table 3: Demographic Information of the Respondents

Qualification of Respondents	Frequency	Percentage
PhD	38	29.5
MSc	59	45.7
BSc	32	24.8
Total	**129**	**100.0**
Sex of Respondents		
Male	50	38.8
Female	78	60.5
Missing	1	0.8
Total	**129**	**100.0**

Source : Researchers' survey 2024

CLUSTER B:

Research Question 1: What are the areas of application of cloud computing in the services of pubic university's libraries in South- East, Nigeria?

In line with the first objective of the study which seeks to find out the application of cloud computing in the services of public university's libraries in south eastern Nigeria, this research question was posed. To answer the question, the researchers used the responses obtained from the eight items on the application of cloud computing in services delivery as shown in Table 4. The result of the analysis revealed that all the eight items had mean values above the cut-off mean of 3.00 and hence the decisions were all 'accepted'.

Table 4: Application of cloud computing services in public university libraries in south eastern Nigeria

S/N	Items	HA	A	U	NA	HNA	Missing	Mean	Std. Dev	Decision
1	Used to store library database	41	66	9	13		0	4.05	.891	HA
2	Used to host library software	36	72	9	8	2	2	4.04	.867	A
3	Used for mailing services	25	73	15	12	4	0	3.80	.963	‘’
4	Used for backup services	30	71	11	9	5	3	3.89	.982	‘’
5	Used for content delivery to clients	25	71	12	16	4	1	3.76	1.010	‘’
6	Used for web hosting	27	66	18	17	0	1	3.80	.923	‘’
7	Used for cataloguing	32	66	9	17	4	1	3.82	1.053	‘’
8	Used for eBook lending	25	45	13	38	7	1	3.34	1.244	‘’

Key: HA – Highly Applicable, A – Applicable, U – undecided, NA – Not Applicable, HNA – Highly not applicable
Source: Researchers’ survey 2024

From the data presented on the Table 4, it shows clearly that items number 1 and 2 had the highest mean values of 4.05 and 4.04 respectively. The implication of this is that the main areas where cloud computing services were applied in the libraries under study were for database storage and library software hosting. Similarly, item number 5 and 8 had the least mean values of 3.76 and 3.34 respectively. This implied that the libraries under study are least applying cloud computing in the areas of content delivery to clients and eBook lending.

Research Question 2: What are the benefits of applying cloud computing services in the public university’s libraries in South- East Nigeria?

Table 5: Benefits of applying cloud computing services in public university libraries in South-East, Nigeria

S/N	Items	SA	A	U	D	SD	Missing	Mean	Std. Dev	Decision
1	It enhances online visibility	34	75	19	7	2	1	4.03	.841	SA
2	It reduces financial burden on physical assets of the institution	25	40	13	38	11	2	3.24	1.306	A
3	It reduce ICT related challenges	25	38	9	45	12	0	3.25	1.335	A
4	Low environmental impact	26	36	19	38	8	2	3.27	1.263	A
5	It increases library clients	35	63	15	11	3	2	3.91	.976	SA

6	Increase in staff productivity	32	69	10	7	3	8	3.99	.899	SA
7	Quick feedback to clients	36	67	15	6	3	2	4.00	.900	SA
8	Reduction in daily operation costs	28	34	15	39	10	3	3.25	1.319	A
9	Facilitates quick system recovery after failure	23	41	36	21	3	1	3.50	1.042	A

Key: SA – Strongly Agree, A – Agree, U – undecided, D – Disagree, SD – Strongly Disagree
Source: Researchers' survey 2024

From the record shown on Table 5, it is obvious that items number 1 and 7 had the highest mean values of 4.03 and 4.00 respectively. The implication of this is that the application of cloud computing services were most beneficial to libraries under study in the aspects of increased visibility and quick feedback. Similarly, items number 2 and 3 had the least mean values of 3.24 and 3.25 respectively. This implied that applying cloud computing in the library being under studied had least benefits of reduction of finance on physical assets and reduction in ICT related challenges.

Research Question 3: What are the constraints confronting the application of cloud computing in public university's libraries in South- East, Nigeria?

Table 6: Challenges of applying cloud computing services in public university's libraries in south eastern Nigeria

S/N	**Items**	**SA**	**A**	**U**	**D**	**SD**	**Missing**	**Mean**	**Std. Dev**	**Decision**
1	Lack of management support	61	59	4	1	3	1	4.36	.791	SA
2	Data insecurity	47	59	17	4	0	2	4.17	.778	SA
3	Compromised privacy	42	57	20	9	0	1	4.03	.878	SA
4	Regulatory compliance concerns	43	54	22	8	1	1	4.02	.913	SA
5	Unskilled manpower	40	74	6	6	2	1	4.13	.823	SA
6	Poor internet connectivity	58	65	3	0	2	1	4.38	.689	SA
7	Low budgetary allocation	55	63	5	1	2	3	4.33	.738	SA
8	Fear of loss of job	38	30	12	31	15	3	3.36	1.434	A

Key: SA – Strongly Agree, A – Agree, U – undecided, D – Disagree, SD – Strongly Disagree
Source: Researchers' survey 2024

Table 6, shows that items 6 and 1 had the highest mean values of 4.38 and 4.36 respectively implying that poor internet connectivity and lack of management support were two major challenges encountered in the application of cloud computing services in the public university's libraries in South- East, Nigeria. In the same vein, item 8 had the least mean value of 3.36 which critically, revealed that fear of loss of job do not pose a constraint to the application of cloud computing services in public university's libraries in South –East, Nigeria.

Discussion of Findings

This research investigated the adoption and application of cloud computing in public university libraries in South Eastern Nigeria. The result in line with answering research question one revealed that cloud computing services such as storage of library databases, software hosting, mailing services, backup services, web hosting, cataloguing, content delivery to clients are some of the ways cloud computing services are applied in library. This is similar to the findings of Almaiah et al. (2020) that listed backup services, database hosting, software hosting as the major factor for the adoption and application of cloud computing in mobile services in University campus in Saudi Arabia, though the study is on mobile computing but the main focus is on cloud computing and this may account for the similar result.

The study in line with research question two outlined the key benefits of adopting and application cloud computing services in library setting to include enhanced online visibility, quick feedback to library clients, increase in staff productivity, more spread of library clients, quick recovery after system failure. This aligns with the findings of Furtheringham (2014) that the adoption of cloud computing services enhances staff productivity. The studies by Mell & Grance (2011), Sandholm & Lee (2014), Carroll et al (2011) posits that the adoption of cloud computing services promises several organizational benefits in terms of budget control, round the clock visibility, more efficient operation ,lower implementation and operation cost and so on. These studies as well corroborate with the findings of this study.

The key challenges confronting adoption and application of cloud computing in academic libraries were revealed by the study as poor internet connectivity, lack of management support, data security concern, low budget provision, privacy concern. This corroborates with findings of (Kayode, ,Tella & Akande, 2020) that noted that poor internet connectivity and data insecurity are the major setback in adopting cloud computing services in a developing clime as is case of Kwara State Nigeria. Similarly, (Yousef, et al, 2019) in their study reported that funding, privacy concern, and sustainability are some obstacles faced in adopting cloud computing services in academic libraries. From the findings as it concerns the challenges of adoption of cloud computing services, it can be extrapolated that funding is the major hindrance to the adoption of cloud computing services in public university libraries in South Eastern Nigeria. Mishra (2016) identified insufficient budget, poor internet connectivity, lack of management support among others as factors militating the adoption and application of cloud computing services by institutions. This also agrees with the findings of this study.

Conclusion

The goal of this study was to investigate the application of cloud computing in public university's libraries in South- East Nigeria. Drawing from the findings of this study, it was discovered that there is a reasonable application of cloud computing services in libraries in areas such as: hosting of relevant library software, electronic mail services, database backup services, cataloguing, among others in public university's libraries in South- East, Nigeria. Accordingly, the justification for applying these services were for the benefits derived from them which included ; to enhanced online visibility, quick feedback to clients' query, high staff productivity. Despite the progress made in application of cloud computing services in these libraries, they are still confronted with poor internet connectivity, lack of management support, data security concerns, poor funding, which are also peculiar to any technology based-services in developing countries as Nigeria.

Recommendations

The study deriving from the findings of this research recommends that library management should take cognizance of the benefits accruing to the application of cloud computing services and implement increased funding for this service. Moreover, the study discovered that unskilled manpower emanating from lack of ICT competence stands out as one of the challenges hampering the application of cloud computing services in the various institutional libraries. Based on this concerted effort should be made in training more library staff of all categories to embrace IT tools in carrying out their duty. More ICT infrastructure that can enhance the application of cloud computing services should be provided. Finally, the management should engage competent cloud computing service providers in handling core aspects of the programme to ensure security of stored data.

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