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## ORIGINAL RESEARCH ARTICLE

### Application of Cloud Computing to Academic Library Services in Kwara State

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#### ABSTRACT

**P**urpose: This study examines the application of cloud computing to academic library services in Kwara state. Method: The population of the study includes library staff of the University of Ilorin, Ilorin, Kwara state university, Malate and Landmark University, Omu-Aran, Kwara State. Meanwhile, the University of Ilorin has a population of 57, Kwara state university 24, and Landmark University, Omu-Aran has 19 given 100 library staff. The research design adopted was a descriptive survey. The total enumerative sampling technique was adopted for the limited population. A researcher-designed questionnaire was used for data collection and descriptive statistic of table count and frequency was used as data analysis. Findings: The study found out that infrastructure as a service, software as a service, and recovery as a service is the type of cloud models adopted by academic libraries in Kwara state. The finding of the study also indicated that google cloud, Alexandria, Duraspace, OCLC are the major vendors of cloud computing. It was also revealed that cloud computing applications to various library services like document download service; document sharing; digital preservation and scanning, social interaction were all done using the cloud. Conclusion: Finally, findings of the research revealed that cloud management, budget constraints, hardware and software, technical skills required for maintenance, connectivity, and dependency on the cloud are the challenges that are facing cloud computing.

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## 1. Introduction

Cloud computing is a general name for anything that concerns delivering hosted services over the Internet. Sulaiman, (2020) observed that this century can best be described as a knowledge era where information is available everywhere to consult, design to use, and make a decision. These services are generally divided into three categories: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), and Software-as-a-Service (SaaS) (Rouse, 2019).

It is the use of the internet for computing needs. According to Dutt (2015), cloud computing can be defined as a method of computing in which massively measurable and elastic IT-enabled capabilities are delivered as a service to external customers using Internet technologies. This idea has emerged for the outsourcing of computing infrastructure; storage of client data and applications that are accessed via a remote server refers to information. However, Information and Communication Technology (ICT) refers to all technologies used to handle telecommunications, broadcast media, intelligent building management systems, audiovisual processing and transmission systems, and network-based control and monitoring functions (Akanbi, Ogunleye & Sulaiman, 2019).

Cloud computing is the delivery of computing as a service instead of a product, where shared resources, software, and information are provided to computers and other devices as a metered or controlled service over a network, typically the internet. It is an enabling process of building an infrastructure for service provisioning from the library of providing end-user services. Cloud computing provides people the way to share distributed resources and services that belong to different organizations, corporations, libraries, or sites (Sahu, 2015). Cloud Computing is internet-based computing where online shared servers provide software, infrastructure, platform devices, and other resources and hosting to customers on a pay-as-you-use basis.

All information that a digitized system has to offer is provided as a service in the cloud computing pattern. Patrons can access

these services available on the “Internet Cloud” without having any previous know-how on managing the resources connected therewith. It is a way of harnessing computing services, which relies on sharing computing gadgets or tools rather than having local servers or personal devices to handle applications.

An academic library is a central and important organ in any academic institution (Olurotimi, 2015). Its importance hinges on the fact that it is attached to research which is the core area of any university in the world. Israel (2012) opined that the core aim of any academic library is to satisfy its patrons by providing materials to meet their educational, research, information, and recreational needs. An academic library is a library that is attached to an academic institution above the secondary level, to serve the teaching, learning, and research needs of students and staff (Umeh, 2017; Adeyemi, 2020). These libraries serve two complementary purposes: to support the curriculum of the school and to support the research of the university staff and students. Against this background, this study examines the application of cloud computing to academic library services in Kwara State, Nigeria.

### *1-1. Statement of the Problem*

The evolution and impacts of information and communication technologies (ICTs) in academic libraries have changed the way libraries services are carried out. Cloud computing is an evolving technological paradigm that facilitates convenience, on-demand network access to a shared pool of configurable computing resources like network, servers, storage, applications, services, and others that can be presented as a service and released with minimal management effort (Dastagiri & Kumar, 2017).

As the intellectual pool of the academic environment, the demand of the patrons on the academic library services is high. This is because the academic library is always expected to be the driving force of intellectual activities; exposition and exploitation of information resources in

various formats, and for the library to meet up with these expectations, creativity, and transformation of services are inevitable for it.

These two mechanisms are highly important for the academic library to remain as an integral part of the host institution that is established to support the mandates of teaching, learning, and research; and also to meet up with the emerging trend of applying technology to its services and various needs of its patrons in a cost-effective manner, it is now paramount than ever for an academic library to apply cloud computing to its services. Cloud computing is a new phenomenon that has enabled the library to host, share, access, and deliver resources, software, hardware, and information are provided on computers or devices as metered or monitored services over the network. It is a very flexible model, that allows users to create or prepare their applications, which others can be used through the internet. Because of the amazing and potential benefits of clouding issues such as security; virus threats, hacking of sites become a challenge to cloud use in an academic library.

However, cloud computing is costly and required a high charge of bandwidth, a library adopting cloud computing should have a way to generate funds that can be used for other things in the library. Moreover, poor training of library staff on handling cloud systems becomes an issue to the services rendered in the library. Thus, this study examines the application of cloud computing to academic library services in Kwara state, Nigeria.

### ***1-2. Objectives of the Study***

The main objective of this study is to investigate the application of cloud computing to academic library services in Kwara state, Nigeria. However, the specific objectives are to:

1. Determining cloud computing models/types applied to the services of an academic library in Kwara State,
2. Determining the types of access to cloud computing by the libraries,

3. Identifying the vendors of cloud computing patronized by the libraries.
4. Identifying the services carried out by the library using cloud computing and
5. Identifying the challenges associated with the application of cloud computing to academic library services in Kwara State.

## **2. Literature review**

### ***2-1. Cloud Computing:***

#### **Conceptual Explanation**

The origin of the term cloud computing is ambiguous, but its invention can be traced to the practice of using drawings of stylized clouds to represent networks in diagrams of computing and communications systems. The term cloud is used as a metaphor for the internet, based on the standardized use of a cloud-like shape to represent a network on telephony schematics and later to indicate the internet in computer network diagrams as an abstraction of the fundamental infrastructure it symbolizes. The internet was represented with the cloud symbol as early as 1994.

Murley (2009) posited that cloud computing is an evolving architecture by which data and applications reside in cyberspace, enhancing access to users through any web-connected device". Wolf (2010) cloud computing is any server usage or software program one can access outside of his or her local server. Cloud computing is simply the collection of computing software, hardware, and services that can be accessed through the internet rather than residing on a desktop or internal server (Yuvaraj, 2013). Jing, et.al (2012) opined that cloud computing is the mode of computing, where the users' data and computing gadgets are not running in the single terminal equipment such as PC, laptops, tablets, and others, but are dedicated in the cloud server through a network so that the users can have access to more information resources through exchange and sharing with others.

Cloud computing is a reliable model with distributed computing, grid computing, parallel computing, and the internet working

together to offer the users with dynamic, constant assimilation, processing, and dissemination of digital information resources and services (Sun, 2013). It is a computing channel where application services are provided through the internet. Alizahed and Hassan (2013) described cloud computing as a user-friendly virtual platform, that permits on-demand access to shared computing resources like storage, servers, networks, applications, and services that are fast to launch and implement with minimum interference from management or services providers.

Infoworld (2013) asserted that cloud computing is a service model that can be categorized into three types in order of service models: infrastructure services, platform services, and software services. Infrastructure as a Service (IaaS) is offered to customers on storage, network resource, a CPU with their need and configuration to other IT resources. Customers develop applications and operating systems they need on their own. The software services model is the recent model. It is a software application accessed with the web browser. This type of cloud computing delivers a single application through the browser to thousands of customers using a multitenant architecture. Service as Platforms (SaaS) is a service platform that offers independent customers to develop services based on their needs.

The platform includes environments in which the application is being run and developed by the customers. A customer cannot edit on the platform infrastructure. Cloud computing is a very flexible model that alone users to also build or prepare their application which can also be used by others through the internet and also provides a common computing platform (Dutt, 2015).

## **2-2. Types of Cloud Computing**

These types can be based on services (infrastructure, recovery, service, and platform) or the basis of usage (private, community, public, and hybrid).

Cloud Computing based on Services:

Recovery as a Service (RaaS): Solomon (2019) asserted that Recovery as a Service

(RaaS) solutions assist organizations and institutions to replace their backup, archiving, disaster recovery, and business continuity solutions in a single or integrated platform. RaaS providers protect and can help organizations and institutions recover entire data centers, servers (OS, applications, configuration, and data), and data (files and databases). RaaS helps institutions to reduce the impact of downtime when disasters happen. RaaS is also known as DRaaS (Disaster Recovery as a Service).

Merits of RaaS are: it prevents temporary or permanent loss of critical company data, prevents permanent loss of physical infrastructure, including IT infrastructure, it is a cost-effective way of recovering data, it enables faster recovery while maintaining accuracy, and it offers greater flexibility on the type of backup required (either primary or secondary backup).

Infrastructure as a Service (IaaS): Infrastructure is referred to as basic resources on the clouds (Pandya, 2015). Resource (infrastructure) is being provided by a third party as a service to the users to use them the way they want. Solomon (2019) posted that IaaS is the lowest level of a cloud solution and refers to cloud-based computing infrastructure as a fully-outsourced service. An IaaS provider will deliver pre-installed and configured hardware or software through a virtualized interface. The customers accessing the cloud services have the freedoms to do what they wish with the services. The merits of IaaS are: it reduces total cost of ownership and capital expenditures, customers pay for the service that they want on the go, access to enterprise-grade IT resources and infrastructure and it allow users to scale up and down based on their requirements at any time.

Platform as a Service (PaaS): Basically, a platform is a set of computational resources, which one can use the infrastructure. In other words, it is a set of computer applications developed and hosted on the cloud to access and manage the data. (e.g. Google App Engine, Windows Azure (Platform)). It offers providers a computing platform and solution stack as a service, apart from simply

providing infrastructures. PaaS services are mostly used by companies that need to develop, test, collaborate and deploy cloud solutions for particular applications.

**Merits of PaaS Solutions Community-** Many people are involved in building cloud applications in PaaS environments most of the time. This establishes a strong supportive community that can help an institution's development team along the way. No more upgrades – Institutions and organizations are not required to update or upgrade the infrastructure software. Instead, the PaaS provider handles and oversees all upgrades, patches, and routine software maintenance. **Lower cost** – Organizations, and institutions are exposed to lower risk since they do not have to make an advanced investment in hardware and software. **Simplified deployment** – The development team can concentrate on developing the cloud application without having to worry about the testing and deployment infrastructure.

**Services as a Service:** Services are a set of programs developed by the service provider to use cloud infrastructure and platform. This provides fully functionally web-based applications on-demand to users. The programs are mainly targeted at business users and can include web conferencing, ERP, CRM, email, time management, project tracking among others. **Merits of SaaS** are Rapid scalability, accessibility from any location with internet, eliminating infrastructure concerns, custom levels of service offerings, bundled maintenance, and supports.

### ***2-3. Cloud Computing based on Usage***

**Private Cloud:** Arokia, Rajan, and Shanmugapriya (2012) opined that private cloud is based upon a stream of shared resources, whose access is restricted within organizational boundaries. However, private cloud deployment is a kind of cloud infrastructure that is available for exclusive use by a single organization comprising multiple consumers (for example, business units). It may be owned, managed, and operated by the organization, a third party, or some combination of them, and it may exist on or off premises of the organization.

In a private cloud, as confirmed by Chukwhu and Lawal (2013) observed that infrastructures are being released, maintained, and operated for a specific organization. Based on the private cloud model, the resources are accessed over a private and secured intranet (local network) and are all owned and controlled by the institution or organization's IT section. Characteristically, private clouds, as pointed out by Database (2015), are operated by the cloud provider separately for a specific client and are very customizable. Also, there are more options regarding where the servers are physically located (at a data center or on-premise), and private cloud providers are also able to offer more flexibility in meeting specific application-related or security and privacy requirements.

**Community Cloud:** Malhotra and Jain (2013) opined that community cloud infrastructure is shared between the organizations with similar interests and requirements whether managed internally or by a third-party and hosted internally or externally (Huang, Lu & Xiong, 2014). The infrastructure is available and designed for exclusive use by a specific community of customers from organizations that have shared concerns (for example, mission, security requirements, policy, and compliance considerations). Community cloud could be established, owned, managed, and operated by one or more of the organizations in the community, a third party, or some combinations of them, and it may exist on or off premises of the institution or organization (Chukwhu and Lawal, 2013).

**Public Cloud:** The cloud infrastructure is available and designed for open use by the general public. It may be owned, managed, and operated by a business, academic, government organization, or some combination of them. It exists on the principle of the cloud provider (Mohanty, Pattannik & Mund, 2014; Huang, Lu & Xiong, 2014).

**Hybrid Cloud:** Ouahabi et al. (2014) deduced that the cloud infrastructure is a combination of two or more distinct cloud infrastructures (private, community, or

public) that remain unique entities, but are joined together by standardized or proprietary technology that facilitates data and application portability. Some vendors combine different cloud deployment strategies to accommodate a large portion of clients and as well maintain a high level of efficiency that is obtainable from the balance support of cloud-based systems (Madhusudhan, 2013).

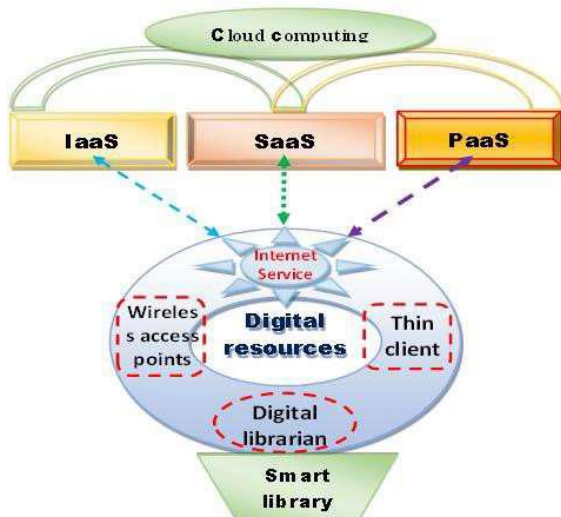


Figure1.. Hybrid cloud

#### 2-4. Application of Cloud Computing to Academic Library Services

Academic libraries are shifting their services with the integration of cloud and networking with the facilities to access these services anytime, anywhere (Neethu & Vanaja, 2017). Cloud computing offers various reliable possibilities for academic libraries that may need help to reduce technology cost, increase capacity reliability and performance for some type of automation activities and services. Cloud computing has a large potential for libraries. Libraries may put more content into cloud computing. Radha (2013) asserted that in an academic library, where information is exploded in recent age and the usages are being increased due to huge demands in information for research, teaching, and learning, the cloud is an inevitable platform; for example, because it helps in storing the information in one place and share the same to all clients whenever required via web-based systems. Romero (2012) described the features of cloud computing and its significance to

information delivery services and how it can be used in a professional environment. The author further opined that cloud computing is a highly measurable platform promising quick access to hardware and software over the internet by relying on new technologies such as virtualization and programming techniques that ensure relatively easy and quick access to information resources in academic libraries. This is also emphasized by Sosa and Ramirez (2012) that cloud computing is a recent operational structure that supports the provision of information technology resources on-demand and reduces management complicity in an academic library. Cloud computing application in academic library services offers an efficient approach to various services like library automation with a multi-user (client), federated search via Web-PAC, ILS – LMS (Integrated library system), Web hosting, Universal OPAC, Online resources sharing, Digital library, and Interlibrary loan, etc.

Neethu and Vanaja (2017) opined the applications of cloud computing by pointing to five major areas, which are: enabling academic libraries to host their web sites; developing and transforming of digital library, content management system, institutional repository, interlibrary loan (IIL) system and integrated library system (ILS) from locally-managed to the vendor-hosted environment; storage of library documents (Google Docs); backing up of media collections, storing and accessing of bibliographic data and developing of PC systems so that users can interact more with the library systems.

#### 2-5. Providers of Cloud Computing Services in Academic Library

There are various providers of cloud computing services as it can be deduced from the literature that their list is exhaustive. However, the major service providers are to be reviewed in this study. Online Computer Library Center (OCLC): OCLC launched the first cloud-based library management services platform in 2011. Since then, more OCLC services have transformed to this platform. Their cloud

architecture has led to higher integration and reuse of library data while allowing tasks to be performed on any Web-capable gadget, including mobile and tablet computers (OCLC, 2019). It also has WorldCat, a platform organized for the provision of cataloging services to users in the cloud.

OCLC is perfectly using cloud computing for libraries and practically demonstrating how it should be done well to others. OCLC has been functioning as a cloud computing vendor for several years because they provide cataloging tools over the internet and permit users to draw on their centralized data store (OCLC, 2014). OCLC has implemented Library Management Systems i.e. World share Management Services (WMS). This service can integrate other services in many areas like acquisitions, analytics, resource sharing, cataloging, and license management segments. It offers the entire library collection management in a cloud-based application. The WSM service promises to include privacy, security, scalability, and technical support.

Ex Libris: This is a well-known cloud service provider based in the USA. It is providing cloud solutions in the field of library and information services with all the software and hardware support needed to provide services to the users. It is available for all types of libraries and consortia. Ex Libris is developed on numerous standards and contains several attributes like compatibility with Unicode font, flexibility, migration of data, customization, etc. According to Ex Libris (2019), it is committed to providing its customers with a secured and reliable platform. Ex Libris has developed a multi-tiered security model that covers all aspects of cloud-based systems. Ex Libris service provision ranges from hardware maintenance, 24 x 7 professionally manned hub, system status page, monitoring services, redundant infrastructure systems (no single point of failure power, climate control, fire control), redundant infrastructure devices, hardware, and operating system upgrades and patches, application upgrades, patches, and maintenance, etc.

Dura Cloud: Dura Cloud is a hosted service from DuraSpace that supports user control in where and how his content is preserved in the cloud. It is fully hosted, easy to use, budget-friendly pricing, smart preservation tools for safety and security (Dura Cloud, 2019). Dura Cloud is providing a cloud solution for digital library services. It is a sister concept of the Duraspace which is a collaboration of the Dspace digital library software and Fedora Commons. Fedora Commons is a roadmap for a digital repository. It provides a complete solution to a digital library with standard software and hardware solution. Dura cloud also provides open-source code and the code needs to be installed on your machine.

## ***2-6. Benefits of Application of Cloud Computing in Academic Library***

Cloud computing has immensely contributed to the ways academic libraries create, processes of service provision by saving cost, improvising services, and also allowing libraries to incorporate resources together to enhance qualitative services. Scholars have made various approaches to note the benefits of cloud computing to library services. Goldner (2010) affirmed that cloud computing technology can create the new workflows needed by librarians because it offers the opportunity for a cooperative platform for libraries to build on. Back-up and recovery and easy access to information are the core benefits of cloud computing emphasized by Neethu and Vanaja (2017). They opined that most cloud service providers are usually competent enough to handle the recovery of information, which makes the entire process of backup and recovery much simpler than other traditional methods of data storage. In the aspect of easy access to information, they described that once the users register in the cloud, they can access the information from anywhere with the availability of an internet connection.

Saving financial and human resources is another benefit observed by Raghavendra, Indrami, and Narayama (2017). The authors asserted that another benefit benefits in moving to a cloud computing environment

for an academic library are the ability to give a trial to new software without any need to buy the hardware as well as being able to scale the computing power to meet the demand of users. This can make an academic library's IT department to be more flexible in raising the amount of cloud computing they require by contacting their vendor with no need to physically acquire new hardware, software, and manpower to meet increased demands. This system will save the library financial and human resources.

Ranchal et.al (2010) identified space maximization is another benefit. He asserted that operating systems, as well as office package applications, are never used to their fullest capabilities. This also amounts to a waste of resources due to duplication of system capacities. But with the trend of cloud computing, academic libraries can maximize space on the cloud because it permits integration of resources from various users. The economy of use is another benefit of cloud computing. Gartner (2015) posited that economy of resources and maximization of utilities through reduced cost associated with waste of resources, management, and maintenance of physical facilities and reinvestment of available funds to optimal services provision. He also acknowledged expansion of service as a benefit by suggesting that deployment of cloud computing can help libraries reclaim clientele patronage and win sponsors' encouragement.

Wada (2018) identified flexibility in the provision and exchange of service as a benefit. It is averred that cloud computing has the propensity to specially assist academic libraries to fully satisfy the needs of their respective clientele to the unimaginable level because the cloud computing paradigm is independent of location and can be accessed on any media having network connectivity and browsers. With cloud computing, information is not stranded on individual machines; it is combined into one digital cloud available at the touch of a finger from many devices. Nooshinfard and Ghorbani (2014) highlighted cost saving, flexibility, innovation, user-centric, openness,

transparency, interoperability, representation, availability anytime anywhere with the aid of a network, connect and converse, create and collaborate as benefits of cloud computing in academic libraries.

Yuvaraj (2013) and Neethu & Vanaja (2017) enumerated several benefits academic libraries would derive from applying cloud computing to their operations and services. According to them, in the meantime academic libraries would optimize their services by applying cloud computing to achieve maximum service provision through high computing power, location and device independence, high scalability, minimal maintenance, little indulgence in library activities, unlimited storage capacity, diverse support, faster deployment and development, greener library services, virtual presence and availability of library services, pay-per-use, reduced technology obsolescence, and no capital investment. With cloud computing, the meager budget of academic libraries can sustain to provide maximum information services.

### ***2-7. Challenges of Application of Cloud Computing to Academic Library***

The evolution of cloud computing brings about another challenge to academic libraries, irrespective of the benefits they enjoy from it. Radha (2013) highlighted three major challenges of cloud computing application to an academic library. This includes data security and privacy; the cost involved for software and hardware, technical skills required for maintenance. Tang (2013) specifically outlined issues of data security (user privacy leaks and virtualization security) and internet bandwidth as utmost challenges of cloud computing applications in academic libraries. This data security may create doubt in the minds of professionals. As in the case of digital data, there is still a huge fear of putting information in the hands of third parties because customers may lose ownership as the data is often stored in servers; and it is very difficult to migrate from cloud to cloud.

According to Pandya (2015), failure in compliance, constant connectivity required,



dependency, quality problems with a cloud service provider, time and budget constraints are challenges of cloud computing in academic libraries. He submitted that since all the development and deployment have been done by cloud service providers, it is very difficult to get a good grip on the overall system. However, irrespective of the way or approach scholars have taken to describe the challenges of cloud computing in academic libraries, it is apparent that time and budget constraints, failure of compliance, the bandwidth of internet service, dependency on the cloud service providers, cost of hardware and software, data privacy and security, technical skills to maintain cloud services the major challenges in academic libraries.

### 3. Method

This study used the descriptive social survey method to gather opinions from respondents.

The population comprises all Professional and Para-Professional Librarians in the University of Ilorin Library, Kwara State University Malate, and Landmark University. A total enumerative sampling technique was adopted. With total enumerative, the whole population of 100 forms the sample size. This total enumerative sampling is advised when the study population is too small, which will make the sample size to be too minute for an empirical study (Adeyemi & Omopupa, 2020).

Researchers self-designed questionnaire comprising two sections (A and B) was used. Section A centered on demographic information while section B details the objective of the study using Likert scale formats Strongly

Agree (SA) [4], Agree (A) [3], Disagree (D) [2]: Strongly Disagree (SD) [1]. The data collected were analyzed using a simple percentage and frequency count of the descriptive method.

**Table 1.**  
*Population and Sample size for the Study*

S/N	Name of Institutions	Para-Professional	Professional	Total
1.	University of Ilorin Library, Ilorin, Nigeria	24	33	57
2.	Kwara State University, Malate	18	6	24
3.	Landmark University, Omu-Aran, Kwara State	15	4	19
	Total	57	43	100

### 4. Data Presentation, Analysis and Discussion

**Table 2.**  
*Gender of the respondents*

S/n	Gender	No of respondents	Percentage (%)
1.	Male	55	55%
2.	Female	45	45%
	Total	100	100%

Source: Authors' Field work, (2021)

Table 2 shows that male respondents, having 55 percent are dominating their female counterpart, who has 45 percent. Though the

number of differences is minimal, it is still reflecting the trend that librarianship is a male-dominated profession.

**Table 3.**  
*Academic Qualifications of the Respondents*

S/n	Academic qualifications	No of respondents	Percentage (%)
1.	Ph.D.	18	18%
2.	Master's	21	21%
3.	B.Sc.	29	29%
4.	HND	26	26%
5.	ND	16	16%
	Total	100	100%

Table 3 indicates that B. Sc. holders are the highest respondents for this study with 29 percent. This is followed by the HND holders, who are having 26 percent, Master's

degree holders are 21 percent, while Ph.D. and ND holders are 18 and 16 percent respectively.

**Table 4.**  
*Years of Working Experience*

S/n	Years of Working Experience	No of respondents	Percentage (%)
1.	1 year	11	11%
2.	2 years	12	12%
3.	3 years	10	10%
4.	4 years	23	23%
5.	5 years and above	44	44%
	Total	100	100%

Source: Authors' Field work, (2021)

Table 4 shows that the staff of libraries with 5 years and above are the most respondents of this study, with 44 percent. Staff with 4 years working experience are 23 percent; 2 years' experience is 12 percent, while 1 year and three years are 11 and 10 percent respectively. The data provided in this table can be relied on. This is because the previous table about academic qualifications showed that B. Sc., HND, and Master's degree holders are the highest respondents cumulatively.

#### 4-1. Analysis of Research Question

Research Objective 1: Cloud computing models/types applied to the services of academic library in Kwara State

Note: AD = Adopted PA=Partially Adopted  
NA = Not Adopted

The table illustrates type of cloud computing services that are being used in the libraries understudy.

**Table 5.**  
*Type of cloud computing adopting in the library*

S/n	Type of cloud computing	AD		PA		NA	
		No	(%)	No	(%)	No	(%)
1.	Recovery as a service	23	23%	19	19%	58	58%
2.	Infrastructure as a service	21	21%	32	32%	47	47%
3.	Platform as a service	52	52%	31	31%	17	17%
4.	Software as a service	59	59%	27	27%	14	14%

Recovery as a service is not adopted in these libraries as 58 percent of the respondents not adopted, while 23 percent says it is adopted and 19 percent says it is partially adopted. It is also observed that 47 percent says the libraries have not adopted infrastructure as services, while 52 percent and 59 percent say

computing. The implication of this table to the study is that majority of the respondents are aware of platform and software as services cloud computing.

**Research objective 2:** Types of access to cloud computing by academic libraries

**Table 6.**

*Access to cloud computing by libraries*

S/n	Items	Yes		No	
		No	(%)	No	(%)
1.	Private	68	68%	32	32%
2.	Community	43	43%	57	57%
3.	Public	63	63%	37	37%
4.	Hybrid	32	32%	68	68%

The table illustrates a type of cloud computing services that are being used in the libraries under study. Recovery as a service is not adopted in these libraries as 58 percent of the respondents are not adopted, while 23 percent says it is adopted and 19 percent says it is partially adopted. It is also observed that 47 percent say the libraries have not adopted infrastructure as services, while 52 percent and 59 percent say the libraries have adopted both platform as a service and software as a service for cloud computing. The implication of this table to the study is that majority of the respondents are aware of platform and software as services cloud computing.

said public cloud computing services are being used in those libraries. However, 68 percent say no to the option that hybrid is being used in those libraries, while 57 percent also say no to the option that community cloud computing is being used in those libraries. The implication of this table to the study is that it may not be easy to specifically ascertain the cloud computing services that are used in those libraries, but it should certainly be one from either private or public. This is because the number of respondents that selected no as an option that hybrid is being used in the library is higher and hybrid should be a combination of two or more other cloud computing systems.

Table 6 observes that 68 percent say yes that private cloud computing services are being used in the library, while 63 percent

Research Objective 3: The vendors of cloud computing patronized by the libraries.

**Table 7.**

*Vendors of cloud computing patronized by the libraries*

S/n	Items	Yes		No	
		No	(%)	No	(%)
1.	OCLC	51	51%	49	49%
2.	Duraspace	58	58%	42	42%
3.	Polaris	16	16%	84	84%
4.	Google cloud	79	79%	21	21%
5.	OSS Lib	32	32%	68	68%
6.	Alexandria	82	82%	18	18%
7.	Ex-Libris cloud	36	36%	64	64%

Table 7 shows the cloud computing vendor being used in academic libraries. 51 percent say yes to OCLC, 58 percent picked Duraspace, 79 percent go for Google cloud and 92 percent go for Alexandria. However, 64 percent go against Ex-libris cloud, 84 against Polaris, while 68 go against OSS Lib

as they are not vendors to the libraries' cloud computing services. It is observed from the responses that Alexandria, Google, and OCLC are the most populations because of their free access.

Research Objective 4: The services carried out by the library using cloud

**Table 8.**  
*Services carried out by the library using cloud*

S/n	Items	Yes		No	
		No	(%)	No	(%)
1	E-book lending services	52	52%	48	48%
2.	Union shared catalogue OPAC	44	44%	56	56%
3.	Document download services	63	63%	37	37%
4.	Digital preservation/scanning services	72	72%	28	28%
5.	Article delivery service	54	54%	46	46%
6	Current awareness service	61	61%	39	39%
7.	Document sharing	72	72%	28	28%
8.	Bulletin board service	38	38%	62	62%
9.	Information common	81	81%	19	19%
10.	Collection development	50	50%	50	50%
11.	File sharing	57	57%	43	43%
12.	Information discovery	42	42%	58	58%
13.	E-Learning	66	66%	34	34%
14.	Information literacy/orientation	24	24%	76	76%
15.	Social interaction with users	71	71%	29	29%

Table 8 indicates that the libraries are using cloud computing for E-books lending by 52 percent. In the same vein, 63 percent were of the view that the libraries are running document download, 72 percent support digital preservation/scanning, 54 and 61 percent said yes that the libraries are using cloud computing for article delivery and CAS respectively. The libraries are also using cloud computing for document sharing by 72 percent, information communication is 81 percent, file sharing is 57 percent, e-learning is 66 percent, and social interaction with users is 71 percent.

However, 56 percent say no to the option that the libraries are using cloud computing for union shared catalog, 62 percent are of the view against the usage of cloud computing for bulletin board services, 58 don't use it for information discovery and supported by 76 percent, who also responded no to the usage of cloud computing for information literacy services. It is also shown in the table, an equal percentage of 50/50 goes for yes and no when asked whether cloud computing is being used for collection development. The implication of this table to the study is that services like file sharing, e-book lending, e-learning document download, and others are typical

services of cloud computing that are carried out in academic libraries but collection development and union shared catalog is less used in academic libraries.

Research Objective 5: Challenges associated with the application of cloud computing to academic library services in Kwara State

**Table 9.**  
*Challenges of the Application of Cloud Computing to Library Services*

S/n	Items	Yes		No	
		No	(%)	No	(%)
1	Data security/privacy	64	64%	36	36%
2.	Technical skill required for maintenance	67	67%	33	33%
3.	Time constraint	28	28%	72	72%
4.	Budget constraint	69	69%	31	31%
5.	Connectivity	58	58%	42	42%
6	Cost of software/hardware	81	81%	19	19%
7.	Dependency on the cloud service provider	59	59%	41	41%
8.	Cloud management	69	69%	31	31%
9.	Internet bandwidth	60	60%	40	40%

Table 9 indicates that data security /privacy is a challenge of cloud computing as 64 percent of the respondents support the assertion; 67 percent say technical skill is also a challenge, 69 percent outlined budget constraint, 58 percent agree that connectivity is also a challenge, while 81 percent are aware that cost of software and hardware are challenges libraries are facing on cloud computing. However, 59 percent also attribute dependency on the cloud service provider as a challenge, 69 percent go with cloud management as a challenge, while 60 percent say internet bandwidth is a challenge. On the contrary, it is only a time constraint that 72 percent go against as a challenge to cloud computing services in the libraries.

Despite the challenges provided, there are still some that can be questioned. For example, the respondents picked security as one of the impacts of cloud computing, while here, they are also supporting the assertion that data security/privacy is a challenge. This is somehow contradictory. Also, going by the number of respondents that go for internet bandwidth and connectivity as

challenges, I can say the numbers are minimal. Though they may still represent the majority of the respondents, I am expecting the percentage to be more than what I am having in the table.

### 5. Discussion of Finding

The finding of the study revealed that platform as a service and software as a service is the cloud computing adopted by academic libraries in Kwara state, while public and private are the major types of access to cloud computing that are adopted by the libraries under study.

The study also found out that Alexandria, OCLC, Google cloud, and Duraspace as vendors for their cloud computing services. E-books lending, document download services, digital preservation, document sharing, information common, file sharing, e-learning, and social interaction with users are the most adopted vendor among academic libraries. This is supported by Ex Libris (2019) that vendors of cloud computing provide its customers with a secured and reliable platform

On the impact of cloud computing on academic services, the study found out that

cloud computing help data searching, file storage, searching scholarly content, web hosting, library automation, and digital preservation and repository. This is supported by the Saving of financial and human resources is another benefit observed by Raghavendra, Indrami, and Narayama (2017) that cloud computing saves financial and human resources of academic libraries.

The study also found out that data security/privacy, technical skill, maintenance, budget constraint, connectivity, cost of software/hardware, dependency on the cloud service provider, cloud management, and internet bandwidth are the challenges the libraries are facing in the event of the application of cloud computing to their services. This is supported by Radha (2013) that data security and privacy, the cost involved for software and hardware, technical skills required for maintenance are major challenges influencing cloud computing among academic libraries.

## 6. Conclusion

The following conclusions are hereby drawn for this study:

It established in the study that Platforms and software services are the most used cloud computing in academic libraries in Kwara state because it is perceived that they are easy to use and users friendly. Also, private and public clouds are access tools for clouds computing in the most academic library. However, the study also concludes that Alexandria, Duraspace, Google cloud, and OCLC are the cloud computing vendors adopted in the libraries and high cost of maintaining cloud computing, security, and, technical skill required for maintenance, budget constraint are challenges of cloud computing among academic libraries.

## 7. Recommendations

The following recommendations were made:

- Adequate budget should be allocated to the library.
- Academic libraries should endeavor to patronize other vendors aside from the popular for healthier competition.

- Training should be organized for librarians on the benefits of cloud computing
- Academic libraries should cooperate among themselves on how to integrate new trends into their services to serve their users well.
- The ICT Section of the Nigerian Library Association should develop a policy on the application of cloud computing to academic library services in Nigeria.

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