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ADOPTION AND IMPLEMENTATION OF CLOUD COMPUTING TECHNOLOGIES AND THEIR IMPACT ON SERVICE DELIVERY AMONG POLYTECHNIC LIBRARIES OF KATSINA STATE

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ABSTRACT

This study investigated the adoption and implementation of cloud computing technologies and their impact on service delivery in polytechnic libraries of Katsina State, Nigeria. Academic libraries play a critical role in supporting teaching, learning, and research. However, the increasing demand for electronic resources, remote access, and efficient information services has necessitated the adoption of emerging technologies, particularly cloud computing, to improve library operations and service delivery. A descriptive survey research design was adopted for the study. The population comprised 350 librarians and academic staff from three public polytechnics in Katsina State, from which a sample of 183 respondents was selected using proportionate stratified sampling. Data were analyzed using descriptive statistics. The findings revealed that respondents were generally aware of cloud computing technologies and their potential to enhance library operations. The study further established that cloud computing adoption in the selected libraries is at a partial stage, with email services and cloud storage being the most frequently utilized applications. Despite this awareness, the overall level of implementation remains low. Nevertheless, cloud computing has improved access to library resources, enhanced the efficiency of service delivery, and reduced operational costs. The major challenges affecting effective implementation include poor internet connectivity, inadequate technical expertise, and the high cost of implementation. The study recommends increased awareness and capacity building on cloud

computing applications, the adoption of cloud-based library management systems such as Koha, and greater investment by government and relevant stakeholders in broadband internet connectivity, ICT infrastructure, and stable electricity supply to facilitate the successful implementation and sustainability of cloud computing technologies in polytechnic libraries.

KEYWORDS: Adoption; Implementation; Cloud Computing Technology; Service Delivery; Academic Library.

INTRODUCTION

The advancement of information and communication technologies (ICTs) has transformed library operations globally. , traditionally viewed as custodians of physical information resources, are increasingly adopting digital technologies to improve service delivery. Cloud computing is one such technology that provides on-demand access to computing resources, storage, and applications over the internet, reducing the dependency on physical servers and enabling efficient library management (Armbrust et al., 2010).

Cloud computing helps to improve the reach of quality online education to learners. Cloud based collaboration such as community, online forum can support learners and students to discuss common difficulties and try to solve from experts. Schools, colleges, institutes and universities can use cloud computing based information management systems to the admission process, offer online and distance education programs, tracking progressive report of students, online exams, collect opinion from learners and students, for instance. Cloud computing based online education systems can offer access to excellence online materials to the students. It can help the educational institute in cutting down the IT infrastructure expenses, IT manpower and yet deliver access to cloud based educational services to a very large number of learners and students. (Bahga & Madiseti, 2014)

Cloud computing works on a principle of sharing of resources and infrastructure for effective and efficient service delivery. It encompasses the provision of software services and with the essential hardware resources used as a virtualized platform across numerous host computers connected by the Internet or an organization's internal network (Treacy, 2009; Buyya, et al., 2009). The US department of Commerce's National Institute of Standards and Technology defines cloud computing as a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. Email servers like Gmail, Hotmail, Yahoo

are popular providers of electronic mail services handling the hardware and software needed to support personal email accounts (Huth & Cebula, 2011) used by individuals and organizations for their day-to-day tasks. Which simply requires a web browser, a smart device, or any Internet enabled devices, and an access to a registered email account.

Cloud computing provides new opportunities for innovation and offers unprecedented new levels of configurability for diverse groups of users of which the library is not left out. Creates possibilities for services to be dynamically configured to the needs of each user with a single unified, usually global-scaled, architecture (Kushida, Murray, & Zysman, 2011). It delivers services incorporated in any of the following nomenclature: data storage, computation (processing power), and networking. That is, sharing of data storage, computing power, and network infrastructure by multiple user groups. Cloud services can be provided to users at any time, regardless of location, with the cost based only on the resources used. Users or subscribers only need to procure from the providers the ‘amount of computing’ required without needing to invest in the entire computing infrastructure (Kushida, Murray, & Zysman, 2011).

Academic Libraries are central to teaching, learning, and research activities in higher institutions. In the digital age, the traditional role of libraries has evolved from physical collections to hybrid and fully digital environments (Madu et al., 2014).

The increasing demand for electronic resources, remote access, and efficient service delivery has compelled academic libraries to adopt emerging information technologies. Cloud computing has emerged as one of the most promising solutions for addressing these needs. In Nigeria, Academic Libraries operate under constraints such as inadequate funding, poor ICT infrastructure, and limited technical skills (Imam, 2024). These challenges are more evident in northern states such as Katsina, making the study of cloud computing adoption timely and relevant.

Libraries are gradually embracing cloud computing to manage collections, automate processes, and provide remote access to library users. However, adoption levels, challenges, and impacts on service delivery vary across institutions. This study examines the adoption, implementation, and impact of cloud computing technologies in Katsina State, focusing on Hassan Usman Katsina Polytechnic and Katsina State Institute of Technology and Management and Federal Polytechnic Daura..

Objectives of the Study

The main objective of this study is to examine the adoption and implementation of cloud computing technologies and their impact on service delivery in Polytechnic Libraries of Katsina State, Nigeria, while the specific Objectives are:

1. To determine the level of awareness of cloud computing technologies among the academic staff of Polytechnics in Katsina State.
2. To identify the types of Cloud Computing Technologies adopted in Katsina Polytechnics libraries.
3. To examine the extent of adoption and implementation of cloud computing technologies in Polytechnics Libraries of Katsina State
4. To assess the impact of Cloud Computing adoption on service delivery in polytechnic libraries of Katsina State.
5. To identify challenges associated with the adoption and implementation of cloud computing in Polytechnic libraries of Katsina State.

Review of Related Literature

Concept of cloud computing

Cloud computing is now being used by most organizations, its application includes, data backup in a case of disaster recovery, software development, and big data analytics. Cloud computing is now being adopted by various professions as well such as health where it is used to develop personalized treatments for patients also financial services companies are using the cloud to sway real-time fraud detection and prevention more so, Video game producers are not left out as they use the cloud to deliver online games to limitless players. The National Institute of Standards and Technology (NIST) has identified five essential characteristics of cloud computing: “on-demand service, broad network access, resource pooling, rapid elasticity, and measured service”. Cloud services exhibit five essential characteristics that demonstrate their relation to, and differences from, traditional computing approaches:

On-demand self-service: this those not require human interaction with a service provider, a customer can singly serve itself computing capabilities like server time and network storage as needed automatically. Secondly, in Broad network access, capabilities are made offered over the network and accessed via standard mechanisms that stimulate use by heterogeneous client platforms, thirdly Resource pooling is a situation where computing resources are pooled to serve multiple consumers with the aid of multitenant model, with diverse physical

and virtual resources which are dynamically assigned to suit the demand of the consumer., fourthly in rapid elasticity, capabilities are unlimited on rapid elasticity, it can be provisioned rapidly and quickly and as well as automatically scale out and in and as well can be purchased in any quantity at any given time, lastly, on measured service, the provision of services is being monitored for the benefit of the user and consumers, it also automatically controls resource usage by leveraging a metering capability.

Cloud computing service models

Choosing a cloud service provider gives users more or less control over their cloud depending on the type. However, when choosing a provider, it is very essential to compare the intent of use. The need will vary depending on what one needs it for, either in libraries, for business, for health services, or personnel benefits as all these needs and purposes require different cloud types and services. Cloud service models are in three categories that one can subscribe to Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). It has been detailed by several scholars as they pointed out its usefulness. Such as (Mell & Gance 2011, Swapna & Biradar, 2017, Dhaka 2017, Neethus & Vanaja 2017, (Makori 2016; Ireno, Tijani & Bakare 2018; Chudasman, Bhatt, & Trivedi, 2019). These three types differ in the level of control that one has over its contents, and the specific functions deliver by the service providers.

Software as a Service (SaaS): services are delivered to users from any online devices. Installing, upgrading and maintenance are the sole responsibilities of the service provider two packages are made available free and also subscribers benefit from low costs. The free one's web 2.0 applications, Skype, Hotmail, and Google Apps, while most business-oriented SaaS, such as Salesforce, are leased on a subscription basis. On the subscription, level access is available 24/7. Platform as a Service (PaaS): These services provide computing platforms with supplies tools to enable companies to build, test, and deploy Web-based applications. Infrastructure as a Service (IaaS)/ or Hardware as a Service. Amazon's Web Services is one of the leads in this area it involves both storage services and computing power. Amazon's Web Services offers two main products including the Elastic Compute Cloud (EC2) that offers computing resources and the Simple Storage Service (S3) for data storage.

Cloud Computing Deployment Models

National Institute of Standard Technology (NIST) explained to cloud deployment models as follows:

Private cloud: the private cloud infrastructure is usually operated for a specific organization; the infrastructure may exist on-premise or off-premise. The organization can choose to manage it by itself or by a third party. Although on-premise infrastructure is usually expensive but secured (Balan, Gupta, Kanal, Singh, & Bhanumurthy, 2014).

Community cloud: community infrastructure is shared between organizations that have similar interests, shared concerns in mission, security requirements, and policy. It may be managed by the organizations or a third party and may exist on-premise or off-premise. (Dillon, Wu, & Chang, 2010).

Public cloud: This is a type of infrastructure in which the computing infrastructure is run, and situated within the sites of the host company's data centers and not in the customers' premises. That is, it is an off-premise arrangement from which services are provided. The physical infrastructure is not being controlled by the subscriber. The cloud infrastructure is made available to the general public or a large industry group and is owned by the service provider. This type of cloud uses a shared infrastructure pool from which many companies and institutions that need their services share the same infrastructure to run their services. The access is without any geographical location just with internet connectivity. (Imam, Ezrah & Abiola, 2024)

Hybrid cloud: Hybrid cloud is a combination of private, community, or public. The cloud infrastructure of the private, community and public are unique entities but bound together by standardized technology that enables data and application portability for transitive information exchange. They use standard methodologies regardless of ownership or location. (Shaheed & Abiola, 2021)

In establishing the relevance of cloud computing in academic libraries, studies such as Adegbilero-Iwari and Hamzat (2017) reviewed the prospect of cloud computing technology in Nigerian academic libraries. They proposed the Library Service Platform (LSP) as the most important gate-way for implementing this technology in Nigeria. The study recommended that for successful adoption of LSP in academic libraries in Nigeria, library authority must form the research team for LSP, assess the library workflow, review the current process and apply innovation and technology in library operations and explore open sources tools for maximum utilization of this technology for the betterment of academic libraries.

Similarly, Arpaci (2017), studied the antecedents and consequences of adopting cloud computing education to achieve knowledge management using the technology acceptance model (TAM). His study was carried out on undergraduate students in a Turkish university. Cloud computing adoption can be promoted if educational institutions can increase the awareness of knowledge management. On the contrary, Raed, Fash, and Chang (2015). Study on the migration of cloud services and deliveries to higher education revealed that the major challenges affecting the adoption of cloud in these universities under study include data security, lock-in, privacy issues, regulatory compliance, data insecurity, Pillai and Seena (2018) surveyed the application and awareness of cloud computing technology at Kerala University. Their findings revealed that 42.16% of library staff have less idea about cloud technology, this is to say the majority of them are not aware of cloud service modules although the majority of these professionals used Google applications in their daily tasks. Therefore, the study recommends an urgent need for the library staff understudy to be trained and informed about cloud computing technology.

Enefu, Gbaje, and Aduku (2015) investigated the basis for the implementation of cloud computing for the National Open University of Nigeria (NOUN) library services. Their findings revealed the library provides services using various networks. Although they used cloud computing in providing services which do not have a wide coverage as some student is left out. they recommended their library need to provide services through Wide Area Network (WAN) that can provide wide coverage to the student also they suggested a hybrid cloud deployment model

Similarly, Wada (2018) carried out a study on “cloud computing implementations in libraries” he stated that implementing cloud computing in libraries will significantly reduce the cost of maintaining systems, save energy and expose library to multi-variant information resources and as well for better optimization of library services, he furthered that digital resources, internet service, thin-client architecture, wireless access point and digital librarian are the major prerequisites for cloud computing deployment. A study by Yuvaraj, (2015). “On implementing and sustaining cloud technology at Banaras Hindu University Library (BHUL)”, revealed that the library is providing valued-added cloud-based library services to its users and as well fully prepared to clamps any challenges that may surface towards cloud computing in the university library. This optimistic attitude was confirmed in a study by According to Kaushik and Kumar (2015), the idea of cloud computing is based on a very fundamental principle of reusability of IT capabilities. Cloud computing broaden horizons

across organizational boundaries compared to automatic, grid, utility, and distributed computing.

However, some country's economic situation is obstacles inhibiting libraries and information center adoption to clouds, according to Makori (2016), library and information centers in Kenya faced abundant operation needs due to off economic situations, he also recommended that cloud computing is progressively thrust as the best means to handle and support the delivery of services in the library and information centers. According to Nag and Nikam (2016), Libraries are now loaded with various expenses. On the other hand, with cloud computing, there is little or nothing to finance. "Pay-as-you-go" & "Subscription" methods are two modes of payment in cloud computing. With it, there is no gainsaying that cloud computing will solve storage issues for libraries. In the same vein, Sahu (2015) reiterates that cloud computing has the tendencies of transforming the way services are delivered given libraries a better prospect to extend their impact. Thus, with cloud computing, the cost of computation, hosting, storage, and delivery of services is meaningfully less.

An earlier study by Abdulsalam and Fatima,(2011) explored the applications of cloud computing in higher education in Nigeria, Their study affirmed that cloud computing has great potentials in improving the ICT applications and infrastructure at higher levels of education in higher institutions in Nigeria, although Their study identified some cogent factors that have militated a successful implementation of cloud computing in Nigeria's higher institutions such factors include unsteady power supply, cost of ownership, lack of access, etc. however for a better transition, they opined such institution keep in contact with reliable organizations such as National Institute of Standards and Technology(NIST) to ensure the suave transition.

Majhi, Meher, and Maharana (2015) conducted a study on "awareness and usage of cloud computing application among LIS professionals" The result revealed that usage of cloud in library operations and services was not significant. A total of 75 % of the library professionals used basic cloud services for personal purposes such as store files online, store personnel videos, and photographs online and as well for collaborative writings and 42 % used this technology for providing library services. The study further revealed that the deep interest to use this technology in library services and operations as they believed that by applying cloud technology it will reduce the overall cost of library and easy collaboration.

A study by Udanor, Obilo, and Aneka (2018), on implementing cloud computing storage in Nigeria tertiary institutions, was able to develop a model of a stable cloud infrastructure that enables researchers to collaborate and share data among the academia. The design and

implementation are based on the Synnefo cloud. Similarly, Yuvaraj (2013) explored the application and usage of cloud technology at libraries of a total of 29 central universities in India. The survey tool designed and collected data from a total of 407 library users from all the universities. Findings revealed that 32.4 percent of library professionals have core computer literacy in terms of professional certification in computer science in addition to a professional degree in library science. Almost 87 percent of the library personnel shows a willingness to provide library services through the cloud. Library professionals indicated the willingness to use layers of cloud computing mainly free software, platform, and infrastructure as cloud services in the central university. Data security and protection of personal data are the major concerns expressed by the library professionals.

Oyeleye, Fagbola and, Daramola, (2014) on the “impact and challenges of the adoption of cloud computing in public universities in the South-west, Nigeria”. Their results revealed that adopting cloud computing has a key influence on cost-effectiveness, enhanced availability, reduced investment in physical assets, reduced IT complexities, and ultimately increased operability. This was affirmed also by Yuvaraj, and Mayank, (2013), that 91% of the organizations in the US and Europe agree that the reduction of cost is a major reason for them to migrate to a cloud environment. From the user's point of view, a study by Ashtari and Eydgahi, (2017) examined The influence of users' perceptions toward the cloud computing technologies was investigated The researchers focused on the associations between variables identified in the literature that were considered to be influencing the perception of students in the university in Southeast Michigan. These variables include users’ perceptions of the usefulness and effectiveness of cloud computing applications, perceived ease of use, Internet self-efficacy, computer anxiety, computer self-efficacy. They carried out an online survey among 40 undergraduate students at Michigan University and used the Technology Acceptance Model (TAM) to analyze the adoption of cloud computing by students.

According to Gisolfi, (2015), with the presence of smart technologies and other innovative IT gadgets, today’s library patrons are techno-savvy and most prefer to interact via email, instant messaging services, streaming news, and media outlets. Hence, libraries must acknowledge technology trends and re-invent their services to provide efficient services, so as not to be bypassed by users that perceive their services to be slow, unappealing, and irrelevant inactive library service delivery. There is a need for libraries to be proactive by re-strategize and restructure their mode of service delivery to satisfy their clientele (McCallum, 2015). Therefore, embracing new technology trends like cloud computing that can improve service delivery to her clientele is the only way for libraries and information centers survival.

Although, the migration to the cloud-based library may not take place out rightly, however it is inevitable to look at various opportunities that cloud base services can offer that will necessitate its adoption by library and information centers. As specified by Neethu and Vanaja (2017) are Cost Efficiency, Scalability, Lower investment, Support included, Greater security and accessibility, Portability, Adjustable storage, Cloud OPAC, Unlimited Storage, Backup and Recovery, Essay Access to Information. More so it is user-centric, interoperability, representation, connect and convert, and create and collaborate, Easy on installation and maintenance, Highly automated, Better mobility (24x7) service, and Shared resources.

METHODOLOGY

This study adopted a descriptive survey research design to investigate the phenomenon under study. The target population comprised 350 personnel drawn from three public polytechnics in Katsina State, Nigeria. The respondents included librarians, academic staff, and ICT personnel working in the selected institutions.

The institutions selected for the study were Federal Polytechnic Daura, Hassan Usman Katsina Polytechnic, and Katsina State Institute of Technology and Management. Respondents were selected through a simple random sampling technique to ensure that all members of the target population had an equal chance of participation.

A sample size of 200 respondents was drawn from the population. Data were collected using a structured questionnaire as the primary research instrument. The questionnaires were administered personally by the researcher with the help of two research assistants. Out of the 200 questionnaires distributed, 183 were properly completed and returned, representing a response rate of 91.5%.

The collected data was analyzed using descriptive statistics, specifically frequency counts and percentages. Data analysis was conducted with the aid of IBM SPSS Statistics to facilitate accurate data processing and presentation of findings.

RESULTS AND DISCUSSIONS

RO₁: To determine the level of awareness of cloud computing technologies among the academic staff of Polytechnics in Katsina State. See Table 1.

Table 1. Level of awareness of cloud computing technologies among the academic staff of Polytechnics in Katsina State.

Statements	SD		D		UD		A		SA		Mean	S.D
	F	%	F	%	F	%	F	%	F	%		
I am aware of cloud computing technologies	0	0.0	20	10.9	55	30.1	71	38.8	37	20.2	3.68	0.92
I understand the concept of cloud computing	0	0.0	30	16.4	40	21.9	56	30.6	57	31.1	3.77	1.07
I am aware of cloud services used in libraries	5	2.7	35	19.1	32	17.5	75	41.0	36	19.7	3.56	1.09
I have received training on cloud computing	10	5.5	10	5.5	45	24.6	56	30.6	62	33.9	3.82	1.13
My institution creates awareness about cloud computing technologies	0	0.0	35	19.1	33	18.0	75	41.0	40	21.9	3.66	1.03

(Field Survey 2026, Key: SD= Strongly Disagree; D= Disagree; UD= Undecided; A= Agree; SA= Strongly Agree)

The data obtained from table 1 show that the Polytechnic staff members in Katsina State are aware of the use of cloud computing technologies. In particular, 59.0% responded agree or strongly agree that they are familiar with cloud computing technologies (Mean = 3.68, SD = 0.92) and 61.7% responded agree or strongly agree that they know what cloud computing is (Mean = 3.77, SD = 1.07). Likewise, 60.7% of the respondents agreed or strongly agreed that they know about the cloud services used in libraries (Mean = 3.56, SD = 1.09); 64.5% agreed or strongly agreed that they have been trained on cloud computing (Mean = 3.82, SD = 1.13); and 62.9% agreed or strongly agreed that their institutions promote awareness of cloud computing technologies (Mean = 3.66, SD = 1.03). This shows that the respondents have good understanding and awareness of the cloud computing technologies and its use in library services.

RO₂: To identify the types of Cloud Computing Technologies adopted in Katsina Polytechnics libraries.

Table 2: Identifies the types of Cloud Computing Technologies adopted in Katsina Polytechnics libraries.

Types of Cloud Computing Technologies adopted in Katsina Polytechnics libraries	Yes	
	F	%
Cloud storage	86	47.0
Cloud-based LMS	71	38.8
Digital repository	83	45.4
Email Services	91	49.7
Online databases	82	44.8
Not sure	95	51.9
Deployment Model		
Public	93	50.8
Private	51	27.9
Hybrid	53	29.0
Not sure	108	59.0
Service Model		
Saas	41	22.4
PaaS	33	18.0
IaaS	39	21.3
Not sure	95	51.9

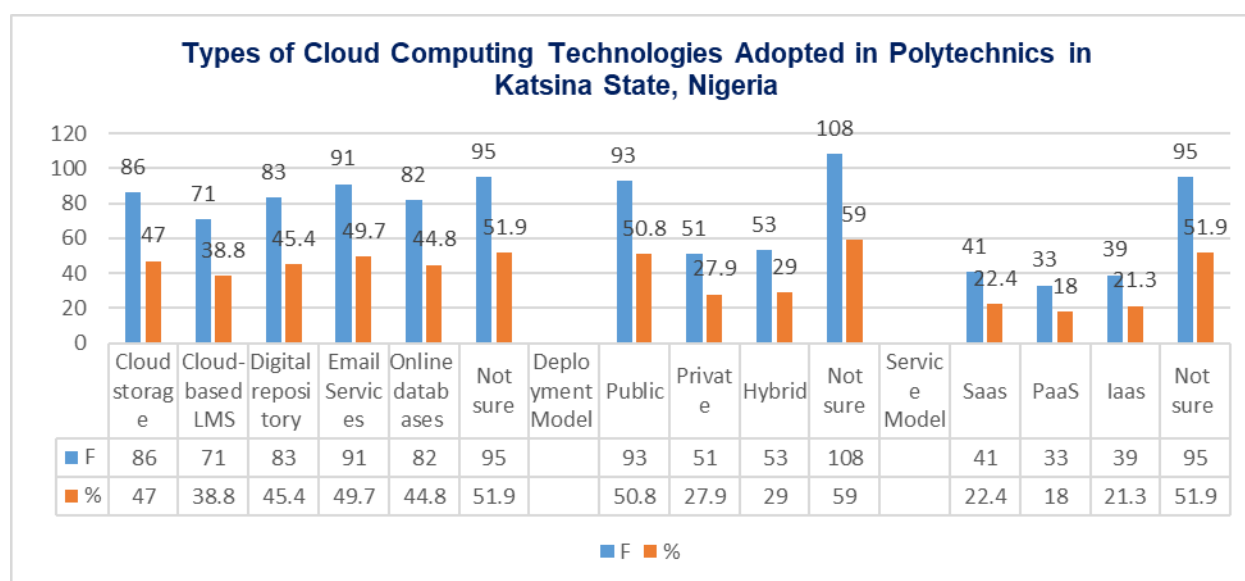


Table 2 shows that, there is an ongoing partial adoption of different types of cloud computing technologies in the polytechnic libraries of Katsina State with significant respondents' uncertainty about the use. When it comes to applications, Email Services had the highest awareness/adoption (49.7%), followed by Cloud Storage (47.0%), Digital Repositories (45.4%), Online Databases (44.8%) and Cloud-based LMS (38.8%). However, over half of the respondents (51.9%) said they did not know about the cloud computing applications that

are being used. When it comes to deployment models, the majority (59.0%) were unsure of the deployment model that was being used, followed by Public Cloud (50.8%) and Hybrid (29.0%). Likewise, SaaS (22.4%), IaaS (21.3%) and PaaS (18.0%) had low levels of recognition with 51.9% unsure.

RO₃: To examine the extent of adoption and implementation of cloud computing technologies in Polytechnics Libraries of Katsina State

Table 3: Extent of adoption and implementation of cloud computing technologies in Polytechnics Libraries of Katsina State.

Statements	VL		L		M		H		VH		Mean	S.D
	F	%	F	%	F	%	F	%	F	%		
Cloud computing is widely adopted in my library												
Library services are delivered using cloud platforms	89	48.6	69	37.7	25	13.7	0	0.0	0	0.0	1.65	0.71
Cloud-based tools are integrated into daily operations	85	46.4	56	30.6	18	9.8	12	6.6	12	6.6	1.96	1.19
My institution supports cloud implementation	45	24.6	79	43.2	12	6.6	39	21.3	8	4.4	2.38	1.19
There is adequate infrastructure for cloud computing	44	24.0	69	37.7	23	12.6	42	23.0	5	2.7	2.43	1.16
My institution creates awareness about cloud computing technologies	34	18.6	73	39.9	42	23.0	21	11.5	13	7.1	2.49	1.13

(Field Survey 2026, Key: 1 = Very Low, 2 = Low, 3 = Moderate, 4 = High, 5 = Very High)

The results presented in Table 3 indicate that the level of acceptance and use of the cloud computing technologies in Polytechnic Libraries in Katsina state is generally low. Most of the respondents indicated that their libraries have very low or low usage of cloud computing. In particular, 86.3% of respondents identified that library services are delivered on cloud platforms very little (mean = 1.65, SD = 0.71) or little (mean = 1.65, SD = 0.71), respectively. Likewise, 77.0% said that cloud-based tools are used every day, very little or little (Mean = 1.96, SD = 1.19). In addition, 67.8% said institutional support for the implementation of cloud is very low or low (Mean = 2.38, SD = 1.19), and 61.7% said that the infrastructure required for cloud implementation is adequate to very low extent (Mean =

2.43, SD = 1.16). Fifth, the awareness created about cloud computing technologies within institutions was also very low (2.49) or low (3.28) by 58.5% of the participants. The results show that the use and implementation of cloud computing technologies are not widespread in the polytechnics' libraries studied.

RO₄: To assess the impact of Cloud Computing adoption on service delivery in polytechnic libraries of Katsina State.

Table 4: Assess the impact of Cloud Computing adoption on service delivery in polytechnic libraries of Katsina State.

Statements	SD		D		UD		A		SA		Mean	S.D
	F	%	F	%	F	%	F	%	F	%		
Cloud computing has improved access to library resources	5	2.7	25	13.7	62	33.9	50	27.3	41	22.4	3.53	1.07
It enhances efficiency in service delivery	35	19.1	10	5.5	50	27.3	80	43.7	8	4.4	3.09	1.20
It reduces operational cost	25	13.7	15	8.2	44	24.0	64	35.0	35	19.1	3.38	1.27
It improves user satisfaction	10	5.5	15	8.2	39	21.3	73	39.9	46	25.1	3.71	1.20
It supports remote access to library services	10	5.5	20	10.9	14	7.7	30	16.4	109	59.6	4.14	1.26

(Field Survey 2026, Key: SD= Strongly Disagree; D= Disagree; UD= Undecided; A= Agree; SA= Strongly Agree)

The findings show that 49.7% of the respondents agreed or strongly agreed that cloud computing has helped enhance access to library resources (Mean = 3.53, SD = 1.07) and 48.1% agreed or strongly agreed that cloud computing has helped to improve efficiency in service delivery (Mean = 3.09, SD = 1.20). Additionally, 54.1% agreed or strongly agreed that it lowers operational cost (Mean = 3.38, SD = 1.27) and 65.0% reported that it boosts user satisfaction (Mean = 3.71, SD = 1.20). Moreover, 76.0% of respondents agreed or strongly agreed that cloud computing helped them in delivering the library services remotely (Mean = 4.14, SD = 1.26), which also showed that the influence of cloud computing on the services delivered in polytechnic library is high.

RO₅: To determine challenges associated with the adoption and implementation of cloud computing in Polytechnic libraries of Katsina State.

Table 5: Challenges associated with the adoption and implementation of cloud computing in Polytechnic libraries of Katsina State.

Statements	SD		D		UD		A		SA		Mean	S.D
	F	%	F	%	F	%	F	%	F	%		
Poor internet connectivity is a challenge	0	0.0	20	10.9	13	7.1	79	43.2	71	38.8	4.10	0.94
Lack of technical expertise affects adoption	5	2.7	10	5.5	35	19.1	57	31.1	76	41.5	4.03	1.04
High cost of implementation is a barrier	5	2.7	15	8.2	28	15.3	59	32.2	76	41.5	4.02	1.07
Security and privacy concerns hinder adoption	0	0.0	15	8.2	19	10.4	87	47.5	62	33.9	4.07	0.88
Lack of institutional support affects usage	15	8.2	0	0.0	23	12.6	22	12.0	123	67.2	4.30	1.21

(Field Survey 2026, Key: SD= Strongly Disagree; D= Disagree; UD= Undecided; A= Agree; SA= Strongly Agree)

Table 5 indicates that there are some challenges that greatly influence acceptance and utilization of cloud computing in the Polytechnic libraries of Katsina State. Poor internet connectivity is a major challenge was agreed by a high proportion of respondents and strongly agreed by 82.0% (Mean = 4.10, SD = 0.94). Likewise, 72.6% agreed or strongly agreed that lack of technical expertise is a barrier (Mean = 4.03, SD = 1.04); and 73.7% agreed or strongly agreed that high cost of implementation is a barrier (Mean = 4.02, SD = 1.07). Furthermore, 81.4% of respondents indicated that security and privacy issues had a negative impact on adoption (Mean = 4.07, SD = 0.88). The most central problem noted was the lack of institutional support, as 79.2% of respondents strongly agreed or agreed it is a problem to using the product (Mean = 4.30, SD = 1.21). In general, the findings suggest that all four of the infrastructural, financial, technical, and institutional challenges discussed in this study can impede the effective use of cloud computing in the focused libraries.

DISCUSSION OF FINDINGS

1. **RO₁: To determine the level of awareness of cloud computing technologies among the academic staff of Polytechnics in Katsina State.** The results show that the highest adoption was for the Email Services application (F = 91, 49.7%), followed by Cloud Storage (F = 86, 47.0%) and Digital Repositories (F = 83, 45.4%), and that over half of the

respondents ($F = 95$, 51.9%) did not know the applications used. The most recognised deployment models were Public Cloud ($F = 93$, 50.8%) and not sure of the model used ($F = 59.0\%$). Likewise, this is how SaaS was the most known service model ($F = 41$, 22.4%), with 51.9% saying they weren't sure of the cloud service classifications. Respondents had low awareness of specific classifications of cloud computing, on average. The finding corroborates the findings of Oloniruha et al. (2026) and Mshelia et al. (2026) who found that the awareness level on the application of cloud computing in library staff is relatively high, but there is also some degree of uncertainty about the deployment and service models of cloud computing. It's different, however, in that the present study indicates that there is a greater share of people who aren't certain of certain cloud computing classifications.

1. RO₂: To identify the types of Cloud Computing Technologies adopted in Katsina Polytechnics libraries. The results show overall low levels of awareness across all categories, with the highest levels of awareness being for service categories (Email Services – 49.7% and Public Cloud – 50.8%), while the lowest levels of awareness were for service models (PaaS – 18.0% and SaaS – 22.4%). The high percentage of “Not Sure” responses (51.9% to 59.0%) also indicates that the respondents did not fully understand the classifications of cloud computing, which again indicates a need for proper training and sensitization program in polytechnic libraries. The results corroborate those of Zubairu et al. (2021) and Njoku and Ken-Agbiriogu (2021) which found that the overall awareness of the types and models of cloud computing among academic library staff are generally low. It differs from that study, however, in that this study actually showed a bit more recognition for Public Cloud and Email Services, with some uncertainty still dominating in categories.

2. RO₃: To examine the extent of adoption and implementation of cloud computing technologies in Polytechnics Libraries of Katsina State. The range of means was 1.65 to 2.49 and the range of standard deviations was 0.71 to 1.19 which suggests that there was not too much or too little variation in responses. The mean score of “My institution creates awareness about cloud computing technologies” (Mean = 2.49, SD = 1.13) was the highest, while the lowest one was obtained for “Library services are delivered using cloud platforms” (Mean = 1.65, SD = 0.71). The grand mean is 2.18 with average SD of 1.08, this shows that the overall level of adoption and implementation of the Cloud Computing Technologies by Polytechnic Libraries of Katsina State is low. The discovery aligns with Akinyoola (2023)'s and Ejedafiru and Ogbogbaidi (2024)'s findings of low adoption of cloud computing in academic libraries, which was attributed to lack of awareness and poor infrastructure. But this

is slightly moderate in the context of overall low institutional awareness creation efforts as is revealed by the present study.

3. RO4: To assess the impact of Cloud Computing adoption on service delivery in polytechnic libraries of Katsina State. The mean scores were found to be between 3.09 and 4.14 and the standard deviations between 1.07 and 1.27 which showed moderate variability in the responses. The finding with the highest mean and lowest SD score was “It supports remote access to library services” (Mean = 4.14, SD = 1.26) and the lowest mean score was “It enhances efficiency in service delivery” (Mean = 3.09, SD = 1.20) respectively. This finding corroborates the results obtained by Okwoli et al. (2026) and Solomon and Bakare (2022) who found that cloud computing has a positive effect on library service delivery, specifically in the area of access and remote library service delivery. But it is different because this study concluded that the efficiency of the delivery services was relatively less improved than that of the remote access and user satisfaction.

1. RQ5: To identify challenges associated with the adoption and implementation of cloud computing in Polytechnic libraries of Katsina State. The result shows that the mean scores were between 4.02 and 4.30 with the standard deviations of 0.88 and 1.21 showing low to moderate level of variability among the responses. The highest Mean score was for “Lack of institutional support affects usage” (Mean = 4.30, SD = 1.21) and the lowest Mean score was for “High cost of implementation is a barrier” (Mean = 4.02, SD = 1.07). The grand mean of 4.10 and average SD of 1.02 shows that the respondents extensively agree that there are multiple challenges that make the adoption and implementation of cloud computing in Katsina State Polytechnic libraries difficult. The result agrees with that of Dumbiri et al. (2024) and Onwubiko et al. (2021) who found that the infrastructural problems, financial problems, and institutional problems have got a significant effect on the adoption of cloud computing in libraries. There is one difference, however, in that this study found that the most severe obstacle was lack of institutional support, as opposed to cost or technical skill.

CONCLUSIONS

The study concludes that, the academic staff in polytechnics in Katsina State have moderate to high awareness of cloud computing technologies, especially in simple applications like email and cloud storage, but there are shortcomings in their understanding of specific deployment and service models. The level of adoption of cloud computing in polytechnic libraries is low, suggesting that there is awareness but this is not yet reflected in action. The positive effects of cloud computing were identified, however, in the context of library service

delivery, particularly in the area of remote access, user satisfaction and access to library resources. Although these advantages exist, some drawbacks like lack of technical expertise, high implementation costs, poor internet connectivity, security issues, and lack of institutional support are significant barriers to effective adoption and implementation. Overall, the results indicate that cloud computing has a strong promise of advancing the provision of library services, but is not yet fully leveraged because of ongoing issues with infrastructure and institutional limitations.

RECOMMENDATIONS

1. Libraries should conduct on-going ICT capacity building programmes like workshops, seminars on basic concepts of cloud computing, how to use Google Drive and how to use the cloud-based e-mail systems (Gmail and institutional e-mail) to increase the awareness and understanding of staff.
2. Targeted sensitization of specific cloud models should be done by the institutions by having hands-on experience on Google Workspace (SaaS), Microsoft Azure (PaaS), and Amazon Web Services (IaaS), so that staff members can clearly understand the cloud models.
3. There is a need for the incorporation of practical systems like cloud-based Library Management Systems (CMS) (e.g., Koha cloud hosting), digital repositories, and online databases (e.g., JSTOR and EBSCOHost), etc. to boost the efficiency of Library management.
4. Libraries should expand the use of cloud platforms for *remote access to e-resources, online reference services, and virtual library services* to improve user satisfaction and ensure 24/7 accessibility.
5. Government and institutional authorities should address key barriers by improving *broadband internet connectivity, providing ICT infrastructure (servers and stable power supply), offering staff ICT training, and increasing funding for cloud adoption projects.*

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