



SAFEGUARDING UNIVERSITY RESEARCH OUTPUT STORED IN THE CLOUD: STRATEGIES, BENEFITS AND CHALLENGES IN ACADEMIC LIBRARIES

By

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ABSTRACT

Purpose: The study was carried out to examine cloud computing as a storage model for safeguarding university research output in academic libraries, its viability, benefits, challenges and strategies.

Design/Methodology/Approach: The study employed a descriptive survey of some selected libraries in South-East and South- South Nigeria to ascertain their capacity in preserving the institution's research output. Five research questions were formulated to guide the study. A total of 129 librarians from eight institutions were randomly sampled to elicit information on where each library archives/stores its institutions' research output, the benefits and challenges of storing university research output in the cloud, and the proficiency of librarians in the skills employed in safeguarding research output stored in the cloud. 130 copies of questionnaire were distributed while 113 were returned out of which 98 useful copies were analyzed using descriptive statistics of frequency, percentage and mean.

Findings: revealed that 37.7% of librarians agreed to storage of research output in the cloud, 46.9% in the local server while 15.3% did not know where their institution's research output was stored. Moreover, majority of the librarians lack the knowledge and various skills employed in safeguarding university research output stored in the cloud.

Implications of the Study: Findings of the study imply that although some of the libraries studied have adopted cloud storage of their research outputs, there are some identified ethical and organizational challenges such as intellectual property issues, data privacy concern, high latency and data integrity and confidentiality. These can be surmounted through increased funding, regular training of librarians and adoption of suitable policies on legislation and security concerns. This is important since this study has empirically demonstrated that the benefits of cloud computing far outweigh its challenges.

Originality and Value: It is therefore recommended that academic libraries should consider all the elements of library services, IT infrastructure, cost implications and staff development while migrating to the cloud. This calls for legislations, or a well-established set of standards that can address the cloud computing issues before its implementation in the library by service providers. Secondly, libraries in Nigeria and Africa should work together as a group to develop privacy standards and guidelines for library systems that rely on the cloud.

Key words: Research Outputs, Academic Libraries, Cloud Computing, Data preservation, Data Security, Data privacy Nigerian Universities

Paper Type: Empirical Research

Introduction

There is no doubt that the emphasis on the social, cultural, economic and environmental impact of research has increased greatly over the years. Through research, universities play a particular and essential role in providing the highest quality idea and information that flow to all other parts of the system-education, business, government leading to the growth and development of the society. Research outputs are important and

expensive products of the scholarly research process. They constitute very important evidence necessary for evaluating research endeavors of an individual researcher in particular and the institution in general. These outputs/research data increase in value as they build up into a collection and as they become more available for re-use to address new and challenging research questions. Ricky (2013) opined that research data can be viewed as university assets arising from the university's

mission to support quality research. Therefore, the application of best practices to safeguard such assets protects the university's intellectual, financial, human and material investment in research. University based research is therefore the foundation for its growth, global visibility and societal development. Research data/output originating from the university appears in the form of books, book chapters, journal articles, practical research records, project reports, inaugural lectures, theses and dissertations, lecture recordings and papers, evaluation reports, workshop reports, working papers, conference papers, conference proceedings, field trip films and records, inventions and community services of university academics. Some of these contents are not only in text form but include speech recordings in cassettes and other digital resources. Research outputs are keys to the evaluation of any university and determine the position of that university with regard to World university ranking which promotes reputation, recognition and global competitiveness. Hence universities now place much emphasis on research and publication not only because it determines institutional and national position but because it promotes the teaching and learning processes.

The academic library supports teaching, learning and research in the university through the acquisition, processing, storage, preservation, marketing and provision of information resources and services to its clients. This has been done through the use of computers, soft ware, LAN e t c. However, advancement in information and communications technology has propelled modern academic libraries to extend services beyond the physical walls of the building through technological and digital applications such as social computing, cloud computing, mobile phones and internet solutions. These applications involve the use of local server/website connected to the internet and or cloud storage/cloud computing; a service where data is remotely maintained, managed and backed up with files stored offline so that they can be accessed from any location through the internet. Business enterprises and organizations are migrating into this model for its economic advantages while universities all over the world are embracing the concept to make their research products available to the

global community, for visibility and many other associated benefits. Stroh, et al (2009) defined cloud computing as the collection of computing software and services that can be accessed via the internet rather than residing on a desktop or internal server. The combination of servers, networks, connections, applications and resources is defined as "Cloud". It is used in the practice of storing, accessing and sharing data, as well as applications and computing power in the cyber space. Cloud storage allows users to store and access data online via the internet from any location at any time and has proven to be more efficient in the storage and management of both institutional data and business files. Hence cloud services have revolutionized how universities/businesses store information. By saving important data/files on a non-localized server, universities can access their data from anywhere in the world as long as there is internet connectivity. Identification of contributors with setting up criteria for determining the collection and authorization of members in the repository is a point to be taken care off. On the other hand, cloud computing has transformed the way libraries deliver their services, providing opportunity to extend their impact. Thus, academic libraries leverage the efficiency, reliability and scalability of cloud computing to improve its efficiency and visibility of its collections and management services thereby increasing their power of cooperation and collaboration.

The heart of every information system is the requirement to protect the confidentiality, integrity and availability of data. Of course, managing the intellectual assets of the university is a critical responsibility of the university as a whole and the library in particular. But the cloud computing system presents a daunting challenge; Steiner (2012) stated that as more data moves from centrally located server storage to the cloud, the university loses control of the online data/information while the potential for personal and institutional data to be compromised increases. There is also knowledge retention and insecurity of sensitive information. Similarly, a major challenge of shared network is that of high risk of physical theft of the device and unauthorized access to information while on local storage, a computer virus can easily

cripple a drive and all the data it contains. There is also the risk of fire incidences, leaking roofs, insect attack on materials stored on the shelves as well as easy damage of CD ROMS due to changes in weather and high cost of regular maintenance of storage devices. These challenges demands that institutions which have embraced cloud storage as a better and more beneficial option to carefully device an alternative means of securing the universities research products in order to ensure its continuous availability and accessibility. This has raised a lot of concern to the universities in Southern Nigeria with regards to the ability of their libraries to secure the university's research products stored in the cloud. Hence the study was initiated to examine the potential of the academic libraries in Southern Nigeria in securing universities research data/products stored in the cloud.

Research Questions

The study examined the preservation strategies of university research outputs in libraries in Southern Nigeria and the challenges. The following research questions guided the study:

1. What is the major preservation strategy/platforms for research outputs in the university libraries in Nigeria?
2. What benefits does the institution derive from preserving research output in the cloud?
3. What challenges does the institution face in preserving/archiving research outputs in the cloud?
4. What strategies are adopted by the library to safeguard university research outputs archived/preserved in the cloud?
5. What is the proficiency of librarians in the strategies for securing research outputs archived in the cloud?

Review of related literature

Preservation of Research Outputs in University Library

The library in its role is charged with the responsibility of collecting, classifying, cataloguing, curating, preserving and providing access to digital content of its institution's repository. University libraries in developing countries primarily store research output in computers, prints, CDROMS, hard disks, external drives, prints and databases. Although information/data can easily be accessed on these storage platforms, they pose a number of challenges with regards to the

preservation of the stored information. These threat ranges from theft, virus attacks, unguided and unauthorized access to the contents and inadequate space for storage. Virus attacks on documents have often resulted to permanent loss of data while unauthorized access leads to infringement of copyright law. These challenges have been a major concern for academic libraries that triggered the consideration for adoption of cloud storage to ensure safety of stored data among other benefits.

Concept of cloud computing

The practice of storing/archiving information/data in the air is generally called cloud computing. In view of the above, cloud computing is internet computing that involves provisioning, utilization and sharing of resources, software, applications and services on the internet requiring minimum management and maintenance efforts. National Institute of Standards and Technology (NIST) (2011) defined 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 provided and released with minimal management effort or service provider interaction.

There are different types of cloud. According to NIST (2011), cloud is composed of four deployment models, namely: private cloud, community cloud, public cloud and hybrid cloud. The private cloud is the cloud model that provides for private use by a single organization comprising multiple consumers (e.g., business units). It may be owned, managed, and operated by the organization, a third party, or a combination of them, and it may exist on or off premises.

The community cloud is the cloud infrastructure that provides for exclusive use by a particular community of consumers from organizations that have common interests (e.g., mission, security requirements, policy, and compliance considerations). It may be owned, managed, and operated by one or more of the organizations in the community, a third party, or some combination of them, and it may exist on or off premises. The Public cloud provides for open use by the general public. It may be owned, managed, and operated by a

business, academic, or government organization, or some combination of them. It exists on the premises of the cloud provider. The hybrid cloud is the cloud model that forms a combination of two or more distinct cloud infrastructures (private, community, or public) that remain unique entities, but are connected together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds). The major cloud providers present in the current market segment include Amazon, Microsoft, Google, IBM, Oracle, Eucalyptus, VMware, Eucalyptus, Citrix, Salesforce.

Cloud computing has low infrastructure challenges which can be minimized by adopting a cloud solution. For instance, the risk of infrastructure in a public cloud is solely borne by the cloud service provider and the client simply billed for the deployment. In case of any infrastructure failure, it is the service provider who will provide instant support to the customer and thus reduce the risk of purchasing and deploying physical servers by the customers. In view of this, cloud computing can help to increase the pace of innovation. This is because the low cost of entry to new markets allow beginner companies to deploy new products quickly and at low cost. This equally enables small companies to compete more effectively with traditional organizations whose deployment process in enterprise data centers can be significantly longer. Increased competition helps to increase the pace of innovation and with many innovations being realized through the use of open source software, the entire industry serves to benefit from the increased pace of innovation that cloud computing promotes.

Academic libraries have taken to the cloud as a better storage facility for the university research products specifically for the benefits arising from it. A number of authors have echoed some of the benefits in their publications. Whitehouse (2016) generally identified efficiency, reliability, scalability, accessibility, capital savings and improved recovery time for small data sets as major advantages of cloud-based services. He observed that bandwidth has become increasingly affordable and capacity optimization technologies has made cloud-based back up more popular and alternative to

portable back up media such as tape. Cloud back up technology is more convenient because information can be accessed from any device connected to the internet from any location at any time. This has allowed research collaborators from different locations to work together and the use of mobile devices to increase productivity. Moreover, cloud storage presents an opportunity for information to be easily shared, searched, retrieved and transferred. Liu and Cai, (2013) argues that shifting library core applications to cloud-based services reduces or eliminates most or the entire local technical needs in managing server hardware and operating systems that underlie the applications. According to Wale, (2011), cloud computing brings along economy of scale and has helped to make overall prices far more affordable for computing, storage, networking, preservation, and overall administration. Supplementing the above arguments, Marston, et al. (2011) opined that the impetus for change right now is seen predominantly from a cost perspective, as organizations increasingly discover that their substantial capital investments in information technology are grossly underutilized. Most importantly, Goldner (2011) opined that cloud computing enables new streamlined workflows for cooperation and community building among libraries. For colleges and universities, cloud computing provides a means to upgrade software and IT hardware attracting students and keeping pace with digital technological developments, (Sultan, 2010). On the other hand, Scale (2010) puts forth his view that cloud computing is currently enabling librarians to shift from the paradigm of ownership and maintenance of resources towards the provision of access to information maintained and controlled by others.

The benefits of cloud computing cannot be over-emphasized. Cloud computing gives the advantage of quick deployment. This means that the entire system begins to function in a matter of minutes once it is on the cloud. Of course, the amount of time taken here will depend on the exact kind of technology that is needed. Once the users register in the cloud, they can access the information from anywhere, where there is Internet connectivity. This convenient feature allows users to move beyond time zone and geographic locations. It has become possible for libraries to add

more systems to manage their diversifying collections which moved from strictly physical collection management to a combination of physical, licensed and digital collections. Since each of these systems has stood alone integrating them has been difficult and at times not possible. However, this has become possible with cloud computing. Also, data stored in the cloud can be easily shared among services and users. The need for local storage, maintenance and backups is therefore removed. Agreements can be reached to share data which normally would be considered private to a single business or organization. Hence libraries can achieve Web scale when they massively aggregate data and users, which is made possible by cloud environment (Goldner, 2011).

Application/Benefits of Cloud Computing in Academic Libraries

According to Mavodza (2013) Cloud computing is applied in academic libraries in the following ways:

- o Building digital libraries/Repositories: Because of the increasing need for every library to make its resources, information and services available in an efficient way through the network, libraries are developing digital libraries using soft wares such as Dspace, Java e t c.
- o Searching library data: OCLC can now be applied in searching and sharing libraries' data on the cloud. OCLC also offers various services pertaining to circulation, cataloguing and acquisition, e t c, through the web share management system – a system that facilitates the development of open and collaborative platforms for sharing of resources, services and ideas. Moreover, university libraries now adopt and implement cloud computing in their system providing access to electronic databases which include Agora, Hinari, OARE, JSTOR, Science Direct, EBSCO Host, and ARDI e t c.
- o Library automation: For automation purposes, Polaris provides many cloud-based services such as acquisitions, cataloguing, process system and digital contents. Libraries now provide access to an extensive collection of books, audio-visual materials and journals. Clients can use the catalogue to locate specific books,

borrow books and other materials, access the e-reserves via the library website and request information. Besides cost benefits, the library will be free from taking maintenance, software updates, backup and so on.

On the uses and implementation of cloud computing in academic libraries, Farkas (2009) argues that it is becoming an increasingly important mechanism that enable many libraries to extend their research online and equally promote collaborative work in ways that have not been possible before. Cloud computing is used at various levels in academic libraries depending on the institution. One of such levels is HathiTrust, which is a large-scale collaborative repository of digital content from research libraries including content digitized via the Google Books project and Internet Archive digitization initiatives, as well as content digitized, Proceedings of 2012 International Conference on Cloud Computing, Technologies, applications & Management locally by libraries. HaithiTrust is a repository for keeping huge amount of digitized data being shared among its members. It was founded in October 2008 and already has over sixty partners mostly including university libraries all around the world. Gokul and Ambili (2016) pointed out that Libraries can utilize cloud computing services such as SaaS, PaaS, and IaaS in a number of areas such as library automation, website hosting, digital library services, search services, storage, Integrated Library System (ILS), Inter Library Loan system etc. Not only does society as a whole benefit from open access through more effective access to information and an expanded and accelerated research cycle, but the visibility, usage, and impact of the work of individual researchers increases (Richardson, 2006).

Besides the huge benefits, cloud storage exposes library data/research output to a new set of challenges which undermine the confidence of library and the university at large on the security of the information. This paper argues that adopting the cloud storage option requires librarians to take cognizance of the security of content and remain resilient in determining access levels and enterprise storage platforms. McLeod and Gormly (2013)

equally concluded that if cloud service providers are to be used, their security, viability, sustainability, and trustworthiness must be paramount.

Challenges of storing university research output in the cloud

The increasing concern about the safety and privacy of data stored in the cloud arises because institutions and businesses are no longer in full control of their information. David (2016) notes that major challenge is that the possibility of private data commingling with organizational data make some businesses uneasy. Other important challenges are security lapses, connectivity and bandwidth, technical challenges, intellectual property problem, service delivery and billing, interoperability and portability, reliability and availability, latency, data location, insider-attack, and security of research products in the cloud (Yunchuan, 2014; Awale, 2012; Ogigau-Neamtiu, 2012; Teneyuca, 2011; Kaveyia, 2010). Data stored in the cloud is less secured than more traditional information technology delivery models. Awale (2012) reports that nearly 40% percent of organizations in East Africa are reluctant to adopt the cloud technology due to data privacy, legislation and security concerns.

In cloud computing, internet connectivity services are paramount because it drives online functions while absence stops it. Kayeyia (2010) noted that in traditional applications, lack of connectivity allows for some local function to continue until the services are restored. In addition, bandwidth issues play crucial roles in delivery of cloud services which enables computing organizations to capitalize on the use of bandwidth and end up over-charging the clients. In the business monopoly market, the organizations sell bandwidth services based on average or peak usage instead of maximum usage. Though it is true that information and data on the cloud can be accessed any time and from anywhere, there are moments when the system can have some serious malfunction. This implies that this technology is prone to outages and other technical issues. Even the best Cloud service providers run into this kind of trouble, in spite of keeping up high standards of maintenance.

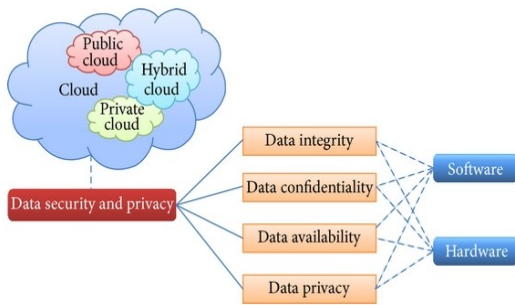
Another challenge has to do with intellectual property issues. After the user

bought the server, the content would be transferred to the cloud, and cloud computing companies host the information. In theory, the owner should have the right to own and manage data- modify and update the elements while others cannot. But in reality, owners may lose control of the data because cloud computing firm who knows the “data core” principles, do everything possible to make use of these data and use the name of data integration, data mining and knowledge service to make the using way legal.

The difficulty in assessing the costs involved due to the on-demand nature of the services is a challenge. Budgeting and assessment of the cost are very difficult unless the provider has some good and comparable benchmarks to offer. The service-level agreements (SLAs) of the provider are not adequate to guarantee the availability and scalability. Businesses will be reluctant to switch to cloud without a strong service quality guarantee. Businesses should have the leverage of migrating in and out of the cloud and switching providers whenever they want, and there should be no lock-in period. Cloud computing services should have the capability to integrate smoothly with the on-premise IT. However, cloud providers still lack round-the-clock service; this results in frequent outages. It is important to monitor the service being provided using internal or third-party tools. It is also vital to have plans to supervise usage, performance, robustness, and business dependency of these services.

Latency is another obvious issue in cloud computing. It is the time taken for the user system to interact with machines in the cloud. Cloud based apps will have higher latency than the native apps installed on a user’s system since there will be an added time of user end communicating with the cloud. Further, higher traffic and un-favorable geographical location can aggravate the problem. Closely related to this is the issue of data location (Teneyuca, 2011). Location transparency is one of the prominent flexibilities for cloud computing, which is a security threat at the same time – without knowing the specific location of data storage, the provision of data protection act for some region might be severely affected and violated. Like any other network scenario, the provision of insider-attack remains a valid threat for cloud computing (Ogigau-Neamtiu, 2012).

Any security tools or other kinds of software used in a cloud environment might have security loopholes which in turn would pose security risks to the cloud infrastructure itself. Finally, there is also the challenge of storage of research data. In the cloud computing environment, it becomes particularly serious because the data is located at different places even in all the globe. Data security and privacy protection are the two main factors of user's concerns about the cloud technology

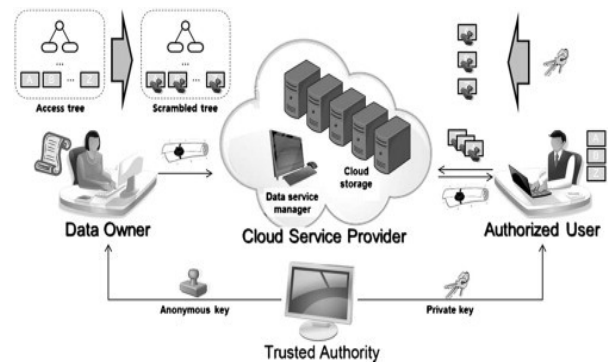


SOURCE: Yunchuan, Sun et al (2014).

Strategies used by academic libraries in securing research outputs/data in the cloud

Academic libraries have devised some security measures to mitigate the challenges posed by cloud computing. These measures include encryption, data splitting, direct contact with the service provider, gradual sequence of migration and investigating cloud vendors (Okai, Uddin, Arshad, Alsaqour & Shah, 2014; Hullavarad, O'Hare & Roy, 2015; CSA, 2010). Encryption is a process that stores information on servers by transforming the information into a form that cannot be understood by an unauthorized person thereby making the library to have direct control over the research data. By using this technique, the data is translated into a secret code that cannot be understood by anyone else except those who have the access code or password to decrypt the encrypted information. This will protect the data and ensure its authenticity and integrity, and further prevent the improper disclosure of confidential educational data stored in the cloud. Encryption is the one of the methods used to ensure the security of data stored in the cloud (Okai, Uddin, Arshad, Alsaqour, & Shah, 2014). Encryption also protects data privacy, provides confidentiality assurance and combats unsolicited access. All sensitive data before exporting to the cloud

must be encrypted to avoid tempering with them.



Source: Brandon (2013)

The second measure is data splitting. This is a process through which libraries store data in different vendors with the aim of protecting their resources since most of the data will be stored remotely. Data splitting is seen as a technique that require the use of more than one service provider; the data to be stored in the cloud should be split across different clouds, in a way, that preserves the confidentiality, availability, as well as integrity of the data. It is said that the use of two or more cloud services improves performance, avoids vendor lock-in, and reduces the risks of data loss and downtimes as security concerns such as data integrity, intrusion, and service availability can be controlled using fault-tolerant protocols across the multiple clouds. The data splitting technique avails the universities the opportunity to use different clouds for different purposes because some clouds are better than others for some applications; for example, the public cloud from Google might be best for email services whereas Microsoft Azure can be used to provide both PaaS and IaaS services. This technique also avails the universities the opportunity to shift easily; if suddenly any of the service providers decide to increase their prices or change their terms of business, the institutions will simply shut down from those providers and move to others with more favorable pricing and terms of business (Okai, Uddin, Arshad, Alsaqour & Shah, 2014).

Thirdly, security and privacy concerns can also be overcome by using digital signatures. It is an electronic signature used to authenticate the identity of the user of the services provided over the cloud, by using this technique, the user must provide the

appropriate login or access credentials before they can have access to the information or application they want to use. This will help to ensure the authenticity, accountability, and integrity of data in the cloud (Okai et al, 2014). Digital signatures improve efficiency, provide security around transactions, and enhance collective approvals in a fraction of the time compared to conventional ink signatures. Nonetheless, there is always the danger and fear of unauthorized or malicious use of digital signatures. To protect the organization the e level of authentication is always required to provide desired levels of assurance while accepting the signature (Hullavarad, O'Hare, & Roy, 2015). Digital signature deals with the problem of protecting the data from being tampered with and impersonation.

Fourthly, it is important that a direct contact is maintained or established with the service provider. A direct contact should be a priority between the university and cloud service provider without the services of an intermediary, to avoid confusion and build clear understanding of the service, because the more the levels or stages that the data have to pass from the vendor to the user, the more the chances of the data being compromised. Direct contact will ensure that data are moved in one -way direction, from the cloud vendor to the University library (Okai, 2014). The fifth approach is migrating gradually to cloud computing. Migrating to cloud computing is not an easy issue, all the more when there is no widely accepted standard for cloud services and a need to develop guidelines and criteria to help entities understand their requirements. Decision support tools that aid decision makers to migrate IT systems to the cloud are also required. However, because of its complexity, the migration toward cloud should not be done all at once, as much as the cloud offers cost savings, increased agility and efficiency caution has to be taken and the movement gradual with low risks applications going first. This will give the university time to see whether the cloud project or the chosen vendor is worthy if so, then the other applications can be moved step by step. In overcoming the barriers of security and privacy concerns, it is important to ensure compatibility between the university and cloud service providers' systems; by moving gradually, the compatibility of both parties

would have been ascertained before more sensitive data are moved to the cloud (Bildosola, Río-Belver, Cilleruelo, & Garechan, 2015). For libraries to have a successful transition of data to the cloud, it is important that the level of service provided in the cloud environment be comparable to the service they provide. Failure to properly migrate applications to cloud computing could ultimately result in higher costs and potential loss of data benefits of cloud computing.

Finally, university libraries have to make a thorough investigation about the vendor host and request that they provide guarantee and a plan of action just in case, or which is intended to take care of the situation when things do not go as planned. The university libraries have to understand some of the standards which they have to deal with when storing data. The institution like National Institute of Standards and Technology (NIST) and the Cloud Security Alliance (CSA) are there to assist the clients to be certain that the right level of security is provided by the cloud, and that there are appropriate backups in place in case of any problems or the occurrences of disasters like fire, flood, or earthquake (CSA, 2010). This investigation is necessary by adopters of the cloud technology in the educational sector to ensure constant availability and confidentiality because of the level of privacy that is required to preserve research results and other confidential information.

Methodology

Descriptive survey design was adopted for the study. Descriptive research aims to accurately and systematically describe a situation or phenomenon. It is an appropriate choice when the research aim is to identify characteristics, frequencies, current trends and categories, and when little or not much is known about the topic or problem being investigated (McCombes, 2019). Area of study is Southern Nigeria. Four universities libraries were selected each from South east and South-South as follows: For South East, these include Enugu state university of science and technology, University of Nigeria Nsukka, Nnamdi Azikiwe university, Awka and the National Open University Enugu state. For South-south, these include Akwaibom state university Uyo, Deita state university Abraka, Ladoke Akintola University of Technology

Oshogbo, Osun state and the Lagos State University, Ojo. These libraries were considered to be in a vantage position to understand cloud computing because they were found to have adopted cloud storage of university research output through their institutional repositories. Population of the study comprised the 213 academic librarians in these institutions out of which 129 were randomly sampled. Instruments for data collection include oral interview and structured questionnaire made up of five clusters and containing a total of 56 items derived from the research questions. Field study formed the basis for data collection and analysis on which respondents answered all items on a four-point Likert scale of 4 = Strongly Agree, 3 = Agree, 2 = Disagree and 1 = Strongly Disagree. The criterion mean was

2.5 therefore mean scores from 2.5 and above was adjudged positive while mean scores below 2.5 was adjudged negative.

In addition, there was an oral interview for librarians at the management cadre to authenticate the information in the responses. Out of the 129 questionnaires distributed, 113 were completed and returned representing 80% response rate. After eliminating incomplete surveys, 98 eligible surveys were used. This gave a response rate of 76%. In addition, oral interview was conducted on librarians at the management cadre to elicit further responses. Data were analyzed descriptively using frequency tables, percentages and mean. The percentages and sample means were calculated with the aid of IBM SPSS statistic 20.

RESULTS

Table 1: Which category of research outputs does your library store in the cloud?

S/N	Statement	SA	A	D	SD	M	SD
1	Book	19	11	62	16	2.5	A
2	Book Chapter	14	17	57	10	2.35	A
3	Journal Article	49	46	3	0	3.46	A
4	Project Report	29	18	37	10	2.59	A
5	Inaugural Lectures	15	21	38	24	2.27	R
6	Evaluation Reports	8	4	52	34	1.85	R
7	Conference Proceedings	31	51	12	4	3.11	A
8	Workshop Reports	38	46	7	7	3.17	A
9	Working Papers	6	2	40	50	1.63	R
10	Thesis	48	30	12	8	3.20	A
11	Dissertations	39	40	13	6	3.14	A
12	Field Trip Films & Records	13	11	46	18	1.98	R
13	Practical Research Records	9	27	45	17	2.28	R
14	Inventions & community Service	3	11	51	33	1.83	R

Table one shows that journal article, thesis, workshop reports, and dissertations have the highest mean scores of between 3.11 - 3.46 indicating that they are research outputs mostly archived on the cloud by the libraries under study. Research outputs such as

evaluation reports, inventions and community service, film trips and records and working papers have the lowest mean scores ranging between 1.63 – 1.83 which implies that they are less archived on the cloud.

Table 2: Mean and Standard Deviation scores of benefits of storing/archiving university research output in the cloud over local storage

S/N	Statement	SA	A	D	SD	M	D
1	For global visibility of university research output	53	45	0	0	3.54	A
2	Promotes data sharing among universities and beyond	41	47	10	0	3.30	A
3	Promotes data sharing among collaborating libraries	49	46	3	0	3.50	A

4	On-demand service	39	48	7	4	3.20	A
5	For broad network access	43	44	8	3	3.29	A
6	Quick deployment and access to information without limitation	52	34	8	4	3.36	A
7	No need for local storage and infrastructure maintenance	31	31	31	4	2.90	A
8	Free from software maintenance	38	46	7	7	2.15	R
9	Enables resource pooling and rapid elasticity	40	50	6	2	3.30	A
10	Possible integration of physical licensed and digital collections	37	36	19	7	3.07	A
11	Measured service	33	50	9	6	3.12	A

Table 2 shows data on the benefits of storing or archiving university research output in the cloud. The results indicated that the respondents agreed on or accepted 10 out of 11 items identified as the benefits of storing the universities' research output in the cloud. From these findings, the most accepted of all the benefits include global visibility of university research output (Mean = 3.54), data sharing among collaborating libraries (Mean =

3.50), quick access to information without limitation (Mean = 3.30) and resource pooling and elasticity (Mean = 3.30). However, the respondents did not agree that storing university research output in the cloud makes the library free from software maintenance (Mean = 2.15). These findings suggest that university libraries stand to gain a lot by storing or archiving university research output in the cloud.

Table 3: Mean and Standard Deviation scores of perceived challenges associated with the storing/archiving of university research output in the cloud?

S/N	Statement	SA	A	D	SD	M	D
1	Data privacy not guaranteed	53	40	2	3	3.40	A
2	Data security not guaranteed	38	44	11	5	3.10	A
3	Internet connectivity problems	27	38	20	13	2.80	A
4	Legislation and security concerns	40	35	14	9	3.08	A
5	Cloud-based applications have higher latency	50	41	4	3	3.40	A
6	Problems of interoperability and portability	46	43	6	3	3.34	A
7	Insider attack poses security risks to the cloud infrastructure	33	36	2	4	2.53	A
8	Cloud services are prone to technical challenges	47	40	6	5	3.31	A
9	Users may not have the right to own and manage their own data (Intellectual property issues)	52	40	4	2	3.44	A
10	Data integrity, data confidentiality not guaranteed	48	42	7	1	3.39	A
11	Budgeting and cost assessment very difficult	40	49	5	4	3.27	A
12	Inadequate power supply	47	30	18	3	3.23	A
13	High cost implications	48	34	9	7	3.25	A
14	Low proficiency in the skills	28	15	35	20	2.52	A
15	Poor funding	31	24	22	21	2.66	A

Table 3 shows data on perceived challenges associated with the storage of university research output in the cloud. As shown in the above table, the respondents agreed on all the items. However, those that received more ratings were as follows; users do not have right to own and manage their own data or intellectual properties issues (Mean = 3.44), data privacy not guaranteed (Mean = 3.40), cloud-based applications have higher latency (Mean = 3.40), and data

integrity and confidentiality no guaranteed (Mean = 3.39). Other challenges are as displayed in the above table, but the highest of all was the issue of intellectual property as perceived by the respondents that users do not have right to own and manage their own data. These findings suggest that the issues of intellectual property, data privacy and security, data integrity and confidentiality are yet to be resolved in academic libraries in Nigeria.

Table 4: Mean and Standard Deviation scores of perceived proficiencies on the following strategies adopted in academic libraries for safeguarding university's research output stored in the cloud?

S/N	Statement	SA	A	D	SD	M	D
1	Encryption	33	39	17	18	3.07	A
2	Use of digital signature	40	45	8	5	3.22	A
3	Data splitting across different clouds	13	15	30	38	1.98	R
4	Data scrambling	22	20	32	24	2.40	R
5	Direct contact with the service provider	10	17	43	28	2.02	R
6	Data masking and data eraser	16	24	30	27	2.27	R

7	Use of backups	46	39	11	2	3.31	A
8	Gradual sequence of migration to the cloud because of its complexities	30	34	25	9	2.86	A
9	Investigating cloud vendors to ensure a good plan of action	19	16	36	28	2.33	R

Table 4 shows data on perceived proficiencies of librarians on strategies adopted for safeguarding university research output in the cloud. The results showed that the librarians were proficient in the adoption of the following strategies; use of backups (Mean = 3.31), use of digital signatures (Mean = 3.22), encryption (Mean = 3.07), and gradual sequence of migration to the cloud because of its complexities (Mean = 2.86). Further, the results showed that the librarians were least proficient in data splitting across different clouds (Mean = 1.98). On the whole, the librarians were found to be most proficient in the use of backups. The overall mean of 2.61 indicates that the proficiencies of the librarians in adopting strategies for safeguarding university research output were slightly above average.

Discussion of Findings

This study was designed to assess cloud computing within the context of storage of university research output. The first research question aimed to find out the category of university research output that was stored or archived in the cloud has shown that among the fourteen categories of research outputs, journal articles workshop reports, conference proceedings, thesis and dissertations were mostly archived in the cloud while others including working papers, inventions and community service, film trips and records are less archived. This implies that majority of libraries in Southern Nigeria were probably at the initial stage of archiving their resources on the cloud starting with the key and most needed outputs to embrace the storage/archiving of university research output in the cloud. The fact that some outputs are still restricted to the local server is a strong limitation with regards to global visibility, online library services, data sharing among universities and research collaboration among libraries as well as access to information. Such institutions will not only lack recognition and reputation but will be poorly ranked among local and international universities.

The second research question was

formulated to identify the perceived benefits of storing/ archiving the university research data in the cloud. The results showed that the librarians really understood the concept of cloud computing and were also aware of its benefits. Some of the perceived benefits of using cloud computing for the storage/ archiving of the university research output include global visibility of university research output, data sharing among collaborating libraries, quick access to information, and resource pooling and elasticity. These findings are in conformity with those in the extant literature that revealed the benefits of cloud storage in academic libraries as consisting but not limited to extending research online, providing access to information, data sharing and promoting collaborative work in new ways (Farkas, 2009; Scale, 2010; Mayzoda, 2013).

The third research question aimed to identify the challenges posed by storing/archiving the university research data in the cloud. The findings revealed that the greatest of these challenges are; users do not have right to own and manage their own data, data privacy not guaranteed, high latency, and data integrity and confidentiality not guaranteed. These concerns have also been raised by Awale (2012), Yunchuan (2014) and Teneyuca (2011). These findings are not surprising because the critical success factors for cloud computing in academic institutions in Nigeria such as data security and internet connectivity are poorly developed. For instance, while data security is porous, internet connectivity is being developed. However, where there is internet connectivity, it is seriously being affected by low bandwidth.

The fourth research question was formulated to determine the proficiencies of librarians in adopting the strategies for safeguarding university research output in the cloud. The results showed that the proficiencies of the librarians were slightly above average. The librarians were most proficient in using backups. Other important areas of their proficiencies include use of digital signatures, encryption, and gradual

sequence of migration to the cloud because of its complexities. These strategies for mitigating the threats posed by cloud computing in academic libraries have been captured in the studies by Okai et al. (2014) and Hallavarad et al. (2015).

The above findings suggest that any university library wishing to adopt cloud storage model especially for storing/archiving the university research output should ensure that librarians are trained to be proficient in adopting some strategies that would guarantee the security, privacy, integrity and confidentiality of research outputs arising from their parent institutions. On the interview with some librarians in the management cadre, they strongly upheld the benefits of archiving research data in the cloud with a firm belief that the associated challenges could be surmounted by the already existing strategies in academic libraries. Within this interaction, they opined that more awareness/training on cloud computing would be incorporated into the in-house training program of the library.

Implications of the study

Findings of the study imply that although some of the libraries studied have adopted cloud storage of their research outputs, there are some identified ethical and organizational challenges which can be surmounted through increased funding, regular training of librarians and adoption of suitable policies on legislation and security concerns. This is important since this study has empirically demonstrated that the benefits of cloud computing were understood by librarians.

The results of this study also revealed that the greatest challenges posed by cloud computing in academic libraries consist of the intellectual property issues, data privacy concern, high latency and data integrity and confidentiality. It has been suggested that these challenges could be mitigated by using backups and digital signatures, encryption and gradual sequence of migration to the cloud. This will enable academic libraries to derive the maximum benefits arising from storage of research output in the cloud such as global visibility of research findings, data sharing among collaborating libraries, quick access to information, and resource pooling and elasticity.

Finally, the competencies of librarians

in adopting appropriate strategies to safeguard the storage of the university research output in the cloud were slightly above average. This implies that librarians need more training specifically designed to enhance their capacity to engage properly in the adoption of the cloud storage model especially for archiving the university research output.

Recommendations and Conclusion

While the percentage use of cloud computing to store/archive the university research data was low, the study empirically demonstrated that some academic libraries in Nigeria are yet to rip the benefits of storage platform. Academic libraries in Nigeria take advantage of cloud-based services to build digital libraries, social networking and information communication. Furthermore, the global visibility of the university research data, data sharing among libraries, quick access to information, resource pooling and elasticity, on-demand service, broad network service, and no need for local storage and infrastructure maintenance benefits of cloud computing make it more attractive. However, some issues associated with cloud computing such as security of information, privacy and confidentiality have not been fully resolved. Hence academic libraries in Nigeria could adopt a number of approaches such as backing up data, digital signatures, encryption, gradual sequence of migration to the cloud and so on to address these problems. In the present study, a good percentage of the librarians sampled have not acquired the skills requirements for cloud migration. It is therefore recommended that academic libraries should consider all the elements of library services, IT infrastructure, cost implications and staff development while migrating to the cloud. This calls for legislations, or a well-established set of standards that can address the cloud computing issues before its implementation in the library by service providers. Secondly, libraries in Nigeria and Africa should work together as a group to develop privacy standards and guidelines for library systems that rely on the cloud.

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