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Adoption of Cloud Computing by Academic Libraries for Research Data Protection

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ADOPTION OF CLOUD COMPUTING BY ACADEMIC LIBRARIES FOR RESEARCH DATA PROTECTION

Abstract

Technological evolution is an influencer for libraries alertness to meet the rising information needs of users. The purpose of the study was to *identify and review possible measures that academic libraries could consider to secure data in the cloud and safeguard research data/assets. The study was guided by descriptive design, which made use of secondary data to address the problem of low utilization of the cloud among academic libraries in African. The findings of the study revealed a low adoption rate of cloud computing by academic libraries in Africa. It was also proven that major challenges that inhibited the adoption of cloud computing by academic libraries were lack of institutional policy guidelines and authentication procedures from cloud service providers. Recommendations of the study were that academic libraries should fully utilize cloud computing services to store research data to enhance access and visibility. The Management of academic libraries should put in place policies and guidelines that will guide in the selection of cloud service provider for research data storage.*

Keywords: *Research Data; Academic Library; Cloud Computing; Data Protection*

Introduction

Academic libraries are connected to higher educational institutions, such as universities, polytechnic institutions, colleges of education, and colleges of technology. These libraries are generally mandated to support the course of teaching, learning, and research to achieve the missions of their parent institutions.

In modern times, the academic library is regarded as a repository of information in both prints and electronic form which responds to the information needs of its diverse users. Libraries have advanced in their activities to integrate Information Technology (IT) based products and services for efficiency.

Academic libraries are struggling to keep their place as the major source of inquiry in the face of emerging information technologies, which has revolutionized not only ways that information is packaged, processed, stored, and disseminated, but also how users seek and access information (Anunobi & Okoye, 2008).

Statement of the problem

It has been observed that there is a low understanding of the concept of cloud computing among librarians in Africa. Even though some academic libraries in the continents have inadvertently deployed cloud computing applications in their operations, the issue of security to protect institutional intellectual property and low understanding of cloud computing and its applications eludes some of these libraries from utilizing cloud services. Wanjiku (2009) noted that the rate of adoption of cloud computing among academic African libraries is very low despite its usefulness in research data management.

For these reasons, the study sought to identify and review possible measures that academic libraries could consider to secure data in the cloud and determine means to safeguard the research data/assets placed in the cloud.

Based on the objectives, the following research questions were formulated:

RQ1: How are libraries using cloud computing applications to archive their research asset/data?

RQ2: What means can academic libraries adapt to secure research data in the cloud?

RQ3: What challenges do academic libraries face in implementing cloud computing to manage their research data/asset?

Review of Literature

The section reviewed related literature on current trends in cloud services to advance research data management and security in academic libraries.

Academic libraries as a service

Access to IT has dramatically changed the way libraries operate. Developments in digital systems have provided technological solutions for academic institutions and libraries to access knowledge in virtual environments. Hence, higher education and learning institutions across the globe have developed digital technology platforms to realize and achieve the goals of the millennium culture and social values (Makori & Mauti, 2016). In this context, academic libraries are required to provide high-quality information to meet the changing needs and behaviour of users.

Knowledge has become the sharpest weapon for development in modern societies. This has necessitated academic libraries to have in-depth knowledge about the nature and level of data produced by its researchers and to help in the management process of institutional research output.

Therefore, research data are defined in several ways by different disciplines of educational institutions. For example, the Engineering and Physical Research Council (2014) identified research data as recorded factual resource generally retained and recognized in the scientific community as necessary to validate research outcomes. In a broader term, library research data are research outcomes, records, files or other documents irrespective of their content or form available in the library for access. Research data are mostly generated in digital format as a result of technological culture. The Monash University Library (2014) classified forms of research data as data files, database contents of video, audio, text, images, and books etc.

Academic research data forms the central part of the global research knowledge-base. As part of their core mandate, academic libraries advocate the promotion of intellectual outputs of researchers, and also organise, manage and preserve research data to facilitate access and usage. Therefore, in recent times, the growth of digital research data has been given priority by academic libraries as they provide long-term repositories of scholarly outputs. These libraries add value to repositories by building semantics for various research data, adding functionality for users, and creating means to share research outputs, which are also research assets of the institutions.

Academic libraries play a critical role to facilitate research processes, teaching and learning through information provisions and service delivery. Many academic libraries operate hybrid form by providing both virtual information resources and services and maintaining and supporting the use of physical collections. Virtual services provided by the libraries include information on CD-ROMs, gateways and e-books, online databases, online access catalogue, bibliographical databases, and e-journals (Angello &Wema, 2010; Afolabi &Abidoye, 2011). University libraries continue to make conscious efforts to keep pace with technological trends in order to meet the increasing information demands of their diverse users.

As part of the initiative to improve access to research based-information, academic libraries in developing countries have embraced emerging Information and Communication Technologies (ICTs) to process, disseminate and preserve research datasets. This is due to the fact that the virtual collection of research datasets can be accessible at all times and from any location. It can also provide access to a wide range of research-based information including electronic theses/ dissertations, scholarly electronic journals among others.

Today, most academic libraries in developing countries and the African continent, in particular, have made a greater stride towards improving ICT infrastructures. For example, higher learning institutions in Tanzania have installed the basic ICT infrastructure for the delivery of research-based information and other teaching and learning resources. With this implementation, the academic libraries have dedicated computer laboratories equipped with LAN, WIFI, and Servers to widen access to such information (Swarts &Wachira, 2010). In addition, many academic libraries in Africa have now embraced institutional repository as a useful tool to disseminate information, especially electronic theses/ dissertations. Despite these achievements, academic libraries in Ghana still face several challenges such as the cost of acquiring and managing infrastructures, slow internet bandwidth, and inadequate competent technical staff. These challenges have a negative impact on access to research data. However, the emergence of new technologies, such as cloud computing in recent years offers the potentials to address the challenges.

Technological advancements are targeted at easing the way people use various computing and Information Technology devices in their daily activities. Academic libraries have continuously strived to keep up with such advancements in order to remain relevant and enhance their service delivery to the users. Globally, these libraries have been implementing various Information

Technology tools to ensure improvement in their service delivery, data/information management, and information access and retrieval. One of the latest technologies that are now being used (or encouraged to be used) by academic libraries around the globe is cloud computing. This became necessary considering the dwindling allocation of resources to the library and more importantly, the need to improve access to remote users by keeping library services up-and-running via the internet, as well as for data storage and management.

In principle, the idea of cloud computing has been in existence for a while. For instance, individuals who make use of e-mail services from third-party I.T companies, such as Yahoo and Google, are able to access their emails from any part of the world once they have access to the internet. This is made possible because the information in their emails is stored in servers that are installed and maintained for constant, uninterrupted functioning by the I.T firms. Therefore, users' information and data are stored far away from their physical location and can only be accessed via the internet. This is the working principle on which cloud computing is based (Mell &Grance, 2009).

The cause benefit of academic libraries sharing hardware and other related services through cloud computing rather than housing software and hardware for single information centers could lead to efficient management of library resources. It also enhances both the library user's experience and staff workflows through spontaneous interfaces.

It is expensive to install and maintain an ICT infrastructure in developing countries such as Ghana and Nigeria. Clouds enable academic libraries to save on software overhead costs, thus allowing libraries to concentrate on other tasks leading to a high return value (Reese, 2009). Bezos (2014) argued that when libraries move their major services to the cloud, they get more than 70 percent of their time and money to improve and grow their library services. This improves the quality of

library services. Also, the library can take advantage of current and rapidly emerging cloud services to fully participate in the digital information landscape. This will further increase the visibility and accessibility of collections in real-time through the sharing of resources, regardless of distance (Bezos, 2014).

Academic libraries can collaborate with one another in a simplistic manner through cloud computing. Hence, library research data could be put together in a single place, and accessed by a group of libraries, the whole cloud could become huge thereby making interoperability easier.

Cloud computing frees libraries from managing technology so they can focus on collection building, services, and innovation. It further encourages libraries and their users to participate in a network as individuals or consortia by allowing reuse and socialization around data (Nuria, 2012). Cloud computing also creates powerful, unified web access for academic libraries and gives users local and global reach. Cloud services present opportunities for academic libraries to innovate and improve. With increasing access to exponential data, cloud computing builds services and discovery engines that library patrons could appreciate. Cloud computing has interactive features to increase engagement and provide better user experience for information researchers and librarians.

APPLICATION OF CLOUD COMPUTING IN ACADEMIC LIBRARIES

Libraries all over the world are becoming interested in the deployment of cloud computing technology to enhance their service delivery to their users. It has been posited that the need for cloud computing in libraries might have resulted from the existing "information explosion, problems in accessing the information, save the time of the users and staff, resource sharing problems, problems in library, resources management, complex demand of users and attraction of

users towards cutting-edge technologies" (Kaushik and Kumar, 2013). Patel, Seyfi, Tew, and Jaradat (2012) had earlier suggested that there were four core areas in which libraries can implement cloud computing services in their operation. These areas include technology, data hosting services, information, and community. Therefore, there are numerous options in cloud computing for libraries to choose from.

Academic libraries can benefit significantly from cloud computing in many areas of their operations. Liu and Cai (2013) noted that libraries will be free from the technical hassles such as server management if their core services become cloud-based. They also posited that considering its scalability, cloud computing can help libraries to address the issue of dwindling financial resources. In an earlier report by Scale (2010), it was submitted that, through the application of cloud computing in academic libraries, librarians are now able to shift focus from ownership and maintenance of resources and give full attention to providing access to information through their various cloud-based services.

Furthermore, Luo (2013) pointed out that academic libraries can deploy cloud-based software, such as QuestionPoint, LibChat, and LibGuides to carry out their virtual referencing service and research guides. Similarly, Cohn, Kelsey, Fiels, and Salter (2002) suggested that librarians should make use of database and library system vendors that provide cloud computing facilities such as the external server that could be used to host library data and software in the cloud. The deployment of such tools in academic libraries will enable them to yield favourably to the yarning of their users. Corroboratively, Prince (2012) noted that available cloud options that libraries could make use of include IaaS or PaaS-hosted systems. The report explained that ExLibris, CyberTools, and VTLS are major SaaS-based Integrated Library System (ILS) that could be deployed in an academic library for service enhancements.

Mavodza (2013) outlined cloud-based tools used in libraries to include; online catalogues; WorldCat; GoogleDocs; subject gateways; GoogleApp Engine, D-Space, and FEDORA. The author however recommended that, for security reasons, academic libraries should make use of private clouds with special permissions to keep their procedures, policies and fiscal data. Similar findings by Yuvaraj (2015) noted that there was heavy dependence on cloud-computing tools among librarians. The report noted that librarians want to imply personal use of cloud computing tools in their works, but many of them could not achieve this due to security concerns.

In another study by Majhi, Meher and Maharana (2015) reported that librarians mostly used cloud computing tools for personal purposes, such as storing files, videos and photographs in cloud-based platforms and for collaborative writing. The authors noted security concerns as an important factor that hindered academic librarians from applying cloud-computing in their professional duties. Similarly, Mahalakshmi and Ally (2012) revealed that librarians were aware of the term cloud computing.

The adoption of cloud computing by academic libraries in Africa is just picking up and is yet to be duly reported (Buyya et al, 2009). However, Ifijeh (2014) noted that the use of cloud computing tools to preserve thesis and dissertations in Institutional repositories is an important model for addressing the problem of deterioration. It could be said that the use of cloud-based services in African libraries is presently concentrated around social media (Owusu-Ansah et al, 2015). This indicates that academic libraries in most African countries are adopting more to Software as a Service model to extensively promote their services, resources and to interact with users through web 2.0 applications like Google apps and social media platforms such as Facebook, Twitter, blogs, Instagram etc.

However, some reasons have accounted for the low adoption rates of cloud computing services by academic libraries. A research study by Adjei (2015) revealed security issues and disclosure of unique personal attributes as some reasons for academic libraries reluctance to adopt the options of cloud computing.

Similarly, Studies have indicated minimal usage of cloud computing services among institutions of higher learning in Africa. According to Seke (2015) very few universities have formally adopted cloud computing as a resource. Earlier studies in Ghana revealed adoption of cloud computing in tertiary institutions were either informal or pre-adoption stage (Yeboah-Boateng and Cudjoe-Seshie, 2013). Invariably, tertiary institutions in Ghana are yet to formally employ cloud computing as an emerging technology. Therefore, the utilization of cloud technology services are yet to be formally adopted and policy documented among some universities in Africa.

The issue of security is one of the major concerns in the application of cloud computing in academic libraries. Bingsi (2009) noted that in as much as there are many benefits to derive from cloud computing in library operations, the challenges of data security, fungibility, standards, and intellectual property remain key factors in its adoption. However, Lanlan (2009) believed that "cloud computing model as the underlying structure of the digital library, and can greatly improve library services in the fields of data security, data sharing and user experience, has the cost benefits, reliability and have scalable solutions. Goldner (2011) also reported that security was the prime concern when it comes to deploying cloud computing for use in academic libraries.

Data security and control in cloud computing

Kaushik and Kumar (2013) noted that cloud computing is presently one of the most popular virtual technologies being deployed by libraries for effective service delivery. They included that

"nowadays libraries are using cloud computing technology for enhancing the services by adding more values, attracting the users and cost-effectiveness." This has resulted in what is now regarded as "cloud libraries" (Kaushik & Kumar, 2013). However, there have been concerns in terms of data security when it comes to implementing cloud computing technology. Data security encompasses data control, data confidentiality, integrity, and availability of data at all times. It is the protection of programs and data in computers and communication systems against unauthorized modification, destruction, disclosure or transfers whether accidental or intentional. Also involves measures taken to enforce the security of the programs and data. Data can be lost in various ways, such as viruses, user errors, computer crashes, hacking among others. In order to protect against data loss, controls need to be put in place.

The confidentiality of data means that sensitive data or information belonging to researchers, individuals or an organization/government should not be accessed by or disclosed to unauthorized people. Integrity, however, means that data should not be modified without the owner's authority. Data integrity is violated when a person accidentally or with malicious intent, erases or modifies important files. The final tenets of data security, thus availability, play a critical role to make information available on demand. This means that any information system and communication link used to access it must be efficient and functional. An information system may be unavailable due to power outages, hardware failures, unplanned upgrades or repairs.

Data leaks can seriously affect researchers' privacy. Privacy is a legal and moral right of every individual. There are numerous issues related to the goals of privacy protection that must be addressed, including data subject rights, owner consent, access to data, and anonymity.

Another critical issue in ensuring confidentiality is where and how the data is stored. This includes the security of the data storage application, operating system, and any other applications that may

be running on the same system as well as the physical storage location. The physical location of data must be adequately secured, with safeguards and regular backups for the event of software or hardware failure. It is important for academic libraries to know the physical storage site and how the backups are protected.

In addition to the insufficient security provisions or an inadequately secured physical storage location, inconsistent use of encryption software keys can also pose a considerable threat to data confidentiality that can result to operational, authentication and authorization failures. This can lead to an unauthorized individual deleting or modifying data, which can severely affect researchers' privacy. If important intellectual property is lost, this may also have severe financial implications and damage the researchers' competitiveness. Such confidentiality breaches also have a negative impact on the academic library, which may lose the confidence of the researchers and may, in the end, jeopardize relation that existed between the academic library and the researchers. Cloud computing is currently perceived as a secure and cost-effective way of preserving and disseminating research assets. Nevertheless, the rate of adoption of cloud computing among academic African libraries is very low (Wanjiku, 2009). However, initiatives are underway to improve the rate of adoption of cloud computing in higher learning institutions in the continent. For example, over 30 higher learning institutions in Africa have partnered with Google to use Google cloud services. The partnership includes grants, technical support, consultation, and training. These institutions include the University of Mauritius (Mauritius), University of Ghana (Ghana), University of Pretoria (South Africa), and University of Ibadan (Nigeria). In East Africa, some of the institutions which have partnered with Google are the National University of Rwanda, Kigali Institute for Education, Kigali Institute for Science and Technology, and the University of

Nairobi (Wanjiku, 2009). Other institutions include the United States International University, the Kenyan Methodist University, and the Makerere University Business School (MUBS).

Setbacks to the adoption of cloud computing by academic libraries

Challenges in the cloud computing environment are the lack of guiding policies, operational procedures and standards for acquisition, development of Information Technology and services among the cloud providers. This could limit organizational control over employees who manage cloud-computing infrastructures. Zhou and Zhang (2010) noted that many privacy and security breaches occur from within the cloud providers themselves, since the employees may have direct access to stored data and sell them to third parties in order to gain profit. Such malicious activities could put research data at risk.

Therefore, it is critical for academic libraries to keep research data with the cloud computing service providers that have put in place audit mechanisms and tools to determine how data is stored, protected and used. Examples of these could be found Amazon and Elastic Compute Cloud (EC2) whose the policies stipulate that administrators are not entitled to access customers' data and thus cannot log into the tenants' system (Subashini & Kavitha, 2011). This will ensure the security of research data stored in the cloud servers.

Methodology

The data presented here derives from 15 academic databases, mostly journals of higher repute across Africa, Europe, the USA and Asia. The searches were conducted by the researchers which began with an online survey of dataset in academic libraries' catalogues at the Enterprise University of Pretoria, South Africa in 2017 where the researchers volunteered to take part in further detailed reviews in dataset on cloud computing in academic libraries. The researchers came

from different sorts of higher learning institutions (research-led and teaching-led institutions, large universities and small institutes) and were either senior library managers with a strategic overview or middle-level managers with direct responsibility for dataset management.

The study was a descriptive research which explored and reviewed related literature from secondary data such as books, journals articles, and databases from three African countries namely; Ghana, Nigeria, and Tanzania respectively.

The approach adopted for the research was given approval under the University of Pretoria, Information School ethics approval process as overseen by the University of Pretoria Research Ethics Committee.

The data sought covered four main areas: firstly, the current state of Academic libraries as a service; secondly, application of cloud computing in academic libraries; thirdly, the story of Data security and control in cloud computing; and fourthly, setbacks to the adoption of cloud computing by academic libraries. The researchers searched and scrutinize reliable but well written articles related but relevant data in cloud computing in academic libraries. Employing their skills in academic articles searches, the researchers spent pain staking time to review the issues involved, which included the academic library's adoption in cloud computing-related strategies and policies for safe guarding dataset with searches lasting two hours on each day which span for a month. A total of 59 related but relevant literature in cloud computing were assembled and reviewed. The literature sought was put under scrutiny, and eventually 50 was used for the analysis to come to the conclusion of the study.

Findings and Discussion

Use of Cloud to Archive Research Data in the Library

Findings from the study revealed that the use of cloud computing to archive research data/assets is a practice that is predominantly in the developed world. Many of the developing countries especially African libraries are yet to adopt cloud to archive their research data.

Benefits of Storing Research Data in the Cloud

Academic libraries could derive the following benefits from using the cloud to archive the research data of their institutions:

- · Cost-effectiveness
- · Visibility and accessibility
- · Resource sharing
- · Interlibrary collaboration
- · Unlimited storage capacity/scalability

Ways of Securing Academic Library's Research Data/Asset in the Cloud

From the literature, it showed that academic libraries have to manage the security of research data they archive in the cloud. These could be done through strong-protected authentication, develop policies and standards to access cloud services from secured networks, and scale up cloud subscription when necessary to avoid unnecessary congestion data susceptibility.

Challenges faced by academic libraries in implementing cloud computing

Despite the benefits accruable from implementing cloud computing in academic libraries, some challenges deterred some academic libraries to employ the technology to archive research data.

Some of these issues bothered on safety, concerns over continuity and reliability of library services in the cloud, network security as well as skill deficits.

CONCLUSION AND FUTURE STUDIES

The research was based on existing literature and was undertaken to determine how academic libraries could ensure data security in the cloud and to identify possible benefits that libraries can derive from storing research data through cloud computing.

This work will contribute to existing knowledge on the application of cloud computing in academic libraries from African perspectives as there are few empirical studies on the subject from the continent. The study concentrated on academic libraries in Ghana, Nigeria, and Tanzania from which members of the research group were drawn. However, there is a dearth of literature on the subject of the three countries.

From the findings of this study, it can be concluded that academic libraries in Africa have partly adopted cloud computing services in their service delivery, but were yet to fully utilize the platform as a tool for storing research data. However, this is not at par with what operates in the developed world.

The study also concluded that academic libraries can benefit from applying cloud computing services in terms of cost-effectiveness, secured data storage, information sharing, efficient service delivery, interoperability and scalability of the systems. Libraries that store their research data in the cloud are able to enhance their accessibility and visibility.

It can also be concluded from the study that academic libraries can, in addition to the security measures put in place by cloud service providers, use some techniques to secure data stored in the

cloud. These techniques include instituting policy guidelines, operational procedures, and strong authentication.

Major challenges that inhibited the adoption of cloud computing by academic libraries from the study were lack of proper policy guidelines and standards, inadequate authentication procedures from cloud service providers, issues of trust by academic libraries and lack of awareness of the importance of cloud computing to academic libraries.

In this technological era, cloud computing should be one of the priorities that academic libraries will consider enhancing their service delivery. The research data/asset of the library will become more useful and visible when it can be accessed beyond across the globe.

RECOMMENDATIONS

Based on the findings and conclusions of this study, the following recommendations were realized:

- Academic libraries should fully utilize cloud computing services to store research data, in order to enhance information sharing and effective service delivery.

- Academic library Managements should put in place policies and guidelines that will guide in the selection of cloud service provider for research data storage.

- Proper mechanisms should be put in place to ensure the realization of cloud computing services in academic libraries. These include: increase in broadband bandwidth and power supply for constant accessibility of information in academic libraries. Proper training on cloud computing services should also be provided for information professionals to enhance the adoption of cloud computing by academic libraries.

- Academic libraries in Africa should ensure that, before storing their research data in the cloud servers, they must review issues revolving security and privacy legislation. There

should be trust agreements between academic libraries and service providers on the cloud

services that will indicate how service providers will ensure data security and privacy.

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