

MIGRATION TO CLOUD BASED TECHNOLOGY IN ACADEMIC LIBRARY ENVIRONMENT IN NIGERIA: PROSPECTS AND CHALLENGES

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Abstract

This paper discusses the migration of cloud-based technology in academic library environment in Nigeria. It explains the concepts and types of cloud computing as well as highlights the problems and prospects encountered in the adoption and application of cloud computing in academic libraries. The paper further provides an account of the potentials of cloud computing in the management, utilization and sharing of information, knowledge and intellectual assets in libraries and for the creation of online communities for scholarly communication, collaboration and participation. The research approach adopted for this study involved a literature review that included scholarly journals, conference proceedings, websites and textbooks. In libraries, cloud service can play a crucial role in management of information services, particularly due to hard economic realities facing organizations. In this paper, cloud computing services offer attractive opportunities for organizations and service providers leading to innovation and the satisfaction of users. The paper recommends that academic libraries should implement new and smart technological solutions to enhance and support delivery of services to its users; the parent institutions should support the academic libraries in all services of installation, licensing, upgrading and maintenance of their cloud systems. In addition, academic libraries should collaborate with other cloud computing organizations to provide necessary infrastructure, networks, servers, applications, platforms and related services.

Keywords: Cloud Computing Technology, Cloud Computing Models, Academic Libraries, Information and Communication Technology, Library Services,

Introduction

Information technology is evolving over the years with emerging trends and new innovations in the field of library and information science. This has greatly brought about a change which resulted in the migration of library operations and services to a cloud - based infrastructure and computing in academic libraries. The twenty-first century librarians should be

able to harness these changes and use them to fulfil their mission to provide access to information when needed. According to Ogbu and Igwebuike (2024), academic libraries need to be ready to adopt and adapt to this change by rebranding the profession of librarianship in order to remain relevant and sustainable in this era of highly information competitive environment. Due to information and communication technologies (ICT) impact and digitalization of library resources, there is a change in the earlier meaning of library from document preservation to knowledge management (Verma, 2015). As due to global change and challenges, the library users are expecting more from the academic libraries. Certainly, technology helped the library professionals and transformed contents in to the digital form and made it available through networked environment. Cloud computing are more helpful for the easy storage and can access it globally in the networked environment. According to Makori (2016), cloud computing provides effective and efficient utilization and sharing of information service and has brought new and innovative ways of empowering the creation, diffusion, utilization and sharing of information, knowledge and intellectual property in libraries, while reducing management- related issues. Application of cloud technology in academic libraries will reduce the cost and users precious time. It is the prime responsibility librarians to work pro-actively and acquire new technology and skill to enhance library services. Librarians have to make sure to transform library users and library personnel to use wide variety of cloud services from personal to professional level. As Chiradeep 2021 pointed out, instead of storing files on a storage device or hard drive, a user can save them on cloud, making it possible to access the files from anywhere, as long as they have access to the web. It is crucial for academic libraries to have a solid understanding, acquire knowledge and skills as pertains to this new technology as well as developing strategies and good policies on the cloud computing technology before considering adoption and applications.

According to Pradipsinh, Atul & Ahmedabad (2019), due to the technological innovation in teaching and learning activity, university library is adopting new challenges by taking care of application of information and communication technology by way of Initiating digitalization, developing institutional repository, training of library personnel to cope-up with the challenges

from technology and provide up to date content to its users. Library is dealing with many advanced operations and their resources are available not only in print format but also many resources procured, processed and to disseminate in digital or electronic format in network or cloud environment (Verma 2015). The application of cloud computing in modern academic libraries extend beyond the physical walls of the building through technological and digital applications such as social computing, cloud computing, mobile phones and Web-based solutions. Cloud computing is displacing client server architecture and reshaping the delivery of information services, and librarians need to play a leadership role in its adoption and implementation.

Literature Review

Definition of Concept

Cloud computing is gaining momentum in academic institutions more especially in the management of academic libraries. In Njoku and Ken-Agbiriogu (2021), academic libraries are those libraries situated in institutions of higher learning such as universities, polytechnics, colleges of education, college of technology which are designed and geared towards the achievement of educational objectives of the parent institutions. Academic libraries are referred to as the heart or nerve centres of institutions of higher learning; this implies that all academic activities revolve around the libraries. Cloud computing is an emerging trend that has greatly affected the services operations of organizations, including that of libraries. Meanwhile, cloud computing means cloud based networking environment that provides services remotely over the internet. Swapna and Birader (2017) described that in cloud computing, the word ‘cloud’ is used as metaphor for the internet, based on the standardized use of a cloud-like shape to denote a network on telephony schematics. The ‘cloud’ element of cloud computing according to them

can be seen as an acronym that stands for c-computing resources; L-location independent; O-can be accessed via online means; U-used as utility and P-is available on demand.

Cloud computing is a kind of computing technology which encourages sharing the resources and services over the internet rather than having these services and resources on local servers/nodes or personal devices (Alabi, 2018). The combination of servers, networks, connection, applications and resources is defined as 'cloud'. Historically according to Wikipedia, the concept of cloud computing emerged as far back as the 1960s, when John McCarthy opined that computation may someday be organized as a public utility. Chellappa in Alabi (2018) gave the first academic definition of the term Cloud Computing in 1997 and later on, in the year 2007 the term cloud computing came into popularity and firstly was used in this context when Kevin Kelly opined that eventually we will have the inter-cloud, the cloud of clouds. In this regard, according to Wikipedia: “Cloud computing is Internet-based computing, whereby shared resources, software, and information are provided to computers and other devices on demand, like the electricity grid.” On the other hand, VMware, company provider of software and services, gives a more business-oriented definition: “Cloud computing is a new approach that reduces IT complexity by leveraging the efficient pooling of on-demand, self-managed virtual infrastructure, consumed as a service.” This implies that services will be accessible at ones comfort zone anywhere and anytime provided there is internet connectivity. Cloud computing technology innovation evolves to better services which aimed at covering a wider audience at a lower cost without proximity to any library rather the direct connection to the internet and libraries resources hosted in the cloud as a way of collaborating and sharing resources. Suci et al in Alabi, (2018) conceptualized, cloud computing as the delivery of computing and storage capacity as service to a community of end-users. They also reiterated that cloud computing also extends the concept of IT services by combining user data, software and on- demand computation resources over a network.

According to Chiradeep(2021), cloud computing is the use of hosted services, such as data storage, servers, databases, networking, and software over the internet. Since cloud

computing began, the world has witnessed an explosion of cloud-based applications and services in IT, which continue to expand. Almost every application we use resides on the cloud, helping us save storage space, expenses, and time. Suciú et al (2013) analysed cloud computing as the delivery of computing and storage capacity as service to a community of end-users. They also reiterated that cloud computing also extends the concept of IT services by combining user data, software and on-demand computation resources over a network.

Types of Cloud Computing

Many scholars have categorized cloud computing in different types. Swapna and Birader (2017) clearly stated the types of cloud computing as: on-the-basis of services and on-the-basis of usage. He further explained that on-the-basis of services includes infrastructure platform, services while on-the-basis of usage, it includes private clouds, public clouds, hybrid clouds, community clouds and special clouds. Dahunsi and Owoseni (2015), describes the typology of cloud computing as service infrastructure as a service (IaaS), platform as a service (PaaS) and software as a service (SaaS). He further describes cloud architectural solution as deployment models; private cloud, community cloud, public cloud and hybrid cloud. Infrastructure as service (IaaS) is providing consumer with computing resources such as computations, storage, networks, and allow the consumer to deploy and run arbitrary software which include operating system and application. Notable commercial solution of (IaaS) according to Swapana and Birader (2017), are Amazon cloud, Rackspace cloud and Gohrid. Others include Platform as services (PaaS) which are set of applications developed by the services provider to use cloud infrastructure; Software as service (SaaS) which provides consumer with the capability to use the provider's application running on a cloud infrastructure. It is a delivery model in which software and associated are centrally hosted on the cloud. All these are major service models which are prominently used to run cloud computing (Dahunsi and Owoseni, 2015). On the bases of Deployment Models, it is being explained briefly by Wada (2018) in four basic categories: private, public, community and hybrid deployment models. Private cloud according to Arokia et al in Alabi (2018) explained that private cloud or model is based upon a pool of shared resources, whose access is limited

with organizational boundaries. Quahabi et al in Njoku, & Ken-Agbiriogu, (2021) explained that cloud infrastructure is a composition of two or more distinct cloud infrastructures (private, community, public) that remain unique entities, but are bound together by standardizing or proprietary technology that enable data and application portability (for example, cloud bursting for load balancing between clouds).

Chiradeep (2021) opined that the services hosted on cloud can be broadly divided into infrastructure-as-a-service (IaaS), platform-as-a-service (PaaS), and software-as-a-service (SaaS). Based on the deployment model, cloud can also be classified as public, private, and hybrid cloud. Further, cloud can be divided into two different layers, namely, front-end and back-end. The layer with which users interact is called the front-end layer. This layer enables a user to access the data that has been stored in cloud through cloud computing software. The layer made up of software and hardware, that is, the computers, servers, central servers, and databases, is the back-end layer. This layer is the primary component of cloud and is entirely responsible for storing information securely. Chiradeep explained the different types of cloud computing in the following order:

Private cloud

In a private cloud, the computing services are offered over a private IT network for the dedicated use of a single organization. Also termed internal, enterprise, or corporate cloud, a private cloud is usually managed via internal resources and is not accessible to anyone outside the organization. Private cloud computing provides all the benefits of a public cloud, such as self-service, scalability, and elasticity, along with additional control, security, and customization.

Private clouds provide a higher level of security through company firewalls and internal hosting to ensure that an organization's sensitive data is not accessible to third-party providers. The drawback of private cloud, however, is that the organization becomes responsible for all the management and maintenance of the data centers, which can prove to be quite resource-intensive.

Public cloud

Public cloud refers to computing services offered by third-party providers over the internet. Unlike private cloud, the services on public cloud are available to anyone who wants to use or purchase them. These services could be free or sold on-demand, where users only have to pay per usage for the CPU cycles, storage, or bandwidth they consume.

Public clouds can help businesses save on purchasing, managing, and maintaining on-premises infrastructure since the cloud service provider is responsible for managing the system. They also offer scalable RAM and flexible bandwidth, making it easier for businesses to scale their storage needs.

Hybrid cloud

Hybrid cloud uses a combination of public and private cloud features. The “best of both worlds” cloud model allows a shift of workloads between private and public clouds as the computing and cost requirements change. When the demand for computing and processing fluctuates, hybrid cloud opens a new window allows businesses to scale their on-premises infrastructure up to the public cloud to handle the overflow while ensuring that no third-party data centers have access to their data. In a hybrid cloud model, companies only pay for the resources they use temporarily instead of purchasing and maintaining resources that may not be used for an extended period. In short, a hybrid cloud offers the benefits of a public cloud without its security risks.

Based on the service model, cloud can be categorized into IaaS (Infrastructure-as-a-Service), PaaS (Platform-as-a-Service), and SaaS (Software-as-a-Service). Let’s take a look at each one.

Infrastructure as a service (IaaS)

Infrastructure as a service or IaaS is a type of cloud computing in which a service provider is responsible for providing servers, storage, and networking over a virtual interface. In

this service, the user doesn't need to manage the cloud infrastructure but has control over the storage, operating systems, and deployed applications.

Instead of the user, a third-party vendor hosts the hardware, software, servers, storage, and other infrastructure components. The vendor also hosts the user's applications and maintains a backup.

Platform as a service (PaaS)

Platform as a service or PaaS is a type of cloud computing that provides a development and deployment environment in cloud that allows users to develop and run applications without the complexity of building or maintaining the infrastructure. It provides users with resources to develop cloud-based applications. In this type of service, a user purchases the resources from a vendor on a pay-as-you-go basis and can access them over a secure connection. PaaS doesn't require users to manage the underlying infrastructure, i.e., the network, servers, operating systems, or storage, but gives them control over the deployed applications. This allows organizations to focus on the deployment and management of their applications by freeing them of the responsibility of software maintenance, planning, and resource procurement.

Software as a service (SaaS)

SaaS or software as a service allows users to access a vendor's software on cloud on a subscription basis. In this type of cloud computing, users don't need to install or download applications on their local devices. Instead, the applications are located on a remote cloud network that can be directly accessed through the web or an API. In the SaaS model, the service provider manages all the hardware, middleware, application software, and security. Also referred to as 'hosted software' or 'on-demand software', SaaS makes it easy for enterprises to streamline their maintenance and support.

Application of Cloud –Based Technology in Academic Libraries

Transitioning from Web- to application-based systems has brought new ways of handling and supporting delivery of services. This has seen the emergence of outsourcing services without owning the complex and expensive information infrastructure. Outsourcing is the best management and technology strategy for organizations to deliver cost-effective quality services to the clients.

According to Alabi (2018), academic libraries can apply cloud computing to its services in order to enhance effectiveness and efficiency. Alabi pointed out that there are crucial areas libraries must consider before adopting cloud computing such as:

Architectural: Develop an understanding of the technology the cloud provider utilizes;

Identity Access Management: Ensure the correct controls are communicated to the service provider so as they can secure authentication, and other identification and access management functions;

Software Isolation: Understand virtualization and other isolation techniques of the cloud provider will implement;

Data Protection: Evaluate the cloud provider's data management solutions and maintenances;

Availability: Ensure that the contract provisions and procedures for availability, data backup and recovery, and disaster recovery meet the library's continuity and contingency planning requirements and lastly,

Incident Response: Ensure that the contract provisions and procedures for incident response meet the requirements of your library.

Challenges Facing the Adoption of Cloud Computing in Academic Libraries

The biggest challenge of cloud computing in Chiradeep (2021) is the security concerns associated with the technology. Although cloud service providers assure you of implementing the best security standards and industry certifications, there's always a risk while storing your data on cloud. In addition to security risk, Chiradeep enlisted the following issues facing the adoption of cloud computing:

Downtime: Almost every cloud user will tell you that outages tops their list of cloud computing challenges Opens a new window. At times, cloud service providers may get overwhelmed due to the huge number of clients they provide services to each day. This may lead to technical outages, due to which your applications may temporarily experience some downtime.

Internet connection dependency: A user may not be able to access the data on cloud without a good internet connection and a compatible device. Moreover, using public Wi-Fi to access your files could pose a threat if the right security measures are not taken.

Financial commitment: Cloud providers use a pay-as-you-go pricing model. However, businesses need to give a monthly or annual financial commitment for most subscription plans. This needs to be factored into their operating costs.

Security risks: Even if your cloud service provider promises you that they have the most reliable security certifications, there's always a chance of losing your data. With hackers increasingly targeting cloud storage to gain access to sensitive business data, this might be an even greater concern, for which the appropriate measures need to be taken.

Limited access: A user may have minimal control since the cloud service provider owns and manages the infrastructure. The user would only be able to manage applications and not the backend infrastructure. Crucial tasks, such as firmware management, may not be passed to the user at all. You always have to trust a third-party vendor to ensure security and take care of your data.

In Alabi (2018), standardization issues in the adoption of cloud computing technology to library services cannot be overlooked. Alabi explained that being able to keep important data secure has always been a priority in IT, but as cloud computing takes information outside of the virtual secure walls most corporations have raised red flags to its adoption. The problem is further aggravated as the standard apex body International Organization for Standardization (ISO) claims to have developed 19,500 standards on different aspects in the world till date but no standards have been developed yet on cloud computing. Giving the concern a prime importance, legislations and guidelines with the cloud service provider should be framed. These issues demand for a well-established set of standards that can address the cloud computing phenomena before its implementation in the libraries. This is a very critical observation which that will make libraries to feel reluctant. In developing countries, there are other issues in terms of clarity of concept, application and adoption for library services, how it works etc. These may pose challenges to its adoption. Other challenges as observed by Khajeh and Sriram in Alabi, (2018) are the interdisciplinary natures which they considered cannot be fully addressed from a purely technical perspective. The issues of security and availability of confidential information of libraries and individual still pose as a major problem thereby making libraries and individuals reluctant about depending on cloud- based services. Fear of cloud vendors going out of business and change in services that could affect the application of the cloud library. Another major fear exhibited by libraries is the potential drawbacks of cloud computing security and availability as a result of security breaches in cloud-based services of some high-profile organizations. Another challenge is with regards to current technology skills level, that is, the issue of not having IT staff and librarians with the technical skills and knowledge to manage and provide services.

In addition, cloud computing technology security and management is majorly the concern of trained experts. Geoffery (2013), explained that once the relationship is established the library can rest that the information is safe and well maintained in capable hands as much of the works on cloud computing attempts to allay the concerns and fears of potential users of the service.

Prospects of the Adoption of Cloud Computing in Academic Libraries

Cloud technology is ideal for growing academic libraries. Cloud computing provides effective and efficient utilization and sharing of information service and has brought new and innovative ways of empowering the creation, diffusion, utilization and sharing of information, knowledge and intellectual property in libraries, while reducing management- related issues. Libraries are powerhouses of information, knowledge and communication (Makori, 2015). Cloud computing has significant impact on the services of any organization. Mate (2016) stated the advantages of cloud computing as cost efficiency. Cloud computing is the most cost efficient method to use, maintain and upgrade as explained. He further said that cloud computing is advantageous to libraries because of its information, automatic software integration and quick deployment. According to Chiradeep (2021), the most important reason why cloud computing is growing rapidly is the various benefits it offers. It saves businesses the time and resources required to set up full-fledged physical IT infrastructure. Others include:

Reduced costs: Maintaining IT systems requires big outlays of capital, something that cloud helps reduce. By using the resources provided by the cloud provider, businesses avoid the need to purchase expensive infrastructure, substantially reducing their expenditure. Cloud providers work on the pay-as-you-go model, which means businesses only pay for the services they use, further reducing costs.

Scalability: Cloud allows organizations to grow their users from merely a few to thousands in a very short time. Depending on the need, a business can scale their storage needs up or down, allowing organizations to be flexible.

Flexibility and collaboration: Since the data on cloud can be accessed directly via the internet, it gives employees the ability to work from anywhere, anytime. Cloud gives you the freedom to set up your virtual office anywhere you are. It also allows teams to work on a project across locations by giving them access to the same files as third-party vendors.

Business continuity: Cloud safely stores and protects your data in the event of an outage or crisis. This makes it easier to resume work once the systems are up and running again.

Competitive edge: Cloud takes care of various business aspects, such as maintaining the IT infrastructure, licensing software, or training personnel to manage your data. It, therefore, gives you an edge over your competitors since the time and resources you invest are minimal.

In Njoku & Ken-Agbiriogu (2021), some benefits of cloud computing to librarians include high computing power, location and device independency, high scalability, less maintenance, less indulgence, unlimited storage capacity, diverse support, faster deployment, etc with cloud computing optimization of resources and services are ensured in libraries. These benefits have positive implication to library services and growths.

In addition, Alabi (2018) observed that cloud tools promotes and enables sharing and easier collaboration amongst libraries and equally library work. It will reduce support and hardware needs, such as constant upgrade of computer systems and the infrastructural cloud computing does not need larger number of IT staff for its operation since it is not the responsibility of libraries to manage the software rather it is the services provider who does the maintenance. Cloud computing reduces IT equipment in the office. Adopting the right cloud tools can enable collaboration as a patron does not need to be present in a physical library to access services provided especially if they are using a private or secure Wi-Fi connection. Similarly, by creating a Base camp platform where patron can view each other activities it will enable team collaboration tools advantage for colleagues such as video conferencing, file sharing via office365 and instant messaging these are made possible on the Software as a service platform environment.

RECOMMENDATION

1. Academic libraries should implement new and smart technological solutions to enhance and support delivery of services to its users.
2. The parent institutions should support the academic libraries in all services of installation, licensing, upgrading and maintenance of their cloud systems.
3. Academic libraries should collaborate with other cloud computing organizations to provide necessary infrastructure, networks, servers, applications, platforms and related services.
4. Information professionals should handle service needs with minimum costs.
5. The government should provide adequate funding in tertiary institutions.

Conclusion

Application of cloud computing technology could help academic libraries and librarians to overcome constraints like those associated with locally supported infrastructure. This by implication will empower them to render more effective, efficient and quality services that will help meet the high and unstable demands of library users. With cloud computing deployed in libraries, it is certain that the quality of network will be enhanced and libraries can explore it efficiently and this will make impact on researchers' input and output in developing countries. Computing technology, communication technology, and mass storage technology are some of the areas of continuous development that reshape the way libraries access, retrieve, store, manipulate and disseminate information to users. This is why academic libraries should adopt cloud computing through careful planning and strategic evaluation of the adoption process. It is important therefore that in adopting cloud computing in libraries, collaboration with experts is essential to successful implementation of the technology for enhancing service delivery.

References

- Alabi, O. C.(2018): *Issues in the application of cloud computing in academic libraries: implications for developing countries. journal of applied information science and technology*, 11 (1) (2018)
- Chiradeep, B. M. (2021): *What is cloud computing? definition, benefits, types and trends.* <https://www.spiceworks.com/user/about/chiradeepbasumallick>
- Dahunsi, F. M. & Owoseni, T.M. (2015). *Cloud computing in Nigeria: the cloud ecosystem perspective. Nigerian journal of technology (nijotech)*, 34(1), (pp 209-216).
- Geoffrey, M. (2013) “, *In computer world servers and data center* pp 45-50
- Makori, E.O. (2016): *Exploration of cloud computing practices in university libraries in Kenya. library hi tech news number 9 2016*, pp. 16-22, © emerald group publishing limited, 0741-9058, doi 10.1108/lhtn-11-2015-007716
- Makori, E.O. (2015), *Micro factors influencing use of electronic information resources among postgraduate students in institutions of higher learning in Kenya. Library Hi Tech News. Vol. 32 No. 1, pp. 18-21.*
- Njoku, L. C. & Ken-Agbiriogu, E. (2021): *Awareness and use of cloud computing: its implications in selected academic libraries in imo state, nigeria. information impact: journal of information and knowledge management*, 12:1, 62-75, doi: 5https://dx.doi.org/10.4314/ijikm.v12i1.5
- Ogbu, K . N . & Igwebuike, E . U . (2024) : *Key paradigm shift and evolving trends in academic libraries in the contemporary time: the way forward. 1st international hybrid conference 2024,Nnamdi Azikiwe Library, University of Nigeria Nsukka*

- Pradipsinh C. , Atul B. & Ahmedabad, D. T. (2019): *Application of cloud computing in university libraries: case study of selected university libraries in Gujarat*
- Suciu, G et al (2013). *Cloud computing as evolution of distributed computing: a case study for slapos distributed cloud computing platform. Inf. Econ.*, 17(4), 109-122.
- Swapna, G . & Biradar, B .S . (2017). *Application of cloud computing technology in libraries. international journal of library and information studies*, 7(1), 52.
- Verma, M. K. (2015): *Changing role of library professinal in digital environment: a study*
- Wada, I. (2018). *Cloud computing implementation in libraries: a synergy for library services operation. international journal of library and information science*, 10(2), pp 17-27.