Cloud Computing for Information Service Delivery in Public Libraries in Nigeria

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Abstract
Cloud computing is a recent revolution in information and communication technology. The application of cloud computing in library and information services in advanced countries has brought a novel trend in the scheme of information provision and services. This discourse is therefore an exploration of the possibility of the application of cloud computing model to the different key areas of information access, preservation, storage, retrieval and dissemination in Nigerian public libraries. The paper highlights the concept and principles of the application of the model to the general aspects of information resources management and 24/7 hours online information services delivery. Also periscopes into the setbacks and the sustainable ways for the application of cloud computing model for library managers and professionals to come up with strategic plans of implementation.

Keywords: Cloud Computing; paradigm shift; information service; public libraries; Nigeria

1.1 Introduction

The availability and application of information and communication technologies (ICTs) into library and information services has brought about significant changes in the ways with which library and information services are provided. The change has altered the way information is organized, stored, retrieved, dissemination and shared. The advent of ICT has equally introduced tools and services with huge potentials to address the challenges associated with traditional library system by positioning the library to effectively participate in global information exchange and information resources management activities. The latest of these numerous ICT tools and programmes that is so appealing to library and information services management in public libraries in Nigeria is

cloud computing. Public libraries are institutions that require linkage and partnerships with other institutions and organizations to effectively meet with their mandates of information resources management and provision of functional information services to clients.

Public libraries in advanced countries have long been enjoying the provision of current and up-to-date information resources to clients due to the application of the proceeds of cloud computing in the collection and management of varieties of information resources (Swain, 2013). With the good aspects of cloud computing enjoyed in advanced countries public libraries, information professionals should be made to thoroughly understand what constitutes cloud computing and how best it can be applied to

the management of information resources in the areas of processing, storage, retrieval and dissemination to clients in public libraries in Nigeria that are automated, computerized and digitized in an Internet-compliant environment.

2.1 Review of Related Literature

According to Swain (2013), cloud computing cannot be achieved by public libraries that are not computerized, digitized and hooked up to the Internet. Cloud computing Swain maintains is an operational model of information technology that has recently been witnessed to be amenable to being applied in various aspects of library and information services to effectively provide varieties of information to satisfy the needs of client. Sharif (2010) opines that cloud computing is the most potential model to change how the internet and information systems of new generations based on the latest ICT function and are effectively used everywhere in the world. It is the latest discovery of the development of the Internet enabling execution of all sorts of programmes and activities as the network does.

This is very much amenable to the management of information resources in public libraries and service provisioning to clients. In this 21st century information age the practice of librarianship is faced with challenges as a result of constant change of technologies. The emergence of cloud computing has made the role of the public library managers more practical and pragmatic in information services delivery to clients on daily basis (Min, 2012; Grant, 2013; Liu, 2013). This contemporary trend in cloud computing requires that information professionals and library managers to increase digitized contents in their libraries.

Cloud computing makes libraries, information centres and learning resource centres to be open access because of the digitization and virtualization of resources and services and dissemination through the Internet. The integration of all types of metadata (structured information resources and objects) into the collection and repositories of public libraries and turning them to the Internet (open access) through digitization and virtualization is quite a herculean task to library managers.

The conversion or digitization of information resources and throwing them open through the Internet makes library managers and information professionals to stand on their toes in handing out the plethora of information resources and services consumed by internet patrons through the use of various advanced methods, technologies and systems of realizing virtualization data services. Moreover, public libraries of the modern information age in advanced countries have witnessed rapid transformation from traditional libraries to digital libraries thus, adopting the newly developed model in the form of cloud computing to redesign and restructure the scheme of information provision and services.

The emergence of cloud computing and its application to information resources management and service provisioning is a clarion call on information professionals and public library managers in Nigeria to strive hard to find suitable methods of applying cloud computing to streamline the huge channel of information in libraries for effective information resources management and open access information provisioning through digitization, virtualization and the Internet. This effective cloud computing information resources management should be in the areas of information resources accumulation, processing, storage, preservation, repackaging, retrieval and dissemination.

Prior to the era of popularizing cloud computing, digital libraries were viewed as a hallmark for managing and archiving the ever

increasing information resources explosion. For public libraries in Nigeria to cope with this phenomenon of information explosion and achieve effective resources management and service provisioning Rabiu (2016) opines that with the increased publication of research results there is the imperative to use more scalability, superior, preservation measures and on-demand service application. These are the attributes of cloud computing. Deploying cloud computing to manage library resources for worldwide service provisioning to clients, it is envisaged would position Nigerian public libraries to deal with the geometric increasing rate of information resources published across the globe. This is the intent of this discourse.

2.2 Exposing the Concept of Cloud Computing

As a novel computing model, the development of cloud computing has brought to the field of library and information science a new perspective to look at the current information resources management, resource sharing and service provisioning challenges in libraries. Murley (2009) defined cloud computing as an emerging architecture by which data and applications dwell in cyberspace, facilitating access to users through any web-connected device. According to Wolt (2013), cloud computing is any server usage or software application one can access outside of his/her local server. It is a new technology model for IT services. Predicated on this, Cervone (2010) is of the view that CLOUD (common location, independent, online utility on demand) COMPUTING takes the concept of virtualization even further and adds a couple of additional twists as well. He maintains that cloud computing offers an organization the great flexibility and stability to satisfy computing requirements for multifarious needs.

Cloud computing refers to a large scale distributed computing paradigm that is driven by economies of scale in which a pool of abstracted, virtualized, dynamically scalable managed computing power, storage, platforms and services are delivered on demand to external customers over the Internet. As a specialized distributing computer paradigm, cloud computing has the following features: it is massively scalable; can be encapsulated as an abstract entity that delivers different levels of services to customers outside the cloud; driven by economics of scale; and the services can be dynamically configured (via virtualization or other approaches) and delivered on demand (Goldener, 2015). According to the National Institute for Standards and Technology, NIST (2011), cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

Mell (2011), Foster (2017) and Breeding (2018) posit that the librarianship conceptualization of cloud computing may well be that "cloud computing is used broadly to describe nearly any type of virtualized computing environment where a library relies on a remote hosting environment for a major automation component. Cloud computing is the delivery of computing services over the Internet. Cloud services allow individuals and businesses to use software and hardware that are managed by third parties at remote locations. Examples of cloud services include online file storage, social networking sites, webmail and online business applications. The cloud computing model allows access to information and computer resources from anywhere that a network connection is available. It provides a shared pool of resources, including data storage space networks, computer processing power, and specialized corporate and user applications.

Cloud computing applications and infrastructure are built with the assumption that users will access them from the Internet on multiple platforms and from anywhere in the world. In the views of Mavodza (2016) libraries and information centres in this contemporary information age have delivered into the dominion of digital librarianship to explore all facets of information technology, thus making information agencies and organizations to extensively bank on the cloud. Behrend (2017) opines that cloud computing in the parlance of information science and services is used to describe the software application or other resources that exist online and are available to multiple users via the Internet, rather than being installed on a particular user's local computer. A service provider owns the equipment and is responsible for housing, running and maintaining it. Salesforce.com, Google Apps, Amazon web services, Black Berry Media (BBM) WhatsApp and Facebook are the popular examples of cloud computing.

In this contemporary information age of the 21st century, cloud computing has popularized and enhanced the image of providing library and information services. It has made libraries which were hitherto operating based on closed access (for immediate local operational environment only) now operate based on open access via the Internet. Libraries have achieved this through digitization and virtualization using the open software and web 2.0 principles to bank in the cloud for open accessibility to information resources all over the global village.

In view of the foregoing, library cloud computing is all about effort put together by libraries to better manage their computing service and other ICT based works. It is a system whereby libraries in a geographic area through collaborative arrangement engage other outfits (cloud computing service providers) to manage all the library computing services at agreed terms and conditions, which range from the provision of hardware and software services to the library geographic work stations (Armbrust, 2017).

2.3 Imperatives of Cloud Computing in Public Libraries

With the emergence of World Wide Web (www), the provision of services and information in libraries has been restructured recognizing that future libraries shift focus from huge collection building to networked services. Rather they should emphasize on referral service to potentially appropriate points in a vast network of resources accessible through the internet or its successors (Lancaster, 2017). The World Wide Web has enabled libraries to extend their link and connection to wide networks and full-content databases. The incredible use of the internet among library users has indeed made it imperative that libraries offer their services online since users do have viable alternatives of finding information than using the conventional library. Sadeh (2014) and Cosh (2016) in their separate works reminded that Web 2.0 technologies have proved themselves very much popular amongst web designers. This has led to further challenges in the management of pool of information resources and provision of services to clients by analog or conventional libraries.

Cloud computing in public libraries is justified when Fox (2016) expresses that "currently the bandwidth potential at the back of internet has been triggered up exponentially. These network-based applications have become much more efficient on the wire and data comprehension standards that strengthened transmission of multi-media contents over the cloud environment. The future of the application of cloud computing in digital libraries will contextually address the current momentum of open access publishing which will continue

to grow and give libraries more opportunities to focus more on building services based on widely available scholarly content rather than exhausting their meager resources on procuring these publications.

Infact, cloud computing services encourages the sharing of information resources ubiquitously by library clients. Here most users meet normal operating flows in the cloud environment and are always braced up in facing the accompanying challenges after one of the potential challenges occurs and is effectively handled. In essence, cloud computing allows users to explore and experiment on their own in the cloud environment. Cloud based services can be well efficiently backup a given wed site thus allowing users save such web site in their local storage gadgets. To this effect, Wang (2014) opines that these users can seek the need of cloud vendors to harmonize series of commercial standards for the successful implementation of local web site storage and information sourcing in the cloud environment.

According to Nie (2014) and Liu and Cai (2016), cloud computing technology has brought a tremendous change and new vista in the provision of library and information services to clients which was hitherto badly lacking. The cloud computing technology has today caught the attention of the library world. Furthermore, Liu and Cai (2016) in their study on the overview of cloud computing and its increasing impact on systems librarianship and proposed strategies for systems librarians as they embrace the shift to cloud computing. They found that cloud computing has a great impact on systems librarianship because of late, it promises and has the prospect of providing a solid web-based library platform by offering viable information services to client with incredible speed and in quick time all round 24/7 hours.

Cloud computing in advanced countries public libraries has made tremendous impact on the effective management of information resources by avoiding unnecessary information resources procurement and the proper harnessing of available ones in the areas of processing, repackaging, storage, retrieval and dissemination through the mechanisms of the creation of geographic workstations (database), digitization, virtualization and creation of website in the cloud environment. Before now, this created the full opportunity for automation and computerization of advanced countries public libraries. Furthermore, with cloud computing technology, libraries of all types in Nigeria would metamorphose to systems libraries thus leading to the emergence of systems librarians. For libraries in Nigeria therefore to remain relevant and afloat in this 21st century information age of global competitiveness, they would have to embrace the dynamics of cloud computing technology.

2.4 Models of Cloud Computing for Nigerian Public Libraries

The usefulness of cloud computing in information delivery services and its application to the professional environment cannot be over emphasized. It is a highly scalable platform promising quick access to hardware and software over the Internet relying on new technologies such digitization, virtualization, programming techniques such as multi-tenancy and/or scalability, load balancing that ensures relatively easy and quick access to information resources. Cloud computing allows the provision of information technology resources on demand and lowering management complexity. Cloud computing helps in bridging the gap between digital libraries and information technology (IT) by facilitating unfettered sharing of data among libraries in a geographic workstation or database which in turn reduces the overall cost incurred by individual libraries (Romero,

2017). It is in consideration of all these that it has been advocated that libraries, especially public libraries should choose for themselves the model of cloud computing they would adopt.

Public Cloud: The type of cloud computing services, applications and storage offered to prospective public (users) across the Internet as a service for payment or pay as you use or pay as you go basis. In the parlance of library and information science this is referred to as fee-based information service. Public clouds are appealing to many businesses and organizations because they have the features of complexity and cost, the underlying architecture is fixed and there is less scope for customization for security and performance. Public cloud computing service can be offered as Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS).

Private Cloud: The type of computing service where applications, infrastructure and storage are deployed as "stand alone" solutions for a single organization like library or library consortium. It could be managed internally within an organization or library consortium or externally, by engaging the services of a third party. Private clouds offer advanced security features and other sophiscated features not possible in a public cloud.

Hybrid Cloud: Hybrid cloud is the type of cloud computing services that combine the features of public and private computing. It combines the external features of public cloud and the internal features of private cloud. These are likened to the features of the extranet and intranet models.

3.1 Service Layers of Cloud Computing for Public Libraries in Nigeria

There are models and service layers of cloud computing that are suitable and adaptable to the operational and information environment of public libraries in Nigeria.

The fundamental requirement for this adaptability and effective provision of cloud computing layers of services is for both public libraries and librarians to metamorphose to systems libraries and systems librarians. These models and service layers include: Platform as a Service (PaaS), Software as a Service (SaaS) and Infrastructure as a Service (IaaS).

Platform as a Service (PaaS): This is a model of cloud computing that delivers applications over the Internet. In this model and service layer the cloud computing service provider delivers both hardware and software tools. The hardware and software tools should be in line with needs of the library and the requirements of the services to be provided to clients in the cloud. Mahalakshmi and Ally (2016) and Rabiu (2016) describe these tools as those needed for application development to a library's users or clients as a service. A PaaS provider hosts (owns or houses) the hardware and software on his infrastructure. In this model, if a library subscribes to any cloud computing service provider, the PaaS cloud computing model (provider) would take away the library's burden of installing hardware and software to run library application in whatever area of service. For instance, if a library wants to create open access to its institutional repository, i.e. special reserved rooms or Starks, e.g. Nigeriana, Special and Government Documents Sections, it is the cloud computing service provider (PaaS) that would take the burden (responsibility) of providing and installing the hardware and software for automation, computerization, digitization, virtualization and creation of web in the cloud environment for the accessibility of the special collection or information resources in these repositories in the cloud via the Internet. This is because open and close access, and special collections are obtainable in public libraries in Nigeria.

Software as a Service (SaaS): Cloud

computing model that delivers application over the web. The cloud computing service provider users the model to deliver software applications and the related functuality to his clients. It allows a library to access library related applications over the web at a highly reduced cost. As a result of the merits of cloud computing, the related software are remotely accessed. The library does not need to install the accessed software again and services are cost cutting on the part of the library. The software that could be accessed include OPALS, Access-it, CodeAchi, LIBERO, LMS, and Soutron. Others are Evergreen, PMB, EasyLib, ILS, LibMgt and OpenBiblio (www.goodfirm.co/libautom) examples of SAAS are: Google, Twitter, Facebook, Flicker, etc.

Infrastructure as a Service (IaaS): Model of cloud computing that delivers and provides hardware, software and equipment as infrastructure especially at the unified resource layer. It can as well include part of the fabric layer. It also delivers software application environments with a resource usage-based (utilization-based) pricing model. Infrastructure can scale up and down based on application needs, i.e. rate or level of demand (Numberg & Mark, 2016).

3.2 Merits Nigerian Librarians Should Embrace in Adopting Cloud Computing

The application of cloud computing to Nigerian public libraries that have huge number of patrons offers a good number of merits.

Cloud computing as a contemporary paradigm in providing functional and operational information to clients via the Internet has been likened to having the great potential for cost reduction and complexity of owning and operating computers and computer networks. As a result of the fact that cloud users do not have to invest on information technology infrastructure such as purchase of hardware or software licenses, cloud computing is beneficial because of its low upfront costs, rapid return on investment and rapid development.

Cloud computing creates room for customization and flexibility of use as well as provide strategic solutions that can make use of new innovations.

As mentioned earlier in this paper, the scalability tendency in the application of cloud computing in public libraries services provides the means which enables it to offer unlimited processing and storage service.

With respect to cloud computing, the cloud is reliable and dependable in the area of access to computer applications for the utilization of both hardware and software facilities and documents from anywhere in the world via internet connectivity through the mobile internet apparatuses such as tabletops, laptops and smartphones or the fixed or stationed internet mechanism of the desktop personal computer (PC) system.

Cloud computing offers appreciable level of efficiency and skillfulness in computing services. This feature stems from the cloud computing is run on the platform where there is a pool or cluster of experts and resources. It also makes libraries to free up resources in order for them (libraries and managers) to focus properly on innovations and develop new service products or lines.

In the sphere of privacy and security, information stored in the cloud environment is more secured and better protected. Loss of information in the cloud environment through any means is ruled out.

Summarily, Romero (2017) opines that cloud computing automatically increases or reduces the consumption of hardware or software resources as per the requirements; offers more efficient and effective control of expenditures; provides immediate access to the

improvement and updating of hardware and software; and provides remote access to electronic resources with less cost irrespective of geographical barriers. In all its ramifications, cloud computing is tremendously useful for content organization and sharing, creating tutorials,, collaboration, scheduling and data storage.

3.3 Challenges of Cloud Computing Nigerian Librarians Should Look Out For

These challenges are directly likened to the sorry state of affairs in public libraries in Nigeria. The challenges of cloud computing in library and information services are embedded in its demerits. Particularly, these writers maintain that inspite of the attractive merits of cloud computing, it suffers from certain setbacks that are worrisome to librarians.

Security of library resources in the cloud environment is a serious concern. Entrusting cloud service providers with library resources may at the end jeopardize library programmes and services. This fear is hinged upon the thinking that as cloud service providers host several servers and users, they may not be hundred percent competent to provide services that would be capable of segregating library resources and data in the cloud environment.

Effective negotiation with cloud computing service providers by librarians and libraries is a very big setback. Library managers who are seasoned systems librarians should negotiate intelligently as professionals with cloud computing service providers on cost effective basis, software suitability, and functionality. This negotiation during subscription is to avoid the pitfalls experienced during the era of library automation with library automation software vendors.

The challenged posed by the issue of epileptic and erratic nature of power supply from the national grid should not be swept under the carpet while considering the demand of providing cloud computing services by libraries. Cloud computing is a service that is accessible online via internet connectivity that needs 24/7 hours electricity. Unfortunately a good number or even all public libraries do not have stable independent power source to run their system (libraries) and systems (computers and electronic based information services).

As cloud computing is based online with effective bandwidths and internet connectivity. It requires prompt, fast, dedicated and reliable internet connectivity at all times. It is not out of place to state that most libraries in developing countries are suffering from low bandwidth which invariably hinder strong and effective internet connectivity required for cloud computing.

Deploying cloud computing to the provision of electronic-based library and information services to information seekers/users involves a huge financial and capital outlay. It is a capital intensive social project to which government pays no priority attention and which libraries themselves cannot bring to function without support.

The negative attitude of Nigerian librarians themselves toward being amendable to change and proactive innovators is a very big ditch towards the installation of cloud computing infrastructure and services. Rather than being "aggressive" innovators and revolutionalized change agents, Nigerian librarians, inspite of the demands of the 21st century information superhighway era, continue to remain apologetic, uninspiring and unenterprising analog bibliographic library service providers. This is antithetical to cloud computing service provisioning in public libraries in Nigeria.

4.1 Sustainable Ways Forward

There are always two sides to a coin-the pros and cons. Having considered the merits and demerits of cloud computing in this discourse, it is imperative that the sustainable ways forward are proffered.

On the issue of security of library resources in the cloud environment, libraries domicile in the cyberspace should adopt the mechanisms of cryptography and encryptions. This would enable systems library managers and their libraries to convert data contained in their domain into a secret code prior to transmission to public telecommunication channels- the Internet. This makes the content of resources in the cloud incomprehensible to all but authorized recipient(s). Aptly described, encryption is a security measure taken to protect organizations confidential information such as credit card numbers used in online business transactions and ensure that only those who have paid for a fee-based service can obtain it. By implication therefore libraries adopting the mechanisms of cryptography and encryption in preserving the security of information resources in the cloud would be encouraged to provide content-based online information services based on the selling and using of coded scratch cards to clients for them to source/surf libraries cloud domain (website) for information needed (online fee-based service).

On effective negotiation, sponsoring bodies of public libraries in Nigeria need to evolve and implement policies that would bother on encouraging libraries to migrate to content-based libraries and further metamorphosing to systems libraries and systems librarians. With this, library managers would be in the best position to effectively negotiate with cloud computing services providers, hardware, and software vendors and be assured of the desired results.

On the issue of epileptic and erratic power supply from the national grid and electricity distribution companies, systems library managers in liaison with their parent bodies should provide reliable independent private power source. This would enable Nigerian public libraries to provide 24/7 hours power supply and content-based online fee-based services to clients.

For cloud computing services to be equally effective library mangers and boards in Nigeria should ensure they provide high level bandwidths and internet connectivity that would ensure the provision of real time service to the satisfaction of clients. Real time online information would require and indeed activate prompt, fast, dedicated and reliable internet connectivity at all times.

Ordinarily, the provision of analog bibliographic library and information services to clients gulps a huge amount of funds. In the vein for libraries to be internet-compliant and go ahead to provide online services in the cyberspace, they need to be adequately funded by their proprietors. Funding is not needed only for the acquisition of hardware and software, but for the paraphernalia of cloud computing, including human resources recruitment, training and development.

On the negative attitude of librarians

in Nigeria towards change, simply put, they should turn to "aggressive" content-oriented systems librarians, correspondingly working in content-based systems libraries. By this, they would be dynamic, proactive, projective and innovative information services providers in the cloud environment.

4.2 Prospects and Conclusion

Proffering solutions to challenges in a given situation is problem half solved and holistically implementing proffered solutions, if not completely eradicating challenges, makes for a near total elimination of bottlenecks. This axiom applies to the application of cloud computing technology services in Nigerian public libraries. With the implementation of the recommendations above, cloud computing has the potential of revolutionalizing the provision of library and information services in Nigeria. With respect to the complex nature of library resources, data management handling and administration, cloud computing is considered the most striking model for supporting libraries in effective service provisioning, long term preservation and perpetual access to data. It is instructive to note that there must be the quest for cloud computing service provider who would host, run and maintain the library data system.

Through the application of cloud computing, public libraries in Nigeria would be in a better position to manage complex data storage, information, access sharing and consumption. It is the contention of this paper that as librarians clamour for cloud computing service online, they should bear in mind that the model is all about librarians putting effort together to effectively manage their libraries computing service and all other aspects of ICT related services. This is a clarion call on library managers, librarians and their libraries that they should adopt cloud computing as a platform for running library consortium on private cloud computing model and on the service layer of Software as a Service (SaaS).

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