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## Application of Cloud Computing Technology in Public Library Services in Nigeria: Strategic Framework for Operational Success

C.P.C Onwubiko

*Abia State University, Uturu*

Justice Nnamdi Okorie

*Abia State University, Uturu, justice202020@yahoo.com*

Blessing C. Onu

*Federal Polytechnic, Nekede*

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**APPLICATION OF CLOUD COMPUTING TECHNOLOGY  
IN PUBLIC LIBRARY SERVICES IN NIGERIA:  
STRATEGIC FRAMEWORK FOR OPERATIONAL SUCCESS**

**BY**

**C.P.C ONWUBIKO**

**DEPARTMENT OF LIBRARY AND INFORMATION SCIENCE,  
ABIA STATE UNIVERSITY, UTURU**

**JUSTICE N. OKORIE**

**DEPARTMENT OF LIBRARY AND INFORMATION SCIENCE  
ABIA STATE UNIVERSITY, UTURU**

**AND**

**BLESSING C. ONU**

**DEPARTMENT OF LIBRARY AND INFORMATION SCIENCE  
FEDERAL POLYTECHNIC, NEKEDE**

# **Application of Cloud Computing Technology in Public Library Services in Nigeria: Strategic Framework for Operational Success**

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**C.P.C Onwubiko**

Department of Library and Information Science,  
Abia State University, Uturu

**Justice N. Okorie**

Department of Library and Information Science  
Abia State University, Uturu

and

**Blessing C. Onu**

Department of Library and Information Science  
Federal Polytechnic, Nekede

## **Abstract**

*The discourse is all about the application of cloud computing technology in public libraries services in Nigeria. It gives the conceptual overview of cloud computing, features and the service models, which include SaaS, PaaS, and IaaS. The paper also discusses cloud deployment storage models in private, community, public, hybrid and personal cloud. The advocates of cloud computing in libraries are highlighted, alongside cloud computing vendors for libraries. Services areas amendable to cloud computing technology, benefit and challenges are featured in the paper. The hallmark of the paper is the presentation of strategic framework for operational success of the application of cloud computing in public libraries. Concluding, the discourse opines that cloud computing has permeated into libraries in advanced countries and is fast moving to libraries in Asia. Predicated on the framework on operational success and its gained popularity, the discourse advocates that it should be applied in public libraries services in Nigeria.*

**Key Words:** *Application; cloud computing; public libraries; Nigeria; Strategic framework.*

## **Introduction**

The use of computers today in the discharge of a whole lot of responsibilities and functions by organizations, businesses, information agencies and of course individuals has witnessed a quantum leap. As a result of this phenomenon, organizations and individuals invest heavily on hardware, software and maintenance. Also with the global running of the age, christened information superhighway, the desire for the acquisition of information and utilization of the paraphernalias of ICT including cloud computing technology has become fashion of the day. Cloud computing ensures quick and appropriate access to every information when needed on real time basis.

Cloud computing is that virtual pool of corrupting resources through the internet which makes it possible to separate the process of building an infrastructure for service provisioning from the library of providing end user services. It provides people the way to share distributed resources and services that belong to different organizations, establishments, libraries and sites via the internet in open environment (Zhu, 2012). Cloud computing technology has become a new buzzword in the field of libraries and service provisioning in advanced countries. It is a blessing to these libraries because it encompasses the running of different ICT services without much of a problem as third-party services manage servers and undertake upgrades and backup of data.

Cloud computing is a new technology model for IT services which many organizations, establishments and even individuals in developed countries are adopting. It transforms the way systems are built and services delivered, providing libraries with an opportunity to extend their impact to clients and the society at large. Kelley (2016) maintains that cloud based services provide a means for libraries to free resources on web and disseminate information to clients cloud based services also bring cutting-edge services to libraries that have less information technology expertise. In this age of information superhighway cloud based services is important for it offers infrastructure, platform and software as a service. Above all, because of the enormity of information resources and data embedded in it, cloud computing

services is attracting and receiving a great deal of attention and patronage among organizations, establishments, government and individuals. As a web-based technology, cloud computing is a combination of technologies and tendencies (trends) that makes infrastructures and applications more dynamic, more flexible and replaceable. In the words of Suman and Singh (2016) applications such as e-mails, web conferencing, customer relationships management (CRM) are all tracked in one cloud. Libraries also use computers to run such other services as integrated library management software (ILMS) website or portal, digital library or institutional repositories.

Showing the presence of libraries in the web, cloud computing technology helps libraries to maintain record data, private and delicate data. They also adopt this technology for electronic journal access, hosting digital libraries, tracking statistical data and integrating library hosting. This implies that a considerable increase of digitized contents urges libraries, archives and learning resource centers to integrate new media of all types like record labels and film archives, neo documents and similar such materials into the general collection and special documents reserved areas (repositories).

As all these are made realizable by cloud computing technology, the emergence and application of this model in public library services in Nigeria would make the role of library managers and professionals more practical and pragmatic to the service they provide on daily basis. Moreover, public libraries of the modern cloud computing generation envisaged in Nigeria would witness a rapid transformation from conventional libraries to digital and virtual libraries, thus adopting cloud computing model to redesign and restructure the scheme of information services delivery.

Though cloud computing services has the great potentials of revolutionizing library and information services in Nigeria, it is essential for library managers and professionals to have a solid understanding of this new technology landscape to move beyond a vague awareness of it to a more nuanced well-informed understanding of such concepts software - as - a-service and infrastructure -as-a-service and platform-as-a- service their and their relative merits, caveats and risks.

In view of the foregoing, it is the intent of this discourse to present the strategic framework for operational success of the application of cloud computing technology in public library services in Nigeria.

### **Cloud Computing: Conceptual Overview**

In this 21<sup>st</sup> century era of information age, technology has become the concern of libraries, library managers and information professionals. Technology today plays a critical role in the provision of real time information to clients by libraries. For libraries, managers and professionals (information providers) cloud computing would provide the opportunity of realizing the aforementioned goal. But the question now is what is cloud computing? In the words of Suman and Singh (2016) cloud computing is not a new technology but a new form of computing that has not yet got a definite generally accepted definition and interpretation. However, they maintain that cloud computing is a web-based technology, which is a new form of computing. It is a service provided on the internet or network. It is one of the most important in the 21<sup>st</sup> century that offers infrastructure, platform and software as a service. Cloud computing is a conjunction of technologies with trends that make infrastructures and applications more dynamic, more flexible and replaceable.

According to Wikipedia, cloud computing refers to the delivery of computing as a service rather than product, whereby shared resources, software and information are provided to computers and other devices as a metered service (charge for computing services based on usage, similar to how one is billed for water, electricity, phone call services, DSTV, GoTv, Startimes etc. subscriptions at home) over a network, infrastructure, storage of client data and applications that are accessed via a remote computer. As expressed in the parenthesis above, in cloud computing model, organizations needed to buy or pay for only those services which are to be needed by them. In this pick and choose model, subscribing individuals, libraries, establishments, and government are to make their requests to service providers to add or remove the service as per the needs.

Though no yet universally accepted definition of cloud computing, Lebeko (2013) sees it as a large 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. This definition has some features embedded in it.

- It is massively scalable;
- Can be encapsulated as an abstracted entity that delivers different levels of services to customers outside the cloud;
- Driven by economies of scale; and
- The services can be dynamically configured (via virtualization and other approaches) and delivered on demand.

National Institute of Standards and Technology (NIST, 2011), sees cloud computing as a model for enabling ubiquitous, 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. The description of Gartner Group and Forrester is cloud computing are apt. They are respectively of the opinion that cloud computing is that style of computing in which massively scalable and elastic, IT-enabled capabilities are delivered as a service to external customers using internet technologies; and it is a pool of abstracted, highly scalable and managed computer infrastructure capable of hosting end-users (customers) applications and billed by consumption. All in essence imply that cloud computing is a type of computing that basically relies on sharing computing resources rather than having local servers or personal devices to handle applications. Cloud computing is a concept referring to a network computing model that relies on distributed systems to deliver computing services on demand. Rather than requiring local infrastructure and expertise to configure and manage hardware, cloud computing facilities remote access to robust computing power.

Cloud computing is a new technology model or technique for Information and Communication Technology services that is internet based where virtually shared servers provide software, infrastructure, platform devices and other resources and hosting customers on pay-as-you-use basis. All information that a digitized system has

to offer is provided as a service in the cloud computing model. Users can access these services available on the Internet Cloud without having any previous know-how on managing the resources involved (Sahu, 2017). Cloud computing is a flexible model. In it, users can also build or prepare their own applications which can also be used by others through the Internet. Cloud computing in all its ramifications provides a common computing platform for users.

In the parlance of library and information science and service provisioning, Foster (2008), Mell (2011), Breeding (2013), and Lebeko (2013), 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. Sultan (2013) notes that cloud computing in libraries is a democratizing force and to that end, access to cloud technologies helps library managers and information professionals overcome limitations and utilize robust computing in their practice of librarianship. Cloud computing in recent times has entered the library technology sphere. It brings the opportunity for libraries to shift away from the need to own and operate their own servers to power their core automation applications and to instead shift to gaining similar functionality through web-based services. Cloud computing is the delivery of computing services over the Internet. It allows libraries, businesses, establishments and individuals to use software and hardware that are managed by third parties (cloud computing service providers) at remote locations. Examples of cloud services include online file storage, social networking sites, webmail and online business applications. Rabiou (2016) opines that 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 such as storage space, networks, computer processing power and specialized corporate and user applications. In effective and efficient service delivery to clients, cloud computing gives libraries the opportunity to extend their impact because of its transformation of the way systems are built and services delivered.

According to Tritt and Kendrick (2018), cloud computing provides layers of the cloud computing stack of Platform as a Service (PaaS), Infrastructure as a Service (IaaS) and Software as a Service (SaaS), but to libraries, SaaS cloud computing technologies are the most accessible and applicable form of cloud computing to library and information services. SaaS refers to software designed for end-users and made available over the Internet. Popular examples of SaaS include Google Docs, Evernote and Dropbox. SaaS computing technologies bring powerful options to those other organizations who do not have the expertise, staff, time or infrastructure to implement and support various computing services.

In view of the foregoing overviews, cloud computing in all its ramifications is anchored on the fulcrum of virtualization, distributed computing, utility computing, networking and web software services. It is a service-oriented architecture, reduced information technology overhead for end-user, great flexibility, reduced total cost of ownership, on-demand services, increase network reliability and efficiency, as increasing the variety of technology resources available from user desktops.

Breeding (2012; 2013) sums it up by saying “clouds, because of their massive redundancy and clustering are very fault tolerant and since cloud computing is elastic, it can expand or shrink as computer power needs increase or decrease”.

### **Features of Cloud Computing**

Cloud computing possesses some characteristic features that makes it appeal to library managers and professionals for its application to library and information services. NIST (2011) has identified these features to include: On-demand service; broad network access, resource pooling; rapid elasticity; measured service; and multi tenancy.

**On-Demand Self-Service:** Within the ambit of on-demand self-service, libraries, establishments, organizations, governments and individual can secure cloud-hosting services through a cloud host provider, which normally could be the user’s software vendor. These consumers have access to user services as well as have the power to modify cloud services through an online control panel or directly with the

provider. According to NIST Amazon Web Services (AWS), Microsoft Azure, Google and Salesforce.com are the cloud service providers that provide on-demand self-services.

**Broad Network Access:** Cloud service consumers can access cloud capabilities that are available over the Internet through standard mechanisms that promote use by heterogeneous thin or thick platforms such as mobile (smart) phones, laptops and PDAs as well as other traditional or cloud-based software services.

**Resource Pooling:** Resource pooling simply means pooling the resources of cloud computing service provider together to serve and satisfy the needs of multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically designed and redesigned according to consumers' demand. There is a degree of location independence in that individual consumer. Generally have no controls or knowledge over the exact location of the provided resources, but may be able to specify location at a higher level of abstraction (country, state or data centre). Example of resources include storage, processing, memory, network bandwidth, and virtual machines. Even private clouds tend to pool resources between different parts (units, sections, departments) of the same organization. Resources pooling leads to economy in carrying out work.

**Rapid Elasticity:** This refers to the rate of frequency in time (the speed) and elasticity with which capabilities of cloud computing service provisioning is provided or sourced or in some cases automatically or quickly scale out and rapidly released to quickly scale in. To consumers, the service capabilities available or provided often appear to be unlimited and can be purchased in any quantity at any time. Simply put, rapid elasticity is based on the needs of consumers. Consumers have the liberty at any time to add or remove any type of software. Elasticity is the best option in cloud computing because this elasticity is critical for business and libraries as their employees can keep an eye on information resources and data update to satisfy users and for businesses their projects, and contracts stand on 24/7 hours even when they are on the move or in the office.

**Measured Service:** In cloud computing service, measured service shows the measurement of utilization of resources such as storage, processing, branding or active use account. This service tremendously contributes in the effective running of organizations. It has the resource use. This helps to charge as per usage. In this measured service, one can choose or decide on the software to use or not to use. Accordingly, the consumer can plan and service provider will charge on usage. Just like Enugu Electricity Distribution Company (EEDC) will sell electricity and charge per unit and mobile companies charge for per call or pulse. This type of service provides transparency as both the user and service provider can check and control the use of resources.

**Multi-Tenancy:** This is all about the need to promulgate a policy on the provision of services to a variety and categories of users by cloud computing service providers. It refers to the need for policy driven enforcement, segmentation, isolation, governance, service levels, and charge back/billing models for different consumer constituencies.

### **Service Models of Cloud Computing**

Cloud computing information technology has wider meaning as it essentially has three different types of service models, viz; SaaS, PaaS and IaaS.

#### **Software as a Service (SaaS)**

Service in which software or applications are provided to users as a service. It is popularly known as software-on-demand. Software is hosted remotely; i.e. it provides remote access to software and its functions. In other words, the programme can be accessed online via any suitable client such as a web browser. In this model, users are provided the access of the applications through licenses or subscriptions. In this case, they are not required to handle the installation, set-up and daily upkeep and maintenance. SaaS is used on rental basis-pay-as-you-go, pay-as-you-need model where the user-has to pay only for the software or applications which he/she is or would be using or even at no charge. SaaS is used to store, back-up, update and transfer data as people also refer to it as backup as a service (BaaS). There is

widespread usage of SaaS because there are usually no starting costs involved-end users including organizations pay only for the amount of storage space utilized. Examples of SaaS are Google, Twitters, Facebook, Flickr, Salesforce, Microsoft, Zoho and others.

### **Platform as a Service (PaaS)**

The computing platform in which web applications are created quickly and easily without the need of purchasing and maintaining the software and infrastructure required for it. Here, a layer of software or development environment is encapsulated and offered as a service (i.e. Environment as a Service, EaaS, PaaS=EaaS upon which other levels of service are built. It is therefore a category of service which provides platform or environment to allow the developers to build the required applications of softwares and the users have the access simply via web browser over the Internet. With PaaS (EaaS), it becomes flexible to change and upgrade the operating system features frequently. That is software are deployed and configuration settings are done by users. PaaS is appreciated because all types of enterprises or users, irrespective of size are adopting this service because it is very hassle free, no worry about the maintenance of hardware or software infrastructure. Organizations (users) have to simply recent the use of platforms of vendors such as Windows Azure, Google AppEngine and Salesforce.com, etc. This service has the disadvantage of all rebuilt software applications in a vendor's custody being locked in one platform. However, service provisioning is like water and electricity facility where users pay only for what they use.

### **Infrastructure as a Service (IaaS) or Hardware as a Service (HaaS)**

IaaS or HaaS is a pay-as-you-go or pay-as-you-use model computing service in which users are offered both storage and computing power services. These include virtual service space or platform (environment), storage, network connections, internet providers (IP) addresses and bandwidth for the handling of organizations workloads. All these are the equipment or hardware provided as assembled or put together by computing service providers called network architects. In this case, as these equipment are owned and provided by the service provider, he is saddled with the

responsibility of housing, running and maintaining them. The client typically pays on the basis of pay-as-per-use. The service is highly appreciated because of its features or capability of providing on-demand self-service, broad network access and measured services. Some common examples of IaaS or HaaS are Amazon's Web Services (AWS) which provides Simple Storage Services (S3) for data storage and elastic computing by organizations for many purposes, viz-a-viz; to run high computing simulations, for content delivery, host backup in organizations websites, media collections and many other services; GoGrid, 3 Tera, etc.

### **Cloud Deployment Storage Models**

Cloud computing is designed to have several deployment models, each of which provides distinct trade-offs for agencies which are migrating applications to cloud environment. Cloud deployment storage models include:

**Private Cloud Storage:** This cloud infrastructure is operated solely for an organization. It is managed by the organization or a third party and may exist on the basis of on-premises or off-premises. Private cloud storage helps in maintaining security and performance concerns while providing the benefits of cloud storage.

**Community Cloud Storage:** This cloud infrastructure is shared by several organizations to support a specific community that has shared concerns, e.g. missions, security requirements, policy and compliance considerations. Community cloud storage service could be managed by organizations or the service provider and like the private cloud could as well exist on the basis of on-premises or off-premises.

**Public Cloud Storage:** In public cloud storage, data are stored in defined or specific data centre from where all organizations involved can source information. This data centre is maintained by a separate service provider out of the organizations. By implication, the cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services. The enterprises backup their data in public cloud storage, and enjoys free from maintaining hardware and software resources (infrastructure) needed for storage of data. Live data

generated by applications (softwares) running on an enterprise's can also be stored in public cloud storage.

**Hybrid Cloud Storage:** This is a mixture of the public, private and community cloud storages. Here the cloud infrastructure is a composition of the aforementioned cloud storage which on their special identities or features remain unique entities but are bound together by standardized or proprietary technology that enables data and application profitability; e.g. cloud bursting for load-balancing between clouds.

**Personal Cloud Storage:** Here data of an individual is stored in the cloud and this can be from anywhere there is internet connectivity without the fear of any physical barrier. It is a subset of public cloud storage. It is also called mobile cloud storage because in this type of cloud storage the stored data is synchronized and shared across multiple devices like tablet computers and mobile phones.

### **Advocates of Cloud Computing in Libraries**

Today, we are living in the age of information. Information and communication technology plays a vital role in handling library resources. This ranges from collection selection and acquisition, organization, storage, retrieval, dissemination and analysis of information dissemination. Due to the enormity of the above activities, libraries do face a whole lot of challenges in trying to assuage the information needs of clients, hence the advocacy of cloud computing in libraries. The advocates include;

#### **Amazon Web Services (AWS)**

Amazon is a major player in cloud computing. It offers a wide range of prominent services. These include simple storage service (S3), elastic computing cloud (EC2), simple database (SDB) and Simple Queuing Service (SQS). AWS provides a scalable and reliable low-cost platform of infrastructure in the cloud that powers hundreds of thousands of businesses in countries around the world. Some of the solutions offered by Amazon through cloud computing include application hosting, web hosting, backup and storage, enterprise IT, content delivery and databases. For the sake of new users Amazon offers a free service for a period of one-year on all its cloud computing services to launch new applications, test existing

applications or make them gain handsome experience with AWS. This is a boost to new library entrants.

### **Google Apps**

Google Apps cloud services a multi-tenant internet scale infrastructure offers faster access to innovations, superior reliability and security and maximum economies of scale as compared to on-premises, hosted and software plus services technologies. Google Apps is available free for individuals and organizations (limited up to 10 user accounts), educational institutions and non-profit making organizations and for a price to businesses and organizations. Google Apps offers Gmail which is now most preferred email service. It also provides Google Docs, Google Sites, Google videos, and other services. Google Apps helps organizations to move their e-mail services, web services and office applications. Google has also Google App Engine Service. With this service, organizations can build and host web apps on the same systems that power Google applications. It offers fast development and deployment, simple administration with no need to worry about hardware purchase or backups, and effortless scalability.

### **Microsoft Windows Azure (MsWA)**

Microsoft Corporation has created its own cloud platform on February 1, 2009 which was known as Windows Azure before March 25, 2014. After this period it was renamed Microsoft Azure. Microsoft provides this service through its data centres. In this platform, organizations can develop and run applications itself with unbounded scalability. Users have to pay only for the services they choose or utilize. Windows Azure allows developers to developers to develop and run their own applications quickly while leveraging current skills to develop applications with NET, PHP, or Java. Some of the scenarios offered by Windows Azure for businesses and organizations include SaaS, storage, computing, data-base management (DBM) and others.

## **Rackspace Cloud**

This offers three distinct types of services for organizations and businesses. These services are cloud servers, cloud files and load balancers. It offers free architecture assistance to its users with every account. Cloud servers are available to organizations in different sizes. It uses Akamai's content delivery network (CDN) to globally deliver the stored media and files. Its third service, cloud or load balancer helps organizations to enhance their server capacities and to balance the load factor and these service is extended only on-demand.

## **Cloud Computing Vendors for Libraries**

Libraries are specialized on non-profit making information agencies that enhance the academic potentials of citizens in society. The resources, data and media required, especially in cloud computing are customized, thus needing specialized vendors to succeed. The prominent vendors for libraries cloud computing services are presented below.

**OCLC's Webscale:** This is a popular cloud computing vendor that is perfectly using cloud computing for libraries, thus setting the pace for others. Years together OCLC has been functioning as a cloud computing vendor because it provides cataloguing tools over the Internet and allows member institutions to draw on their centralized data store, OCLC has implemented the plan of library management system i.e. Worldshare Management Services (WMS). This library management system has services for many areas such as acquisitions, analytics, resource-sharing, cataloguing and license management components. The fundamental purposes of webscale are that libraries can share their resources, data and innovations with ease. This generates cost-benefit advantage for libraries, effectiveness and efficiencies that would not have been possible if they were utilizing separate specialized systems.

**Ex-Libris Cloud:** Ex-Libris is another leading library software vendor from USA. It provides cloud-based solutions to automate library operations. It developed most products for locally implemented solutions and adapted them to a hosted environment later. There are 5300 libraries from 80 countries in the cloud computing

website of Ex-Libris Cloud solutions for the automation of their library resources. It allows libraries to enhance their efficiency and lower the cost of operations as well as extend their value through launching new services. It has changed the way of providing traditional management of library resources through its library based system, Alma. The company promises to adhere to the tenets of data security, updates and standards in implementing cloud services to safeguard the interest of customers.

**Duraspace's Dura Cloud:** Provides open source repository solutions by undertaking turnkey projects for organizations and libraries to enable them to share scholarly literature using DSpace and Fadora Commons. Duraspace is particularly devoted to improve and sustain Fadora and DSpace. These open source repository solutions are very suitable for Institutional Repository (IR) solutions. Its new service DuraCloud provides digital preservation support services in the cloud, which is cost effective and simple for libraries. DuraCloud helps libraries to move content to the cloud and store it with different service providers to eliminate the risk of data loss. The cloud solutions offered include online backup, preservation and archives, media access, online sharing and cloud broker.

**OSS Labs:** Adopting the various capabilities of Amazon such as high durability of data, ISO standards based strong information security and flexibility, OSS Labs provide robust open based solutions to demanding customers. OSS Labs offer hosting and maintenance services for KOHA ILS and DSpace IR. OSS Labs use Amazon's cloud services. With OSS Labs, library operations are very cost effective and library staff need not worry about maintenance of software and other applications.

### **Application of Cloud Computing in Libraries**

Cloud computing is a popular and critical phenomenon in the provision of library and information services in advanced countries. Over there, libraries are adequately funded, staffed, equipped, automated and digitalized to promptly adopt to clients changes in demand and technology. Here comes the imperatives of the application of computer technology (cloud computing), hardwares and softwares as done in advanced countries to critical aspects of library services and guaranteeing the

security and stability of data stored in various remotely connected computers. Critical areas of library services amenable to cloud computing include;

**Computing E-books Lending Services:** Cloud platform is popular and workable in lending in e-books and other electronic book format information resources. It makes information resources to get to users instantly.

**Union/Share Cataloguing/OPAC:** Networking libraries have the privilege of using the same platform in giving access to their collection on one platform. Through cloud computing creation of union catalogue and information resource sharing becomes very easy.

**Digital Preservation/Scanning Service:** Digitization and scanning work with cloud computing is done centrally to avoid duplication and save time. With this cloud service libraries can preserve their collection in digital form in the form of archives.

**Article Delivery Service:** Libraries can use cloud computing for article delivery service to their patrons. Publishers are already using this technology for providing access to libraries for online acquisition transactions.

**Current Awareness Service (CAS):**To provide current awareness service to all patrons has become easy with cloud computing.

**Bulletin Board Service:** The application of cloud computing technology in libraries is amenable in using it to provide new services on bulletin board.

**Information Common:** Like the bulletin board, information common is a kind of display of some aspects of information resources using cloud computing service. Libraries have the opportunity of displaying bibliographical data, content pages, cover pages, question papers, syllabus and other reading materials on one platform. It is cost effective and makes libraries avoid duplication of purchase.

**Collection Development:** Cloud computing is used for collection development. Duplication is easily avoided and alternate resources can be located and made accessible to patrons.

**File Sharing:** To share various files in electronic form is easy with cloud computing.

**Information Delivery:** Cloud provides a platform to store all information that one can access anytime from anywhere. Information searching and delivery becomes easy and timely and it is very useful for researchers.

**E-learning:** In the E-learning environment, cloud computing is a boom. Cloud computing makes learning worthwhile for students. Study materials are kept on the cloud for easy accessibility to students for reference purpose and online examination can also be conducted. Discussions and revisions can be done at a time from different places.

**Information Literacy and Orientation:** Cloud computing has made it feasible and possible for libraries to conduct information literacy and orientation courses for students. This is made realizable because tutorials are kept in the cloud for users to access.

**Socialization:** Cloud computing has made it possible for libraries to interact freely with users on social and academic challenges they are confronted with.

**Generally,** cloud computing application is also feasible in the areas of acquisitions, cataloguing, process system, digital content and provision for inclusion of cutting edge technologies used in libraries and supports various standards such as MARC 21, XML, Z39.50, Unicode and others that are directly related to library and information areas (Suman and Singh, 2016)

### **Benefits of Cloud Computing in Libraries**

Access to data over the Internet has become easier in modern times with the rise in availability of web-enabled devices like smartphones, tablets, laptops and other devices. The benefits of shifting an organization or library to the cloud are enormous, counting from the features of cloud computing. In all, the discourse is obliged to present the benefits as follows:

- **Cost Saving:** In cloud computing libraries, organizations and individuals pay only for those services they choose. In essence, cloud computing helps to reduce the cost of managing and maintaining information and communication systems in libraries and other organizations. Libraries can use cloud resources of service providers instead of spending funds for procuring expensive systems and equipment. Thus the technology enables libraries and other organizations to save on cost.
- **Easy on Installation and Maintenance:** With cloud computing technology, libraries need not worry about server updates and other computing issues. It enables library ICT staff to concentrate on other tasks of information provisioning to clients because the need to procure hardwares to run the servers has been undertaken by the service provider.
- **Increased Storage:** The cloud holds more storage capacity than a personal computer or the servers available in libraries and it is possible to extend as per the need as the cloud is elastic.
- **Automation:** With the help of cloud computing technology, every software update or maintenance is done automatically by the service provider and the ICT staff of libraries need not worry about all these.
- **Flexibility:** Cloud computing in and for libraries is very flexible. It makes libraries to have the liberty to add or remove any of their facilities from the cloud, thus saving cost and time of users. Cloud computing technology enables libraries to expand their services at any time.
- **Better Mobility:** With cloud computing, library users rather than remain glued at their desks with a PC can access library servers from wherever place they are.
- **Shared Resources:** This is the main and important feature of cloud computing that participating libraries can share their resources. By sharing their resources, libraries can save on cost as they can access enormous resources at one place. Multiple types of resources such as photos, videos on indigenous and contemporary knowledge, presentations, documents, etc. can be stored. Back-up facility is also provided by cloud computing, and it is compatible with most computers and operating systems.

## Challenges of Cloud Computing in Libraries

Though with enormous benefits in library systems and operations, cloud computing has got the other (negative) side of it. These include;

- **Privacy and Security of Data:** This is a very big concern that there is a risk about the privacy and security of data. This can be accessed by others in cloud and it is more risky when the data is sensitive. As the proper security model is not yet in place, data stored on the cloud is vulnerable to attacks from viruses and theft. In addition, there is also the risk of data loss if there is system failure or improper backup.
- **Physical Location:** In cloud computing, the physical location of servers is difficult to find as these servers are provided through the Internet. It is hard to undertake the audit of software and security.
- **Network Connectivity and Bandwidth:** This is another great concern of cloud computing application in libraries. This is because this service is directly connected to internet connectivity. If there is connection failure, users would not access data because this service is provided through the Internet. Also, in cloud computing more bandwidth is required as it may not work on low-speed.
- **Internet Connections:** As cloud computing is based on internet connectivity, cloud computing service providers do possess overriding powers over libraries and other organization who these services of cloudpreneurs are provided for. In this case, cloudpreneurs maintain and customize the services of these libraries and organizations. As it is difficult to access, the physical location of servers, libraries and other organizations using this service depend wholly on the cloudpreneurs (service providers) for backups, updates, restore and disaster recovery.
- **Flexibility is Limited:** Cloud computing has limited flexibility for the user as the service is provided by a third party-the cloudpreneur. So there is little scope for customization as per specific requirements.
- **Cost:** At the initial stage of subscribing to cloud computing, cost of mounting, maintaining, backing up and updating hardware and software and services is minimal. However, as time goes by and services increase as a result of demand,

cost of cloud computing invariably increases, thus warranting libraries and other organizations paying higher charges.

- **Knowledge and Integration:** It is imperative, libraries have a pool of well-trained ICT staff. Unfortunately, this seems not to come by in public libraries. Absence of trained ICT staff means that libraries would wholly be dependent on service providers. Also, the integration of equipment used in different data centres are difficult. This seems to be attributed to the fact these equipment are different from the peripheral equipment in libraries, such as printers, USB drives, and other peripherals.

The presentation of the above demerits is not to scare library managers and librarians from cloud computing. Rather, it is to make them be adequately aware that they exist and to propel them to be on their toes and proactive in applying cloud computing technology in library services.

### **Framework for Operational Success**

Cloud computing is a new phenomenon in the ICT, Internet and computing systems technology. It emerged due to developments in this 21<sup>st</sup> century supersonic information age hinged upon the Internet and associated technologies. Though new cloud computing is popular in libraries across advanced countries and fast spreading to libraries in Asian countries. Thus, what is also good for the goose is good for the gander. This is the motivation for this discourse and presentation of the strategic framework to achieve public libraries operational success in applying cloud computing technology in library and information services delivery. These strategies include;

- Government should develop positive attitude to education and information service delivery to the people.
- An adjunct to the above is that government should come up with a favourable national policy on public library development.
- Public library managers leveraging on the above should evolve and implement a robust and comprehensive ICT policy for service to clients.

- Bearing availability of required fund, library managers should expose present staff members to aggressive training and retraining programmes for them to achieve the new knowledge and skills in cloud computing technology in libraries.
- Public libraries, generally should be adequately staffed because of the enormous demand made on them as a result of emerging changes in the ICT, Internet and computer systems technologies.
- A corollary to the above is that library managers should embark on strategic staff recruitment exercise that would focus on content, cloud and systems librarians.
- Cloud computing involves a huge financial outlay, hence libraries in general should be adequately funded.
- Also, libraries should be adequately provided with ICT facilities.
- Generally, information professionals should be amenable and adaptable to change and embrace the dynamics of the 21<sup>st</sup> century supersonic information age.

## **Conclusion**

Cloud computing technology and services has introduced a new vista in the annals of library and information services delivery to clients so far in advanced and some Asian countries, cloud computing has made libraries greener by sharing computing powers thus reducing carbon footprints. Where applied cloud computing has created a powerful unified presence for libraries on the web and gives users a local, group, and global reach.

In view of all that has been presented in this paper, especially the holistic adoption of the letters of the strategic framework, public libraries in Nigeria will achieve robust operational success in applying cloud-based application to library and information services delivery to clients. Library services would be effectively and efficiently handled on real time basis, thus satisfying information needs of users and saving their time.

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