Research Paper

Application of Cloud Computing To Library Processes: The Nigerian Perspective

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ABSTRACT
This research x-rayed the application of cloud computing to library processes, with focus in Nigerian. The research was a systematic literature review. Cloud computing is seen as a new computing technology provided over the Internet, which access is not limited by time or location, and it offers services free of charge, save for cost of the resources and access. Models for these cloud computing services are Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). Cloud computing services allow resources sharing among users, they are easy to maintain, and the chances of system failure are minimal. Application of cloud computing in libraries are in the areas of collaboration, building digital repositories, serving as backup, automation, rendering cheap services. For Nigerian libraries, cloud computing can help to render remote access, multiple access, faster response, at any time. However, achieving these have been faced with some setbacks which include security issues, technical issues, lack of knowledge and skills, inadequate power, finance and poor network. The research recommends that librarians should be proactive and early adopters of new technologies, libraries should safeguard users' sensitive information, as well as regularly training of librarians.
***Key words:** cloud computing, library, SaaS, PaaS, IaaS, Nigeria*

I. INTRODUCTION

In cloud computing, the word '*cloud*' is used to mean the Internet. Lewis (2009) as cited by Swapna and Biradar (2017) opined that 'Cloud' element of cloud computing can be seen as an acronym for:
C: **Computing** resources,
L: that is **Location** independent,
O: can be accessed via **Online** means,
U: used as a **Utility** and
D: is available on **Demand**.

Cloud computing is a new technique of computing service offered over the Internet, which can be accessed irrespective of geographical location. For Yudah and Geoffrey (2019), cloud computing is generally used to describe data centres that are available to many users over the Internet, this is because it provides a shared pool of resources, including data storage space, network, computer processing power, and specialized corporate and user applications. Cloud computing as advancement in technology allows the delivery of software, infrastructure, and services over the Internet (Kutty, 2019).

Cloud computing services work on the principle of sharing resources and infrastructure for effective and efficient service delivery. In libraries, cloud services can be provided to users at any time, regardless of location, with the cost based only on the resources used (Luo, 2013). That is, the access to the cloud services is free; the cost is only on the access to the Internet.

MODELS OF CLOUD COMPUTING
Cloud computing IT model has wider meaning as it essentially has three different types of services viz. SaaS, PaaS and IaaS.

1. Software as a Service (SaaS): This model avails to the customer, the use of the provider's application running on a cloud infrastructure and accessible from various climes and devices through a client's interface. It is a service in which software or applications are provided to the users as a service, that is, the programme can be accessed online via any suitable client such as a web browser.It is also known as software on demand (Dutt, 2015). In this model, users are provided the access of the applications through licenses or subscriptions. The softwareis provided in a 'pay-as-you-go' model, where the user has to pay only for the software or applications which s/he is going to use or at no charge. Example of such services is Google Apps, etc.
It is usually hosted centrally and scope for customization or control of applications or software is little. However, there are benefits like the user has no worry about hosting, installing, upgrading, or maintaining the software or applications. In addition, the user has low initial costs, and access to support services (usually 24/7).

2. Platform as a Service (PaaS): This supports full software life-cycle which allows consumers to develop cloud services applications directly on the PaaS cloud. It is a category of service which provides platform or environment to allow the developers to build the required applications or software and the users have the access simply via a web browser over the internet. Software is deployed and configuration settings are done by users. Wasike andNjoroge (2015) noted that all types of enterprises, irrespective of its size, are adopting this service as it is very hassle free, no worry about the maintenance of hardware or software infrastructure.
In this model, the enterprises are helped in building, testing and deploying web based applications.The enterprises need not to invest for the infrastructure they require for building web and mobile applications. They have to simply rent the use of platforms of vendors such as Windows, Azure, Google AppEngine, and Force.com.
However, there is a disadvantage that the applications or software which are built using these vendors' services, are usually locked into that one platform (Dutt, 2015).

3. Infrastructure as a Service (IaaS): In this model, what is been shared or used by the cloud consumers are the IT infrastructure provided in the IaaS cloud. It is also called Hardware as a Service (HaaS). In this pay-as-you-go service model, the user is offered both storage and computing power services. It includes virtual service space or a platform, storage, network connections, IP addresses and bandwidth. In this model, users do not buy separately software, servers, network equipment or data-centre space; rather they buy all these as a fully outsourced service. The cost of the services is on computing basis, the user pay for bundle of services chosen. An example can be taken from Wasike andNjoroge (2015) who averred that Amazon's web services provide Simple Storage Services (S3) for data storage and elastic compute cloud (EC2) for computing resources. Amazon's web services are being used by organizations for many purposes viz. to run high performance computing simulations, for content delivery etc. It is also being used to host or backup the organizations' websites, to host their media collections and many other services.

CHARACTERISTICS OF CLOUD COMPUTING
Mentioned below are the main characteristics of clouds computing, as propounded by Dutt (2015) and Luo (2013):
1. Resources are shared among users. It works very fast in the distributed computing environment.
2. It ensures "on-demand" provision of resources, without having engineers for peak loads.
3. It reduces the cost of services. By sharing common infrastructure, it ensures to work efficiently with multiple users and multiple applications.
4. Users can access it from any corner of the world simply through the internet connection because the infrastructure is provided by a third-party.
5. They are easy to maintain as compared to individual applications, since they are installed on a common platform and can be accessed from different places.
6. There are minimum chances of infrastructure failure, so servers are more reliable and highly available.
7. As the company need not to set its own infrastructure, so there are cost reductions through pay-as-per usage of resources.
8. User can access services by using Application Programming Interfaces (APIs) on the cloud and pay as per the usage.

APPLICATION OF CLOUD COMPUTING TO LIBRARY PROCESSES

Through cloud computing services, libraries in Nigeria can form a sort of collaboration by sharing their resources together in a centrally located server hosted on the Internet. Wasike andNjoroge (2015) observed that like the OCLC (Online Computer Library Centre) libraries can chose to share their cataloguing tools, and indeed any other library resources via the Internet for other member-libraries to access and use.With cloud computing, libraries in Nigeria can have a kind of union catalogue, hosted over the Internet; this can ease the process of inter-library cooperation, as libraries will know what are contained in each other's.

With cloud computing solutions, libraries can share scholarly literature, thus providing effective services to their users. Dutt, (2015) noted that these open source repository solutions are very famous in information retrieval solutions. For Kaur (2014), libraries can build, maintain and sustain digital repositories on cloud infrastructure. This makes searching of library data/information easier, faster and more convenient, and for Luo (2013) it makes reference work much easy and fun to involve in.

With cloud computing, the library can host her website on a third party server, which is cheaper and cost efficient. Cloud computing services also serve as back up for libraries to save and archive information. Without mincing words, cloud computing services give the library the opportunity to automate the library. This assertion was made by Kutty (2019) when the researcher posits that most vendors of library automation packages are provided on the cloud and third party services.Dutt (2015) opines that cloud computing is used for Collection Development. This will ensure that duplications are easily avoided and alternate resources can be located and made accessible to patrons.

II. METHODOLGY

The study adopted the systematic review of literature to find out the trends in the application of cloud computing in library processes. The literatures that were reviewed are literature from ResearchGate Database, from 2012 to 2022 that are relevant to the discussion. The reason for the adoption of the ResearchGate Database is because it offers open access research articles of scholars and researchers in various specializations. That made it possible to get the articles for review at almost no cost to the reviewer.

SYSTEMATIC LITERATURE REVIEW

Fakir, Bhakar and Waghchoure (2020) investigated the Applications of Cloud Computing for Library Management System. They noted that libraries are changing their services with addition of cloud and networking, removing the barriers of time and location to service rendering. They noted that cloud computing can be applied in library automation system; in the search for scholarly materials; cloud computing serve as frameworks for repositories and digital libraries; cloud computing are used for hosting websites of libraries; also, libraries can use the cloud to store sensitive documents; as well as use cloud computing for building up community strength; and for browsing library data. The research recommended that library professionals in this virtual age should spread cloud-based services as a consistent medium for ease of use and dissemination of library services totheir patrons

Azam (2019) studied the Application of Cloud Computing in Library Management: Innovation, Opportunities and Challenges. He asserted that cloud computing offers a major shift from the traditional ways of library management services to more technical and user-oriented. For him, cloud computing application will eliminate huge cost of operating the library, especially since it allows for scalability. Cloud computing application in libraries also offers the advantage of security as it is hosted on the worldwide network that uses the latest security standards. However, he noted that the challenges to successfully implementing cloud computing in libraries are because of huge cost of initial setup (especially bandwidth cost); lack of trustworthy service providers with good reputations; cloud computing needs continuous monitoring and supervision, which is resource-consuming (time and human); general security and password concerns. The research concluded by recommending that libraries can collaborate in order to over the challenge of cost, leading to sharing of e-resources together.

Swapna and Biradar (2017) researched on Application of Cloud Computing Technology in Libraries. They asserted that cloud computing came as a boon for libraries and offer various opportunities to libraries to connect their services to the cloud. They pointed out some cloud computing initiatives for libraries to include OCLC Webscale, used for providing cataloguing tools over the internet; Ex-Libris Cloud, used for library automation;Duraspace Cloud, used for providing open source repository solutions; OSS (Open Source Software)
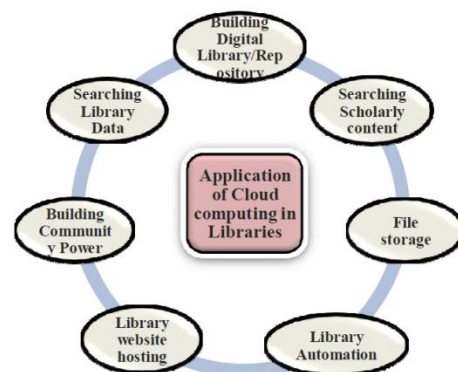
Labs, used for institutionalrepository hosting and software maintenance subscription services for libraries. The researchers noted that cloud computing technologies can be applied in the library in the following areas: building digital library/repository; searching scholarly contents; file storage; library automation; library website hosting; building community power; searching library data. They observed some of the benefits of cloud computing in libraries as cost-saving, easy installation and maintenance, increased storage space; highly automated, flexibility, better mobility, shared resources. They however noted that some disadvantages are issues on security and privacy, requirement of high bandwidth and connectivity, dependence on outside agencies. The research concluded by recommending that libraries should embrace cloud computing because cloud computing technology provides libraries an opportunityto improve their services and relevance in today's information society. It can bring several benefits for libraries and give them a different future.

Yudah and Geoffrey (2018) studied Cloud Computing in Libraries: Prospects and Challenges from Kenyan Perspective. They outlined the advantages of cloud computing thus: cost reduction, scalability, reduced risks, greater security and accessibility. They however noted that the challenges in adopting cloud computing are: less control over software preferences, unauthorized data mining, legislative restrictions in data storage locations, functionality problem of incompatibility, inadequate bandwidth, security and privacy issues. On the application of cloud computing in libraries, the researchers noted that PaaS allows libraries to use Integrated Library System; SaaS allows libraries to use Lib-Guide, Library Catalogues. They however noted that there are no clear cut demarcations between Paas and SaaS in cloud computing applications in libraries. They concluded by recommending that libraries should collaborate in the area of cloud computing in order to reduce cost.

Dutt (2015) worked on Cloud Computing and its Application in Libraries. He noted that cloud computing has completely changed the way of the use of the power of computer, removing the barrier of location. He averred that cloud computing applications in libraries are in the areas of OCLC's Webscale, which is used for online library cataloguing; Ex-Libris Cloud, which offers solutions to automate library operations; Duraspace'sDuraCloud, which offers open source repository solutions; OSS Lab, which will provide robust open based solutions to demanding customers. He further noted areas of enhancement in library services brought about by cloud computing applications. These include: e-book lending services, Union/Shared Catalogue/OPAC. Document download service, digital preservation/scanning service, article delivery service, current awareness services (CAS), document sharing, bulletin board service, file sharing, e-learning, among others. He recommended that librarians should up-skill, become ICT competent.

Abidi and Abidi (2012) investigated Cloud Libraries: A Novel Application of Cloud Computing. They noted that with increased publications regularly, libraries are finding it difficult to keep pace with the ever growing need of enhanced and better forms of information. They are of the view that cloud computing can help libraries collaborate with each other in a facile manner; cloud computing provide flexible scale to adjust up or down depending on your on your data capacity; again, cloud computing can offer libraries reduced cost in the long run, paying only for what they use. The researchers however noted that cloud computing come with challenges of security and privacy. They recommended that libraries should collaborate so that they can reduce duplicating data, with the aim of using library budget more profitably.

Nayana and Aswath (2016) researched on Cloud Computing and Library Automation: An Overview. They noted that major advantages of cloud computing to library automation are adaptability and collaboration. For them, the applications of cloud computing in libraries are in the areas of sharing library data, searching scholarly content, building digital repositories, hosting website, library networking and collaboration, library automation. They averred that cloud computing in library automation leads to time saving, effective utilization of resources, data storage, web OPAC, and a host of others. According to the researchers, while the advantages of cloud computing include scalability, highly automated, greater accessibility, and convenience; the limitations include security and privacy issues, dependency (loss of control) and high cost. They highlighted some cloud base automation soft wares to include Cybrarian, Polaris, Mandarin, Ex-Libris. They concluded by recommending that libraries should understand more about the issues of security, privacy, trustworthiness and legality before moving to the cloud based services.

Radha (2013) worked on Application of Cloud Computing at Library and Information Centres. She noted that cloud computing help pass the hurdles of hardware failure, software installs, upgrade and compatibility issues. She posited that cloud computing in libraries include library automation with multi users (clients), Web OPAC, ILS – MLS (Integrated Library System – Management Library System), Web hosting, Universal OPAC, Online resource sharing, Digital library and Inter-library loan. She also noted that with cloud computing, libraries can be automated, grant 24/7 access to patrons. For her, the advantages of cloud computing to libraries include cost saving, easy installation and maintenance, increased storage, highly automated, flexibility; while the disadvantages include data security and privacy issues, startup cost, technical skills. She then recommended that librarians should skill up in the area of ICT and they should collaborate with IT professionals.

Gandgoankar, Mente and Shinde (2015) investigated the Impact of Cloud Computing on Libraries: Need for Switchover from Classical Libraries to Cloud Libraries. They noted that the merits of cloud computing in libraries are: cost effectiveness, higher security, less maintenance, easy backup and recovery, higher performance, 24/7 availability, huge storage capacity and device portability. The researchers posited that the areas where cloud computing can be applied in libraries include development of digital libraries, searching the library for data, website hosting, searching scholarly content, file storage and library automation. The researchers went further to describe some cloud libraries to include OCLC, Library of Congress, Scribd and Google Scholar. They concluded by recommending that librarians should be part of the emerging trend of shifting to cloud libraries so that they can offer faster and trustworthy services to users.

More (2014) researched on Vista of Cloud Computing in Libraries. She noted that a need for cloud computing in libraries arises from the desire to meet users' requirement by providing appropriate, comprehensive and multi-level services. She averred that some of the benefits of cloud computing to the library are that it is economical; it allows for resource sharing; it allows for customization of library services; flexible choices to manage the library; easy and remote access to library resources. The research recommended that careful attention should be given before deployment to the cloud, because of the technicalities involved, so as to have a successful transition.

PROSPECTS OF CLOUD COMPUTING IN NIGERIAN LIBRARIES

From the above reviews of literature, it can be stated that:

Cloud computing, if harnessed, can bring a lot of benefits to the libraries in Nigeria and change for the better how they render services to their patrons in this IT age.

Cloud computing solutions give librarians the opportunity to render services to library clienteles, anytime, anywhere (Kaushik and Kumar, 2013). Because cloud computing services allow access from remote locations, Avram (2014) opined that the librarians can login to the server from anywhere, using his/her browser of app and attend to users' queries even from the comfort of his/her bedroom.

With cloud computing solutions, librarians can attend to multiple users at the same time. This is obviously not easy, if at all possible, with the traditional library operations. Cloud computing offers the librarian the ability to attend to many queries simultaneously, since some of such queries may be similar, and as such same answer will be sufficient for them (Wasike andNjoroge, 2015; Kimutai and Muli, 2015). From another perspective, the answers to the queries from a user may be seen while looking out for the answers to another user's queries. This is possible because when all queries come in, the librarian is able to see all at once. For the traditional setting, the librarian will not be able to know the queries of another user until it is time to start attending to him/her.

Kimutai and Muli, (2015) observed that cloud computing solutions can offer to libraries' patrons, the opportunity of getting their information needs met, without having to leave their comfort zones. Also, as averred by Kaur (2014), these services allows them have their information needs met anytime such needs arises, as they can lodge in their queries, any day, anytime, from anywhere.

CHALLENGES OF CLOUD COMPUTING IN NIGERIAN LIBRARIES

Despite the numerous benefits cloud computing can bring to libraries in Nigeria, there are a lot of challenges militating against its implementation and use in libraries. Some of these are:

Security and Privacy Issues: Most cloud solution providers who provide cloud solutions for free or minimal cost, own the data 'clients' put into their cloud and are free to mine the date (Yudah and Geoffrey, 2018). This becomes a serious challenge as sensitive information pertaining to library users may be mined by these cloud solution providers.

Technical Issues: Yudah and Geoffrey (2018) have observed that in spite of cloud solutions being generally well maintained, often to a higher standard than in-house systems, there will be times the system may not work as required. Compounding this challenge will be the lack of skilled technical staff who will address the issues whenever they arise.

Apathy by the traditionally trained librarians to acquiring new knowledge and skills in modern technologies that will help them remain relevant (Kimutai and Muli, 2015). Closely linked to this challenge is the inadequate training of young librarians in library schools on digital library operations (Avram, 2014).

For Wasike andNjoroge (2015), inadequate power supply is a major challenge in Africa, to the application of ICTs in libraries. Alternative sources of power are very expensive and the cost of maintenance is very high.

Finance: In Nigeria, a major challenge that faces libraries, irrespective of the type of library is reduced budgetary allocations. Without finance, subscription to the cloud services will not be possible.

Poor network and high cost of subscription are other challenges that grossly affect the deployment and usage of cloud computing services in Nigerian libraries. These facilities run on the internet, and most of the internet service providers have very weak network signals at a very high price.

III. SUMMARY OF THE FINDINGS

From the systematic literature review, below are the areas where cloud computing are applied in libraries. Library automation system; search for scholarly materials; cloud computing serve as frameworks for repositories and digital libraries; cloud computing are used for hosting websites of libraries; storage of sensitive documents; building up community strength; searching or browsing library data.

Cloud computing initiatives in libraries include cataloguing tools over the internet; library automation; open source repository solutions; institutionalrepository hosting and software maintenance subscription services for libraries.

Advantages of cloud computing in libraries are: adaptability and collaboration; removal of the barriers or time and location to service rendering; elimination of huge cost of operation of the library; easy installation and maintenance; increased storage space; scalability; reduced risk; flexibility; readily available.

Challenges of cloud computing in libraries include unauthorized data mining; less control over software preferences; legislative restrictions in data storage location; inadequate bandwidth; lack of trust and good reputation; general security and password concerns; dependence on outside agencies

IMPART OF THE STUDY

Heads of libraries and library managers: Library managers and heads of library will from this research understand the areas they can apply cloud computing in libraries, as well as know the advantages and disadvantages of applying cloud computing in libraries; therefore giving them the right amount of information to make right decisions.

Libraries:This study will help libraries to explorethe possibilities of cloud computing to libraries. Knowing about all the security and privacy issues will place libraries in a better position to negotiate their deals with the service providers when they are venturing into cloud computing.

Library policy makers:This research will help library policy makers to understand the rudiments of cloud computing in library processes, making them to develop policies that place libraries in a better stead this information era.

Researchers: This study will help researchers to update their knowledge on the subject of cloud computing to library process, especially in the Nigerian perspective.

IV. RECOMMENDATIONS

Librarians in Nigeria should be proactive as well as fast adopters of new technologies in delivering information services in this information age. A way to achieve this is to constantly be on top of their game, through updating of their knowledge as well as advocating for libraries.

Libraries should ensure they own or at least control their cloud services, so that the challenge of theft of sensitive information of library clients may not occur.

Librarians should regularly go for training and retraining to keep abreast with modern trends in librarianship. In like vein, library schools should teach more of ICT related courses in practical ways that are applicable to libraries in Nigeria.

The issue of power in Nigeria should be addressed once for all. While this may be seen as a long term project, alternative power supplies like generators and inverters should be provided for libraries before the issues in the power sector are fully addressed.

Since the importance of information cannot be over emphasized, government agencies and all parent bodies to libraries should increase the budgetary allocations to libraries.

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