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CLOUD HOSTING OF KOHA AND DSPACE FOR EFFECTIVE AND EFFICIENT LIBRARY SERVICES IN NIGERIAN ACADEMIC LIBRARIES

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ABSTRACT

Cloud computing provides a library with cost-effective and dependable technological facilities and computing machines to support the library in carrying out its function of information dissemination and preservation. This transformation has had a favourable impact on many aspects of library operations and services. The automation of library operations and services, as well as the digitalization of information resources, are key parts of library operations and services. Nigerian libraries are investing heavily in order to meet the information demands of the twenty-first century in line with what obtains in Western climes. A functional Online Public Access Catalogue (OPAC) and interactive institutional repository should be the final product of every automation and digitization project in libraries. This does not appear to be the case in Nigerian libraries. Unreliable software, erratic power supply, low Internet bandwidth, lack of experienced personnel, systems failure, poor administrative support, inadequate staff training, and poor technical infrastructure are just some of the challenges that Nigerian libraries face in achieving a full and successful automation and digitization process that will aid in the effective and efficient service delivery. As a result, this paper looks at two open source software that are widely used in Nigerian libraries for automating library operations and services, as well as developing institutional repositories and propose a practical and cost-effective strategy using cloud computing which is the distribution of computing services via the Internet (the cloud), including servers, storage, databases, networking, software, analytics, and intelligence, in order to provide faster innovation, more flexible resources, and economies of scale.. Recommendations are then made for how Nigerian libraries can take advantage of cloud computing's benefits to overcome certain persisting hurdles and accomplish a successful automation and digitalization process for better delivery of library services.

Keywords: Cloud hosting, OPAC, Institutional repository, Library services, KOHA, DSpace

Introduction

Since the awareness of the necessity for a web-based and searchable Online Public Access Catalogue (OPAC) due to the many benefits it provides (Akanbi, Adekanbi & Bankole, 2021; Vijayakumar & Manasa, 2020). Acknowledging that though it may be slow, strenuous and characterized with many challenges, Oladokun, Oyadeyi and Iyoro (2019) noted that Nigerian libraries have been automating library operations

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and services through the process of retrospective conversion in other to provide their users with speedy and efficient access to information resources. The changing nature of library patrons' information requirements and patterns has also influenced the large investments libraries are making in institutional repositories in order to deliver efficient and effective 21st century library and information services to their patrons. A functional OPAC, according to Oladokun, Oyadeyi and Iyoro (2019) increases library collection visibility, library collection utilization, and cataloguing routine management, among other things.

Institutional repositories (IRs) are an integral part of many academic institutions. Higher education institutions can use institutional repositories to increase the visibility and use of national research (Mooketsi, 2020). These repositories are sets of services that create an open access digital archive filled with the institution's scholarly work and communication created by the faculty, administration, and students (Hwang, Elkins, Hanson, Shotwell & Thompson, 2020). An IR is an archive for collecting, preserving, and disseminating digital copies of the intellectual output of an institution (Chukwueke, Nnadozie & Okafor, 2020). Rafiq (2022) posited that an IR houses electronic content for the purpose of gathering, managing, disseminating, and storing an institution's intellectual output. Creating worldwide visibility for an institution's academic research; single storage point for information material; open access to institutional research output; management, archiving, and maintenance of an institution's digital assets and intellectual output are just a few of the benefits outlined by Omeluzor (2014), Bhardwaj (2014), as well as Utulu and Akadri (2014).

Nigerian libraries have implemented automation and institutional repository projects using open source software accessible on the market. The widespread use of KOHA and DSpace for project implementation among academic and research libraries in Nigeria attests to their popularity (Oladokun & Kolawole, 2018; Oladokun, Oyadeyi & Iyoro, 2019; Otunla, Akintola, & Omotayo, 2022; Adam & Kiran, 2021; Oguche, 2018). This could be due to their user-friendliness, stability, collaborative and resource-sharing nature, as well as their cost-effectiveness, which has given libraries more flexibility in their operations and reduced their financial burdens associated with purchasing proprietary software. As a result, it is envisaged that the popularity of these products, as well as the high rate of adoption and the human, material, and financial resources invested in the implementation of their respective projects, will result in seamless access and usage by library users. However, observations have revealed that most libraries' OPACs and IRs are not accessible remotely, as they are hosted locally on a library's dedicated local network or Campus Wide Area Network.

Adam and Kaur (2019) discovered that 23 Nigerian institutions registered their repositories on OpenDOAR (Directory of Open Access Repositories), and most of the repositories are either not functioning or working 24 hours. The lack of essential infrastructure, such as electricity and Internet connections, or insufficient Internet speed, has been a continuous and primary cause of this uncomfortable condition, as it has the potential to derail the projects' goals and efforts. What can libraries do in the face of these issues, which are unlikely to be resolved anytime soon? Since, the main focus of the holdings on IRs is to access them anywhere in the world (Lynch, 2005). The ultimate goal of any library is to deliver adequate services to its user. This paper therefore proposes a cloud computing strategy to overcome some of the issues of library automation and digital repository in the short and long term, with a focus on cloud hosting of KOHA and DSpace application software, in order for libraries to be able to provide round the clock library services to their clientele.

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Cloud Computing

As Information Technology (IT) has advanced through time, there has been a significant reliance on cloud computing. The use of the cloud has significantly increased recently. Many businesses rely on this technology to run their operations and use it as the foundation of their IT infrastructure, (Golightly, Chang, Xu, Gao & Liu, 2022). Cloud Computing is a rapidly growing IT that, after the personal computer and the Internet, is commonly regarded as the third revolution in information technology. The progress of Distributed Computing, Parallel Computing, Grid Computing, and Distributed Databases is termed as cloud computing. Cloud computing is based on the idea of distributing tasks across a large number of distributed computers rather than using local or remote servers (Sanchati & Kulkani, 2011).

In other words, cloud computing is capable of integrating and storing massive amounts of data and resources on personal computers, mobile phones, and other devices in the public cloud to serve users. Cloud computing is a concept for offering on-demand network access to a shared pool of configurable computing resources such as networks, servers, storage applications, and services that can be quickly supplied and released with minimal administrative effort or contact with service providers, (Ali, Mazen & Hassanein, 2018). It refers to the applications and services that run on a distributed network and make use of virtualized resources that can be accessed using regular Internet protocols and networking (Tella *et al* 2020; Sanchati & Kulkani, 2011). The two types of clouds are service and usage environments. The service cloud environment is made up of infrastructure, platforms, and services. The infrastructure is made up of third-party resource clouds that are made available to consumers as a service so that they can use them as they see appropriate. A platform, such as Google App Engine or the Windows Azure platform, is a set of cloud-based computer applications for accessing and managing data.

The services, on the other hand, are a set of apps developed by the service provider to take advantage of cloud infrastructure and platforms such as *Google Docs*. (Pandya, 2012; Shaw, 2013; Ali, Shrestha, Osmanaj & Muhammed, 2020). The use of cloud environments includes public, private, hybrid, and community cloud environments. The public cloud is accessible to anyone and is largely employed by major businesses. Private clouds, which are administered within an institution, are only accessible to members of that institution. A hybrid cloud system is made up of internal and external providers who use both private and public clouds. Google Apps is an example of a hybrid cloud infrastructure. Clouds that are deliberately arranged and limited to a single group are referred to as community clouds. A community cloud is an example of Google Apps Institutional Gmail (Malik, Wani, & Rashid, 2018; Red Hat, 2022; Lutkevich, 2022).

Benefits of Cloud Computing

The benefits of cloud computing as highlighted by Pandya (2012), Ghosh (2012), Dhaka (2012), Shaw (2013) and Sahu, (2015) include the following:

Elasticity and Scalability: One of the most important and fundamental characteristics of cloud systems is elasticity. This is a crucial characteristic of this service: any changes and enhancements to the services are simple and quick, making it incredibly scalable and resilient.

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Multi-tenancy: In cloud systems, where the location of code and/or data is mostly unknown and the same resource may be given to several users, multi tenancy is a critical issue (potentially at the same time). This concerns infrastructure resources as well as data, programs, and services that are shared but must be made available in numerous isolated instances.

Energy Consumption: Energy consumption is important in order to reduce energy consumption's added costs. In a traditional system, all servers must be turned on since the data must be accessible 24 hours a day, seven days a week. Because the cloud is built on a network environment, it allows for significant energy savings.

Reliability: It is a fantastic feature of cloud computing. When redundant websites are viewed, one of the most important characteristics of cloud computing is reliability. Having multiple sites for the same service improves reliability because if one goes down, the other may take over the load.

Security: All systems dealing with potentially sensitive data and code must, of course, be secure. A team of IT experts manages and administers the cloud. As a result, the data will be safe from data loss and system failure.

Consumption-based Billing: A key aspect of cloud systems is their ability to calculate costs based on actual resource utilization. Pay per use is strongly linked to the quality of service support, since it allows certain needs to be stated for the system to meet and so be paid for. One of the best aspects about cloud computing is that you don't have to pay anything if you don't use the resource.

Data Management: Data management is a key characteristic of the cloud environment and an important aspect of storage, where data is dispersed over many resources in a flexible manner. Data consistency must be maintained implicitly over a large number of duplicated data sources. At the same time, when duplicating data across data centers, the system must constantly be aware of the data location.

Managing Cloud Activities: The management and monitoring of cloud applications is one of the most important elements of the cloud. Because the cloud manager is part of a distributed wide-area network infrastructure, it can be monitored from anywhere on the planet. One of the most significant departures from the traditional data center is the storage, management, and administration of all data in the cloud.

Self Service Model: The self-service approach is one of the reasons behind the popularity of cloud-based environments. Users can upload files, build programs, deploy, schedule, manage, and produce reports in some circumstances. This service is made available to consumers on a demand basis.

Disadvantages of Cloud Computing

There is no perfect system. Despite its numerous benefits, there are some areas of concern that needs to be addressed for implementation of cloud computing in libraries such as data security, privacy and reliability among others as highlighted by Abdallaand Varol (2019) as well as Attaran, Attaran and Celik (2017). First, data security and privacy are the biggest concerns about cloud computing. Organisations dealing with sensitive clients' data should put proper security model in place to avoid vulnerability of data stored on the cloud to attacks or theft. Alternatively, libraries adopting cloud computing may exclude patrons' sensitive data from the cloud. Also computing depends on Internet connectivity for access. Since the cloud computing is offered over the Internet, it may mean that the problem of Internet connectivity still exists. Libraries

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can opt for economical alternative like Wi-Fi within the library, where campus wide Internet connectivity is not available, since users can get access to the service at their different locations using their private Internet connection.

Besides, knowledge of cloud computing is essential as working of the service is totally dependent on the service provider. Systems librarians can get further training on cloud computing essentials. Other drawbacks include the problems with unauthorized data access between virtual devices using the same server; mistakes made by a cloud provider regarding the proper administration and storage of sensitive data. Occasionally, faults and system crashes may cause the cloud service to be unavailable for protracted periods of time; Hackers may breach and access a client's cloud-based apps, accessing and disseminating sensitive data.

Opportunities Provided by Cloud Computing for Libraries

The drawbacks of cloud computing notwithstanding, libraries can benefit from cloud computing in a variety of ways, including cost savings, flexibility and creativity, user centeredness, openness, portability, transparency, security, accessibility, interoperability, and representation as stated by Abdalla and Varol (2019), Al Etawi (2018), Dutt (2015) and Pandya (2012).

Cost Effectiveness: In Nigeria, education is underfunded. As a result, library funding has been drastically reduced. A range of resources in various formats extended the problem (printed and digital). Regularly purchasing infrastructure assets, as well as maintaining and upgrading software and hardware, has become a time-consuming task. Cloud computing can save money on purchasing physical IT infrastructure because of economies of scale and the fact that libraries only pay for the services they use.

Flexibility and Innovation: Because the new application will run on the provider's infrastructure, risks can be made for fresh and original concepts. Libraries do not have to make decisions regarding bandwidth, traffic, or other issues.

Support Services: Libraries can take advantage of the most advanced security, availability, and performance methods, eliminating their concerns about obtaining IT expert services from institutions' IT departments, which may not available at the of need.

Greater Security and Accessibility: Access to resources from any geographical point and the ability to test and evaluate resources at no cost.

Adjustable Storage: Unlike the physical server which can be replaced when the storage capacity can no longer meet the needs of the library, the cloud storage capacity is expandable and can be modified to meet the growing needs of the library

Cloud OPAC and Repositories: Majority of libraries across the world have a web-based catalog. Libraries in Nigeria should not be an exception. If library management apps are housed on the cloud, the catalogue will be available and accessible via the cloud at any time and from any location, making it easier for users to find out what materials are available. In addition, network libraries can utilize the same platform to provide access to their collections, encouraging the development of a national union catalogue. Institutional repositories hosted on the cloud will help improve the visibility and accessibility of an institution's research in real time.

E-book lending, document download service, digital preservation, article delivery service, CAS, document sharing, and information commons are some of the other service areas that can be improved by cloud computing.

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Library Automation and Institutional Repository Development in Nigeria

Since the mid-1970s, library automation in Nigeria has been a topic of discussion due to growing awareness of new technologies, librarians' curiosity, and readiness to employ new technology. In Nigeria, automation of library operations and services began in the late 1980s, with institutions such as Bayero University Library in Kano, Ibadan University Library in Ibadan, University of Jos, and Ahmadu Bello University in Zaria at the frontline (Adegbore, 2010). A significant number of libraries in Nigeria have automated their operations and services in recent years. 20 of 36 Nigerian academic libraries survey by Oladokun and Kolawole (2018) have automated their libraries. Library automation has transformed library and information services in Nigerian libraries, allowing them to meet the demands of the information age. Automation makes library holdings more accessible, allowing staff to better serve users and streamline duties like acquisitions, cataloguing, circulation, and reference. Automation also improves the creation of innovative services, as well as Internet and online database searches, and reduces the problem of manual material processing, filling, typing, and retrieval errors, as well as the time spent processing and retrieving information (Martin, 2020; Alotaibi, 2022).

Institutional repositories can function as a scholarly enterprise for a higher education institution, evolving and expanding through time to serve not only the stakeholders in the immediate institution community but also those in the broader community (Adam & Kiran, 2021). An institutional repository is a set of services that a university or organization provides to the people in its community for the administration and sharing of digital content produced by the institution and people in the community (Henok & Yule, 2019). Digital outputs are collected and curated in institutional repositories. Institutional repositories increase the exposure and influence of a university's or institution's research outputs by making them available to the public.

As a result, publicly available institutional repositories promote the university to interested parties such as potential employees, students, and other stakeholders. Manages and evaluates academic and research activities. Institutional repositories also serve as a workflow mechanism for collaborative or large-scale projects, assist the development and sharing of digital instructional materials and aids, and support student endeavours by offering access to theses and dissertations (Malekani & Kavishe, 2018; Omeluzor, 2014). Ogbomo and Muokebe (2015), Ridwan (2015), Mohammed (2013) as well asAdam and Kaur (2019) reported that Nigerian institutions have adopted IRs. The adoption, according to Abbas (2016) and Gbaje and Mohammed (2017), was due to the awareness of the benefits it provides, which include but not limited to increased institutional visibility, facilitate access, preserving and showcasing the intellectual output of an institution to the world,

Challenges of Library Automation and Institutional Repository in Nigeria

IR undoubtedly remains the most popular vehicle for effective scholarly communication and yet its potentials are not adequately harnessed because of lack of ICT infrastructure for the implementation. Significantly, the availability of a university-wide area network and a LAN within the library determines the success of library automation and institutional repository. The poor or unreliable nature and in most cases the unavailability of this important ICT infrastructure as noted by Emezieand Nwaohiri (2014) pose a serious challenge to many universities in Nigeria.

Other factors that inhibit the full and successful implementation of library

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automation and institutional repository among Nigerian libraries include but are not limited to: lack of access to information about the new technologies, inadequate professional librarians to execute the project, lack of maintenance and support staff, lack of supervision, inadequate managerial support, erratic power supply, high cost of procuring hardware, maintenance cost, apathy on the part of library staff, poor funding, lack of training and re-training of staff (Solomon, & Bakare, 2022; Oladokun, Oyadeyi & Iyoro, 2019; Umar, Izah, & Mohammed, 2018; Oladokun & Kolawole, 2018; Adetunji & Oladokun, 2020).

Benefits of Hosting KOHA and DSpace in the Cloud for Effective Library Services

While some of these issues have been there for a long time and may still exist, others can be overcome. Any library's primary responsibility is to ensure that its information resources are accessible and usable at all times. This study proposes cloud hosting of KOHA and DSpace as a cloud computing solution for library automation and institutional repository implementation, respectively, to accomplish this in terms of library automation and institutional repository implementation.

Cloud hosting provides significant operational and financial benefits to libraries by lowering up-front cost, operational and staff costs. Libraries can also benefit technically through professionalised backup and recovery system, scalability, collaboration and copyright convenience. More so, hosting KOHA and DSpace in the cloud brings about enhanced service accessibility such as access to services that are otherwise unavailable; services from multiple access devices and services from multiple device-types. In addition, long-term data retention becomes a more simplified process, eliminating the costly management of disks and tape systems. Libraries using or intending to use a cloud hosting service gets data protection benefits such as round the clock availability, disaster recovery, higher performance, huge storage capacity and device portability (Nayana & Aswath, 2016; Gandgoankar, Mente & Shinde, 2015; Radha, 2013).

Cloud hosting makes websites and apps available with the aid cloud resources. Alternative hosting like the traditional dedicated server does not deploy applications on a single server. The program or website is instead hosted by a network of linked physical and virtual cloud servers, providing greater flexibility and scalability. The traditional dedicated server paradigm requires libraries to build and manage their own data centers, whereas the cloud hosting approach is less expensive. Cloud hosting is easily accessible, scalable, adaptable, cooperative, cost-effective, and offers a reliable data backup solution(Perepa, 2022; Lelii, 2018).

Implementing cloud computing can help libraries save money on system upkeep, conserve energy, gain a global perspective online, connect users to a variety of information sources, and improve services, Wada, (2016). Abidi, Abidi and Armani (2012) noted that libraries will be able to share their electronic data resources, reduce dependence on external agencies on IT issues, reduce capital expenditure on hardware resources and increase efficiency. To prevent libraries from having to invest in hardware, numerous software providers and third-party services are now hosting this service on the cloud. In addition to the cost-benefit analysis, libraries won't have to worry about performing maintenance such software upgrades, backups (Bansode & Pujar, 2012). In view of this, it may be safe to note that hosting KOHA and DSpace in the cloud will provide considerable operational and financial benefits to libraries and

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make the applications to run 24 hours.

Virtual spaces are allotted via cloud hosting. It takes the place of the local hosting setup due high setup costs, access restrictions, and unreliability. KOHA hosting in the cloud is more dependable, safe, and scalable. Different data centers in various locations can be used to access the network data. Using a single physical server for managing virtual resources and providing services may not be as effective as hosting KOHA in the cloud. When a resource is available in the cloud in real time and without any restrictions, access is effortless. The benefits of using a hosting KOHA in the cloud include: easy expansion, access from any web browser over the Internet, regular updates, remote access by both library users and library personnel, and a simple option for backup of bibliographic data (Mazumder, Sarkar, & Roy, 2019).

Some Cloud Service Providers

Bansode and Pujar (2012) and Pandya (2012) highlighted below some cloud service providers that libraries can consider using their services:

Ex Libris: This is a well-known cloud service business with headquarters in the United States. They offer a cloud library solution that includes all of the software and hardware required to give services to consumers. It is a library management system that may be used by any form of library, as well as consortia and is based on a variety of standards and has a number of features such as Unicode font compatibility, flexibility, and more.

Polaris Library Systems: This is a cloud-based library automation system that is now available on the market. In addition, the organization offers a standard acquisition and processing system. The library can also integrate various PC and print management systems at no additional cost with a Polaris ILS Client License. The system employs a number of well-known standards, including MARC 21 for bibliographic data, XML, and Z39.50 for retrieval of content.

Dura Cloud2: This is a cloud-based digital library service provider. Dura Cloud is a subsidiary of Dura space, a partnership between the Dspace digital library software and Fedora Commons. Fedora Commons is a digital repository framework. It provides a complete digital library solution with industry-standard software and hardware.

Google Cloud: Is a collection of Google's public cloud computing services. The platform comprises a variety of Google-hosted services for computation, storage, and application development. The *Google Cloud Platform* services are based on a pay-as-you-go approach, which means that users only pay for the cloud resources they utilize. Specific terms and fees, on the other hand, differ from one service to the next.

Microsoft Windows Azure: Microsoft Azure is a cloud computing service developed by Microsoft for developing, testing, deploying, and managing applications and services through Microsoft-managed data centers. Users can launch general-purpose Microsoft Windows and Linux virtual machines, as well as preset machine images for popular software packages, using virtual machines.

Other cloud service providers include but are not limited to *DigitalOcean*; Whogohost and Amazon's Virtual Cloud Server. Most of these providers offers a trial service period ranging from three to six months and some up to one year. Libraries can take advantage of this trial period to test their services so as to make informed decisions. They also have a flexible pricing model (pay-as-you-use). Libraries can choose the pricing model according to their needs, size and capacities.

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Conclusion

Cloud computing is the optimal management and technology technique to support libraries in light of the current difficult economic condition and low financial budget, as well as inconsistent electricity, low internet speed among others occasioned by inadequate funding of the academic institutions. To better serve their patrons, libraries and other information centers should adopt and use cloud services. Nigerian libraries are not new to cloud-based services, having adopted services such as electronic journal access management, digital library hosting, and a few exploring hosted library management systems and institutional repositories. Because libraries are service-oriented, they are in a good position to adopt cloud computing. As a result, librarians are constantly on the lookout for appropriate solutions within limited resources in order to provide seamless services to users, yet they are frequently challenged with numerous obstacles. This paper proposes that Nigerian academic libraries should host their library automation and institutional repository application software-KOHA and DSpace on the cloud for effective and efficient service delivery

Library automation and institutional repositories are critical components of library operations and services, attracting significant funding from the library budget but yielding a low return on investment due to low accessibility, which is exacerbated by factors such as lack of information about new technologies, insufficient professional librarians to carry out the project, a lack of maintenance and support staff, and insufficient electricity supply among others. Libraries should consider hosting their library management solutions on the cloud to address some of these issues. This will improve and provide 24-hour access to library resources, resulting in more effective library services and efficient library operations. Library staff would also be able to work remotely, and at any time. In addition, the cost of procuring hardware and running a data center will be reduced. A good backup and recovery solution will also eliminate the fear of data loss.

Recommendations

1. Libraries and librarians should break out of their shells and continuously improving themselves by accepting and implementing new information technology.
2. Libraries should embrace cloud computing, which is a rapidly expanding technology.
3. To improve and delocalize their operations and services as well as provide more user-friendly, effective, and professional library and information services., Nigerian academic libraries should host their library management applications on the cloud

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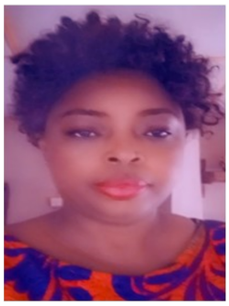

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