International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 11 Issue: 9
***Article Received:** 25 July 2023 **Revised:** 12 September 2023 **Accepted:** 30 September 2023*

Utilizing Cloud Computing Technology for Library Progress: A Literature Analysis

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ABSTRACT
The study explores the revolutionary impact of cloud computing technology in libraries by focusing on how it enhances efficiency, scalability, collaboration, and services. In the digital age where users increasingly rely on electronic resources and frequently access information through computer devices such as smartphones, tablets, and laptops, leveraging the revolutionary potential of cloud computing technology is significant to cater to the users' information needs. This study highlights the status of this revolutionary potential of cloud computing technology by examining the dynamic landscape of cloud computing technology in libraries, with a specific emphasis on cloud computing technology-based architectures and innovative implementations to improve library functionalities using the literature review method. The study further identifies the existing research gap in implementing cloud computing-based technology in libraries. The study also highlights the trends and recommends further studies.

Keywords: Cloud Computing Technologies, Delivery of Services, Cloud Library Architecture, Application of Cloud, Trends in Cloud Computing Technology

I INTRODUCTION

Cloud computing technology is a model that enables ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (Mell & Grance, 2011). Cloud services like Software as a Service (SaaS), Infrastructure as a Service (IaaS), and Platform as a Service can be harnessed to enhance the operational efficiency of libraries (Cohen, 2012) (Islam et al., 2023). These services provide a great opportunity for librarians to integrate traditional library services with technology. Librarians can utilize SaaS to provide access to a wide range of digital resources, such as e-books, audiobooks, and digital archives, host webinars, create online learning facilities, and provide cloud chat services. Librarians can utilize IaaS to host their entire IT infrastructure, including servers and storage, and use it for data analytics.

Further, librarians can utilize PaaS to deploy mobile library apps, resource-sharing platforms etc., (Breeding, 2012). The use of cloud computing technology in library operations and offering library services signifies a substantial advancement in the management, accessibility, and distribution of information in the digital era. Cloud computing technology potentially transforms library services and operations, making them more efficient, scalable, and user-centric (Bhardwaj et al., 2010). This technological paradigm shift offers librarians a range of benefits, from cost reduction to enhanced service delivery. The fundamental characteristics of cloud computing that help librarians are resource pooling, broad network access, rapid elasticity, measured service, and on-demand self-service, which align closely with the dynamic needs of modern library users (Mell & Grance, 2011).

A few librarians have adopted cloud computing technology, heralding a new era in library science and information management. For instance, librarians have adopted cloud-based tools for various purposes, including but not limited to data storage, digital asset management, integrated library systems (ILS), and resource-sharing networks. The scalability of cloud computing technology is most pertinent to libraries since it enables the growth of digital collections and services in accordance with user demand. Furthermore, the collaborative and resource-sharing opportunity offered by cloud computing technology is also pertinent for libraries. It allows the creation of extensive and easily accessible digital repositories, which greatly benefits library users (Singh & Gupta, 2014). Cloud computing offers significant economic advantages for libraries, with storage expenses representing just 10% of operational costs and 1/3 of processing power per system and halving bandwidth costs. Streamlining infrastructure costs, including software and hardware, leads to reduced IT issues for the organization (Jahangiri et al., 2021). Librarians may enhance the extent and quality of their services by employing cloud-based systems, which enable them to engage in larger networks and share resources and knowledge. Librarians must embrace cloud services to address the evolving requirements of library users. Nevertheless, the use of cloud computing technology in libraries presents some difficulties and apprehensions with regard to data security, privacy, and the potential rejection of control over technological infrastructure. Majorly depending on third-party service providers for crucial library operations

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is a most pertinent difficulty (Kaur & Rani, 2015) involved in utilizing cloud computing technology. Despite the challenges, cloud computing technology offers various advantages to libraries in providing services. Thus, the study aims to explore the application of cloud computing technology in libraries.

A Objectives of The Study

- To understand the diverse ways in which cloud computing technology has been utilized in the recent past
- To provide the current status of cloud computing technology usage in libraries.
- To provide a snapshot of available cloud computing technology architecture and applications for libraries

II METHODOLOGY

The study employed a literature review method for conducting a comprehensive review of 39 publications. The Proquest abstracting database was used with the key term "cloud computing + library" to gather publication data. The full text publications were collected from publishers and open access literature providers such as google scholar, E-LIS, DOAJ, ResearchGate, and Academia. The literature focusing on the cloud computing Architecture and application of Cloud Computing Technology in libraries were selected for a comprehensive understanding of the role and impact of Cloud Computing in libraries.

III CLOUD COMPUTING ARCHITECTURE FOR LIBRARIES

Cutting-edge development in libraries is due to a shift towards more intelligent, automated, and user-centric services with the support of recent technological developments such as cloud technology (Sun et al., 2022). Cloud computing technology represents a method of delivering library services via the Internet. This technology encompasses a broad range of components, including applications, platforms, and services. It integrates various layers and servers alongside essential elements like storage, databases, networking, software, analytics, and intelligence (Hua, 2021). These components typically consist of a front end, a back end, and a network that connects them. The front end is the interface that the user or client can view or operate, while the back end is the 'cloud' section of the system. The front end includes the client's computer or computer network. It also includes the application essential for accessing the cloud computing system. Not all cloud computing systems have the same user interface. Various computer programs, servers, and data storage systems on the system's back end create the 'cloud' of computing services (Peterson, 2023). Typically, a cloud computing system will have a minimum of one application server, but it can have as many as necessary. A central server administers the system, monitoring traffic and client demands to ensure everything runs smoothly. It follows a set of rules known as protocols and uses a special kind of software called middleware. Middleware allows networked computers to communicate with each other (Sun et al., 2019). One of the most significant advantages of cloud computing is its flexibility and scalability, which is particularly beneficial for libraries, which often have fluctuating demands and a need to manage a large amount of data and digital resources efficiently.

Cloud computing allows libraries to expand their services and storage capabilities without requiring substantial physical infrastructure upgradation. Different cloud architectures are designed by researchers to offer different services in libraries. Cloud computing technology-based resources sharing architecture is designed and developed to bring readers a better service experience, richer information resources, more comprehensive data analysis results, faster information update speed and safer data protection. The new resource-sharing model is 30 times faster than the traditional one as an algorithm is very effective compared with the traditional clustering algorithm in data processing (Hu, 2019). Further, resource-sharing architecture using cloud computing-related technology like HDFS is used for metadata and MapReduce for searching authors, which includes access layers for "portal entry, registration and verification, application interface layer" for searching documents transfer and other services, basic management layer for data management, "data compression, data encryption, backup, etc, and storage layer for data storage, virtualization, etc. (Sun et al., 2019). To increase the functionality of the search system in classification systems of the library, cloud architecture is designed and developed, which links to third-party resources that contain classification tables, the creation of working tables that contain index-heading or value pairs, and the creation of a directory for storing indexes (Smirnov, 2018). Further, an intelligent search engine to retrieve information from massive data in the OPAC is designed to enhance resource storage and remove information islands (Tang & Hu, 2021). A cloud-based structural architecture for libraries is designed and developed, which includes internet access, thin-client architecture, wireless access points, digital resources, etc., (Ibrahim, 2018). Cloud-based LMS architecture is also designed using IaaS and SaaS, which provides the facility to connect many libraries through a common gateway and allows the sharing of computing and storage devices using virtual machines running on a hypervisor (Shaw & De Sarkar, 2020)

Cloud-based digital repository architecture utilizing MapReduce is designed for university libraries (Rivai & Wang, 2020). Document management systems to archive documents are designed using a transmit system called G-cloud briefcase for academic certification, document management, and database persistence, which has blockchains that have a network of universities. This architecture uniquely manages digital documents and solutions to cloud security and privacy concerns (Stana et al.,

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2021). A framework for building a clustered cloud library, which connects institutions with the community cloud to provide resources through a metasearch engine, is also available for the benefit of users (Shiferaw & D. Cerna, 2016).

IV APPLICATION OF CLOUD COMPUTING IN LIBRARIES

Cloud computing supports on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured services (Singh & Veralakshmi, 2012). This system essentially streamlines and expands the capabilities of library services through digital means. It is important for cost-effectiveness, scalability, accessibility, and support for digital resources and services (Moghaddam & Talawar, 2009). Cloud computing can enhance various library services like cataloguing, digital collections, data storage, and user access to resources. Librarians are experiencing difficulties in accessing their current systems, leading them to declare that they are converting to the cloud, which would inevitably assist them in increasing the level of configuration control over infrastructure resources, memory devices, and software, among other things. They also acknowledge the advantage of laaS, as opposed to managing the infrastructure themselves (Khatib and Opulencia, 2015), which will save the librarians' time and potentially improve efficiency and user experience. Several opensource cloud software that supports librarians in managing libraries efficiently have been designed to offer help to librarians for instance, cloud operating systems like GLIDE, MyGoya, KoHIVE, Zimdesk, and Cloudo and also IaaS software like Cloud stack, Nimbus, open Nebula, etc,, are highly useful for librarians. Management software like delta cloud, jclouds, libcloud, and SaaS like CRM, Nuxeo, Vtiger, etc. are important for cloud computing in libraries (Yuvaraj & Singh, 2013). Ruttenberg considers cloud technology based electronic resource management systems have the potential to improve library staff's visibility into the pre-order procedure. Especially OCLC's License Manager's procedure and workflow; Task and license management, and vendor information along with system review, license selection, etc., is uncomplicated. Meanwhile, CORAL's licensing module has a very useful function that enables users to search for items using an expression and a qualifier (Ruttenberg, 2013). Khatib and Opulencia, who have evaluated the feasibility of deploying an Infrastructure as a Service on a private cloud in public libraries of UAE consider cloud computing as a slew of advantages to develop a realistic solution plan that would allow and pave the way for more flourishing services to be offered (Khatib & Opulencia, 2015). Librarians of Banaras Hindu University also consider environment for adoption of cloud computing tools and Software to be relatively favourable (Yuvaraj, 2015).

Librarians consider cloud computing as an accurate and reliable technology that supports the acquisition process and delivery of services at a faster rate (Kong, 2020) (Tella et al., 2020). They also agree that cloud technology allows the sharing of essential infrastructure, services, and resources as opposed to traditional library management systems (Khozani et al., 2021). Thus, much research has been carried out for the inclusion of cloud technology into library systems since a decade. Most librarians, especially those working in engineering colleges, are aware of cloud technology and use the technology in libraries (Kantharaja & Bharathi, 2020) (Mahalakshmi & Sornam, 2012) (Salih, 2020) (Miss et al., 2021) (Khozani et al., 2021). They are also enthusiastic about using cloud computing technologies to enhance users' services (Yuvaraj, 2015). Similarly, small and rural academic librarians actively use cloud computing to develop and strengthen their librarianship practice and assist their users (Tritt & Kendrick, 2014).

Most librarians use cloud technology-based mailing services (Khozani et al., 2021). They use cloud storage services for storing files, photos, and collaborative writing for personal purposes and for professional purposes they use storage services for maintaining records, providing SDI services, and sharing resources. Additionally, the majority of professionals use a variety of cloud-based technologies, including Yahoo Mail, WhatsApp, YouTube, Google Drive, Google Forms, Doodle, and Google Docs. Libraries employ cloud-based library management software and for information storage/backup (Miss et al., 2021). Few librarians have shifted their storage system to Dropbox (Pillen & Eckard, 2023). Further, they have implemented OCLC's WorldShare Management Services (WMS) (Dula et al., 2012). Few Kerala library professionals have used cloud technology to provide Web OPAC and Journal Discovery Services (Pillai and Seena, 2018). The majority of librarians, especially in Ethiopia, have shown great interest in using cloud technology for service delivery and have favoured an online library collection using an integrated clustered cloud library. To make up for the shortcomings of the present service delivery system (Jahangiri et al., 2021) (Shiferaw et al., 2016)

Most of the librarians, especially in Indian Central University and rural academic colleges, are using cloud-based technology such as Hotmail, Now comment forum, Pinterest, Dropbox, Egnyte file sharing service, Spicy nodes, Open drive, Lucid, and Glide operating system and are interested in switching their traditional system to a cloud-based system. Few librarians have used cloud-based video and presentation services, office applications and storing services, cloud-based file-sharing services, calendar services, and forums and the majority of the librarians used World cat services and OCLC web scale. Further, the majority of them are evaluating the possibility of implementation in their libraries. (Yuvaraj, 2013) (Tritt & Kendrick, 2014) (Majhi et al., 2015) (Pillai & Seena, 2018). However, certain librarians are reluctant to adopt the technology due to relative disadvantages, compatibility, technophobia, government regulations, and competitive pressure (Yakubu et al., 2023). Whereas, some librarians consider cloud technology to enhances accessibility, security, and scalability, although it

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introduces new challenges, such as dependency on internet connectivity and concerns about long-term preservation. They consider that this transition is a step towards more efficient and modernized archival practices (Pillen & Eckard, 2023). Beside this, Librarians especially of the IIT Bombay and IIT Delhi are using the SaaS services such as Turnitin, Grammarly, Summon Serial solution, and several e-journal databases and e-databases, IRINS, EBSCO Discovery Services, but did not utilize PaaS and IaaS models (Sahoo and Panda, 2019).

This indicates that cloud technology has a significant influence on a wide range of library services, and libraries are steadily converting to cloud computing. Librarians consider this development to be a benefit in the digital age (Tripathi and Pandy, 2019). A good number of librarians are providing services only in cloud mode (Tripathi and Pandy, 2019). Many librarians are favouring the training programmes such as a short-term course, in-house training programmes, workshops (Khozani et al., 2021) (Pillai & Seena, 2018) (Islam et al., 2023) and seminars (Majhi et al., 2015) to utilize the cloud base technologies to offer services to users. They are also requesting authorities to provide necessary funding for the application of cloud technology-enabled services (Pillai & Seena, 2018).

V RESEARCH GAP

There are research gaps in the utilization of cloud computing technology in libraries. They are briefed further to draw the attention of librarians and authorities to fill the research gap and find solutions to the problems that are unattended.

Although cloud computing technology based services have advanced significantly, there is a dearth of research on the user experience and accessibility, particularly about how new technologies accommodate the diverse needs of library users, including those with impairments. Moreover, there is a scarcity of comprehensive research on complete cost benefit analysis. Acquiring a thorough understanding of the financial consequences, especially for smaller libraries, is essential for attaining widespread approval. Furthermore, there are a few research works on the long-term sustainability and scalability of this technology in libraries. Insufficient study has been conducted into the impact of technological advancements on library personnel, including the necessary training needed to upgrade their skills and knowledge. Additionally, there is a dearth of research on performance metrics and evaluation frameworks that can accurately assess the effectiveness of cloud-based library services and their impact on library operations and user satisfaction. Finally, there is still a lack of comprehensive and global understanding of how cloud computing is revolutionizing library services.

VI TRENDS IN IMPLEMENTING CLOUD COMPUTING IN LIBRARIES

The use of cloud computing by libraries in India and abroad are recently been evaluated, as many librarians were evaluating the technology for inclusion into library activities.

The present patterns in the implementation of cloud computing in the library domain mirror the shift of libraries towards more agile and user-focused services. Currently, various libraries are moving towards the adoption of cloud-based library management systems such as NewgenLib, Koha, Ex-Libris, and OCLC webscale (Shaw & De Sarkar, 2020) (Pillai and Seena, 2018) (Dutt, 2015). It provides remote access to the OPAC to users, which allows them to access the bibliographical information to collections and full access to archived resources. Additionally, users can also monitor their transaction details through an integrated user portal. It helps librarians to update and maintain the software easily and reduces the need to maintain the local servers. Cloud technology based digital repositories such as DuraCloud are also booming with advances in cloud technology. It enables sharing of mass resources (Cao, 2022) and ensures the long-time preservation of digital assets, such as e-books, digital archives, and multimedia content and also supports access to multi users in real time.

Another important development that requires librarians to pay close attention is the growth of cloud desktop solutions such as Microsoft 365 Cloud Desktop. This adaptable application is available on a variety of platforms and may be accessed via thin client devices or any network-connected device (Hua, 2021). It enables librarians to efficiently manage their activities remotely. Collaborative resource sharing is the major trend in libraries, which enables librarians to adopt the collaborative approach in sharing of resources efficiently with the increasing adoption of cloud storage that ensures data security, scalability, flexibility, real time access to resources (Pillen & Eckard, 2023). The pandemic has led to a surge in the use of videoconferencing software like Zoom. Libraries are adapting by building appropriate IT infrastructure to support videoconferencing supplying necessary equipment and space for video calls.

VII FURTHER RESEARCH

The integration of new technologies like artificial intelligence (AI), machine learning, and the Internet of Things (IoT) into library services is being facilitated by cloud computing. Artificial intelligence (AI) may enhance search and discovery tools and be integrated with library systems to provide automated customer care through chatbots. Power BI can be seamlessly incorporated into a cloud-based library management system to provide tailored reports persuasively and with just a single click.

Libraries can utilize cloud-based technologies integrated with virtual reality to offer training, library orientation, and library tours. The immersive virtual reality (VR) training is designed to cultivate fundamental job abilities, particularly targeting young professionals who are embarking on their careers. Additionally, it facilitates user education.

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VIII CONCLUSION

Cloud computing offers libraries a pathway to modernize, enhance efficiency, expand services, and provide greater access and value to their communities, aligning with library users' evolving expectations and needs in the digital age. Cloud computing architectures available for library field highlights the components and subcomponents that are required for using cloud based technologies in library. It is an essential element in adopting and utilizing the technology's full benefit, such as functionality, offering scalable and flexible solutions for various applications, including library services. Owing to the rapid developments in cloud computing technologies, there has been a dearth of research since 2009, with a particular emphasis on the library field. This topic is dominated by theoretical studies that address ideas. This area is still in its infancy, as shown by the few papers that have reported the utilization of cloud computing technologies in libraries to offer services. Libraries must thus broaden their knowledge and abilities in adopting cloud computing technologies through training while also taking steps to encourage the usage of this technology. Future trends in cloud computing for libraries, such as the increasing use of artificial intelligence and machine learning, should be focused by librarians.

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