

Cloud computing for information management and use in the 21st century library

¹Lucky Oji Akpojotor, *PhD* and ²Okeraghogho Ekuerhare

¹Collection Development Librarian, Federal University of Petroleum Resources, Effurun, Nigeria

²Delta State University of Science and Technology, Ozoro, Nigeria

E-mail: ¹akpojotor.lucky@fupre.edu.ng; ²aekuerhare@yahoo.com

Cell: ¹+2348038932786; ²+2348032192130

Abstract

Librarians are applying different platforms for user services and attaining exceeding satisfaction for information management and use in this Web based era. Cloud computing presents an advantage for libraries. It is providing several opportunities for libraries to link their services, use and manage information on the cloud. Cloud computing is the new type of service provided on the Internet, which has exclusively changed the way computers are used irrespective of geographical barriers to manage and use information. The paper examines cloud computing as a tool for information management and use in the 21st century library. The discourse is about the concept of cloud computing, models of cloud computing and the service, which include IaaS, PaaS and SaaS. The paper also discusses cloud. The paper also discusses cloud deployment storage models in private, community, public, hybrid and personal cloud. Information management concept are highlighted, alongside applications of cloud computing for information management and usage in the 21st century libraries. Benefits of using cloud computing for information management in the 21st century libraries including the risks associated with cloud computing for information management and use in the 21st century libraries. Concluding, the discourse opines that today libraries are shifting to cloud computing technology to process data correctly and quickly. Cloud based services are helping libraries by creating digital libraries, social networking and enhance information sharing. Though, problems regarding data security, privacy, reliability and legal rights have not been fully taken care of. All information personnel must be aware of these issues before choosing cloud based services. Despite these issues, cloud based technology is an incredible development that can improve data management and usage in libraries and offer dependable, rapid services to its users. The study recommends that base on the importance and relevance of cloud computing technology, that it should be applied in library services to manage and use information must especially university libraries in Nigeria.

Keyword: Cloud computing, library technology, information management, information and communication technology, internet hosting services

Introduction

Library as a growing organism (Ranganathan, 1988) has moved from the traditional mode of information storage and delivery system to the mechanization/computerization of information management. Further to the third industrial revolution, after the use PC and Internet which is cloud computing for information management, retrieval and dissemination. The present scenario; information management, retrieval, dissemination, including usage is based on web enabled technologies developed on virtual platforms and generating large

opportunities and virtual paths to use library resources in various forms. Cloud computing is turning to be one of the most popular virtual technologies used by libraries in delivering services and managing information for adequate usage in an effective and efficient manner (Pandya, 2012).

Cloud computing technology offers great advantages to libraries in connecting their services with their users; not only promptly, but also in new formats capable of intrinsic flexibilities such as pay as you use model, access without limitation of time and location. The new concept of cloud

computing in libraries has generated a new model called cloud libraries. Though the usage of cloud computing may vary with the library's nature, services and information needs, most common usage of cloud computing within libraries are towards the development of digital libraries, corporate cataloging, acquisition, storage and resource sharing in a virtual environment using the web. The need of cloud computing arose due to information explosion, problems with accessing information, resource sharing, library resources management, need to save the time of the users and staff, complex demand of users and attraction of users towards cutting edge technologies (Khan, Khan & Galibeen, 2011).

What is cloud computing?

Cloud computing is a completely new technology and it is known as 3rd revolution after PC and Internet. A developing computer paradigm known as "cloud computing" allows users to access data and services from any connected device via the internet and save them in massively scalable data centers in the cloud. (Gosavi, Shinde & Dhakulkar, 2012). Cloud computing is an enhancement of distributed computing, parallel computing, grid computing and distributed databases. Among these, grid and utility computing are known as predecessors of cloud computing. It entails allocating virtual machines on top of a sizable physical machine pool that is housed in the cloud, through which many services can be provided. Cloud Computing is the improvement of distributed computing, parallel computing, grid computing and distributed databases (Reddy, 2012).

According to the definition of NIST (National Institute of Standards and Technology), Cloud computing is a model that makes it possible to quickly create and deploy a shared pool of reconfigurable

computing resources (such as networks, servers, storage, applications, and services) via a network while involving little management labor or service provider involvement. Cloud computing has large potential for libraries, which enables them to upload more content into the cloud. Using cloud computing, user would be able to browse a physical shelf of books, CDs or DVDs or choose to take out an item or scan a barcode into his mobile device. Any researcher would have access to a comprehensive, quickly searchable database that contains copies of all historical and uncommon documents. Many libraries currently share bibliographic information with OCLC and have online catalogues. Online directories are linked to cooperatives that share resources more frequently.

Cloud computing is internet-based computing, involving sharing of resources, software and information provided to computers and other devices on-demand through the internet (Wikipedia, 2012). Basically, the name implies the image or shape of the cloud symbol used to represent the concept. Nimis (2010) explains that through the use of virtual computer and storage capabilities, cloud computing offers information technology infrastructure, platforms, and applications as a type of on-demand service that is charged based on usage. Cloud computing is a type of internet-based computing that involves sharing of resources, applications, and services over the internet with limited administrative and maintenance work or minimum management and maintenance efforts.

Models of cloud computing

There are three service models that are commonly employed in delivering and managing different cloud-based services; they are Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software

as a Service (SaaS). These are enumerated as follows:

- i. *Infrastructure as a Service (IaaS) or Hardware as a Service (HaaS)*: This service model offers a diverse range of features, services, and resources to build a virtual computing infrastructure on demand. Examples of such providers are Amazon Web Services, Rackspace, Savvis, HP, IBM, Sun, and Google Base.
- ii. *Platform as a Service (PaaS)*: This is an offering that enables users to access computing capabilities and software over the internet without needing to manage the underlying infrastructure on their own. Examples of this type of platform include Amazon Elastic Cloud, EMC Atmos, Aptana, and GoGrid, which provide a way for users to access the technology they require without

having to pay for the physical hardware and software.

- iii. *Software as a Service (SaaS)*: Using Software as a Service, users are able to access and employ any programs offered by cloud providers without needing to obtain the software, install it, and handle the applications on their servers. This method does away with the need to manage the cloud infrastructure and platform in which the program operates. Utilizing SaaS enables internet users to make use of online email applications, free facilities, unrestricted storage, and get access remotely from any type of device that has an internet connection.

According to Suman and Singh (2016), below is the elaborate service model using a pictorial representation.

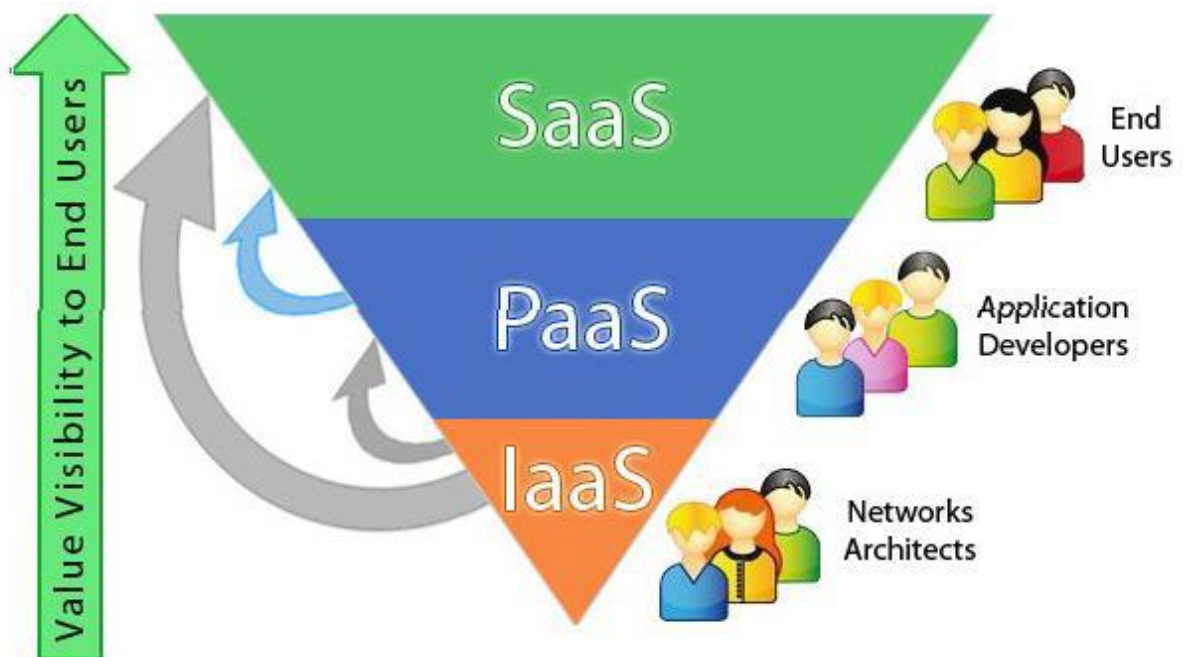


Figure 1: Models of cloud computing Source: Suman and Singh (2016).

Cloud computing deployment model or types

NIST defines cloud deployment model or types is according to where the infrastructure for the deployment resides and who has control over that infrastructure. NIST classified four types of deployment model or types which include:

- i. *Private cloud*: This is an exclusive Cloud arrangement model, created and maintained by an individual organization or third-party, regardless of where it's located, is a Private Cloud. Companies develop this kind of cloud for a variety of reasons, including the optimization of available in-house resources, protection of data security, minimization of data transfer costs, and the need for complete control of critical activities which stay within the firewalls of the company. Additionally, organizations often use a private cloud for their research and teaching activities.
- ii. *Community cloud*: This implies a joint venture of multiple organizations working together to create a cloud infrastructure as well as policies that manage cloud services. The community cloud model is beneficial for gaining economic scalability and democratic equilibrium. The cloud infrastructure

can either be hosted by a third-party vendor or located within one of the organizations of the community.

- iii. *Public cloud*: Public cloud computing services are available to everyone, with different policies, prices, profits, costs, and billing models set up by cloud computing companies. Examples of public cloud services include Amazon EC2, S3, Google App Engine, and Force.com.
- iv. *Hybrid cloud*: The hybrid cloud is a combination of various cloud deployment models (public, private, community, etc.), connected by technology that enable data and application portability. It is a model that is extensively used by institutions and organizations as it maximizes the usage of resources and facilitates the accomplishment of tasks.
- v. *Personal cloud*: 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.



Figure 2: Types Deployment Models Source: <https://chrislazari.com/what-is-cloud-computing/>

Concept information management

Information management is a set of practices used to maintain and effectively distribute data, whether it is physical or digital. Libraries are expected to be able to successfully handle the entirety of this information throughout its life cycle, no matter the nature of the data (e.g. audio, video, papers, etc.) Moreover, they must ensure that the data is available to be accessed from various platforms, such as cell phones and online interfaces. The purpose of this discipline is to guarantee that information is effectively managed, structured, operated, and delivered with the help of people and technological advancements (Sinha, 1992). According to Wikipedia, in the 21st century, Information Management (IM) is a tool utilized by libraries to gather, organize, store, and distribute data to those with a legitimate right or interest in it. The ability to deliver the appropriate info to the correct people in a timely manner is the core focus of Information Management. In today's world, Information Management (IM) environments consist of older information saved in systems like Enterprise Content Management (ECM), Electronic Records Management (ERM), Business Process Management (BPM), Knowledge Management (KM), Taxonomy and Metadata, Web Content Management (WCM), Document Management (DM) and Social Media Governance. These technologies and processes have been developed to maximize information dissemination and usage.

The main purpose of libraries is to make it simple for patrons to access and utilize the ever-growing quantity of information, which varies in complexity and speed. As the need for information reflects new cases, managing this information has become much more intricate. (Casonato, Lapkin, Beyer, Genovese & Friedman, 2011). The current trend of increased demand for accessible, shareable, and useful information has led to a need for a more

effective way of managing information resources that can be accessed through various channels, including mobile devices, in the 21st century. In this regard, Cloud computing is a recent advancement in information management and technology that libraries around the world are capitalizing on. It is quickly becoming the norm for how information is accessed, stored, and shared. With cloud computing, users are able to quickly access and share immense amounts of information.

Applications of cloud computing for information management and usage in the 21st century libraries

Advances in technology, putting together micro electrical components, computers and communication tools, have altered the way data is handled and utilized. Cloud computing has made it less complicated to save, control, use and access details in this digital time. This has created new issues for managing and running data services which have to be tackled to suit the current requirements of customers. These are:

- i. New ways to store information compactly and cheaply;
- ii. New mechanism to manipulate, scan and search such records; and
- iii. New facilities for cheap and rapid transmission of information over long distances.

Thanks to cloud computing, libraries and organizations have more freedom when it comes to making and utilizing data and knowledge. With this new technology, sorting out management issues is much easier and accessing information takes much less effort. People can choose which hardware, software and networking services they would like, either from within their own organization or from an outside source (Armbrust et al., 2010; Joint et al., 2009). Libraries are keeping up with the times by modernizing their services to include cloud

computing and networking. This innovation makes it easy for users to take advantage of the library's services from any place at any time. This technology can help manage and use information in a much more efficient way:

- i. *Cloud based integrated library management system:* Recently, many integrated library management systems have started being offered as cloud-based services. This means that libraries can access them through the internet instead of having to download or install them on their own computers. Many libraries are now opting for this solution. Boss (2014) reported that at the close of 2009, almost all vendors of integrated library systems had Software-as-a-Service options available for libraries to use. By the end of the year, over two thousand libraries worldwide had adopted this option for their integrated library systems.
- ii. *Library automation and house-keeping activities:* Cloud computing services also supports for library automation and house-keeping activities. For example: Polaris provides variant cloud based services such as acquisitions, cataloguing, process system, digital contents and provision for inclusion of cutting edge technologies used in libraries and also supports various standards such as MARC21, XML, Z39.50, Unicode and so on. Now-a-days many of the software vendors such as Ex-Libris, OSS Labs are also offering this service on the cloud and third party services offering hosting of this service on the cloud to save

libraries from investing in hardware for this purpose. It is a cost-benefit approach to make the libraries to be free from taking maintenance namely, software updates, backup and so on.

- iii. *Library Website Hosting:* Cloud computing technology also facilitates many organizations including libraries preferred to host their websites on third party service providers rather than hosting and maintaining their own servers. For example : Google Sites serves as an example of a cloud service for hosting websites outside of the library' s servers and allowing for multiple editors to access the site from varied locations.
- *Building digital library/repositories:* To ensure that libraries are equipped to provide their services, information and resources in a manageable and available way, they must set up a digital library. To do this, special software is needed. Duraspace offers Dspace and Fedora Commons that have open-source codes and user-friendly interfaces in order to provide an all-in-one solution for creating a digital library and repository.
 - *Building Community Power:* Cloud computing technology offers great opportunities for libraries to build networks among the library and information science professionals as well as other interested people including information seekers by using social networking.
 - *Searching library data:* OCLC is an excellent example of the benefits of

using cloud computing in the library world. Its WorldCat service can now be accessed via the cloud, along with a wide range of other library-specific services such as circulation, cataloguing, and acquisition. This kind of collaboration encourages libraries to share their resources, services, and experiences with others in the library community. Additionally, web-scale services enable libraries to use cost-effective and efficient cloud-based platforms, resources, and services and to exchange data and broaden collaboration among the library community.

- *Searching Scholarly Content:* Cloud computing facilitates platform facilitates to discover and share the scholarly content. It acts as collaborative platform to empower libraries for dynamic searching and also for single point search interface, maximizes the usage of all electronic resources, customized search across selected sources reduces noise and highlights relevant content and tools to support the complete research lifecycle. For example: Knimbus is cloud based research platform. It is a

Knowledge Cloud which is dedicated to knowledge discovery and collaborative space for researchers and scholars. It is a collaborative platform for researchers to discover and share knowledge with peers and facilitates to find and access millions of journal articles, patents and e-books, for the users tagging, sharing and discussing of these contents with their peers.

- *File storage.* Cloud computing offers users the convenience of being able to access files from anywhere they have access to the internet. Libraries can make use of this technology by using services like LOCKSS, CLOCKSS, and Portico, which allow them to maintain a digital record for preservation purposes. This makes it possible for users to access their files without the need for special software or hardware. In addition, to access any files on the internet such as Flickr, Dropbox, Jungle Disk, Google Doc, Sky Drive and so on. These services virtually share the files on the web and provide access to anywhere and anytime at their beck and call.

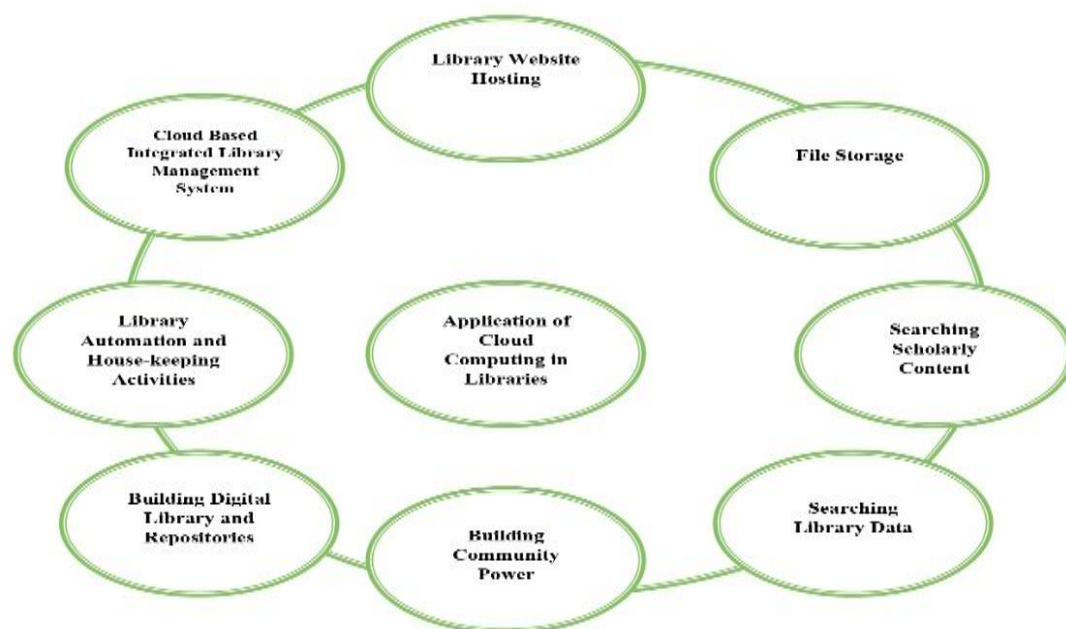


Figure 3: Application of cloud computing for information management and usage

Source: Akpojotor Schematic

Benefits of using cloud computing for information management in the 21st century libraries

According to Right Scale (2014), there are a number of benefits of this innovative practice of using the cloud to manage information for effective dissemination and usage in the 21st century, which include:

- i. *Provisioning, consuming and enhancing services:* Cloud computing provides businesses with the opportunity to manage and adjust their IT resources as they need them, rather than having to pay for the full cost of the IT resources upfront. This makes their technology systems more efficient and cost-effective in the long run (Dhar, 2012).
- ii. *Superior information infrastructure and platform:* Cloud technology has allowed libraries and information centers to make their services available 24/7. This technology

provides a platform for librarians to create virtual communities through a variety of applications such as blogs and social media. In addition, cloud systems can be used to provide library users with cloud integrated library systems and online, cloud-operated public access catalogs for resources over the internet. This technology provides library staff with a unified platform for delivering services, meeting customer needs and applying technological solutions.

- iii. *Best management strategy:* In today's digital age, many libraries have made the switch to using cloud-based applications, rather than their regular web-based systems. This has greatly improved their access to costly and powerful infrastructure, while also reducing the cost of their services. Outsourcing these services is becoming a popular option as it is

- cost-effective, and does not require a lot of effort from the organization or library. It is the most effective way to provide quality information systems and services to library users, thus improving their user experience.
- iv. *Sharing of resources:* Cloud computing is a way for libraries and information centers to maximize their resources and save money. By pooling their technology infrastructure together, they can access and share computing services from an online central hub. Virtualization technology has made it easy to provide resources and services to multiple users at once, which helps libraries and information centers work together to develop and offer solutions to better manage their information.
 - v. *Facilitate innovative services:* Cloud computing provides librarians and other information professionals with the opportunity to redirect their resources away from tasks related to the maintenance and purchase of computers, and focus instead on providing quality information services to their clientele. This requires information professionals to actively search and evaluate for new services and solutions which can be used to enhance the services offered to their audiences. It is more helpful for them to concentrate on information services rather than wasting time and resources building their own software solutions. Outsourcing services can help information professionals to focus more effectively on both standard and advanced information services. Cloud computing accelerates the introduction of new services in libraries, and is a more cost-effective solution for gaining access to the most up-to-date tools, in comparison to owning the technological resources outright - which can be expensive in libraries with restricted financial input. Furthermore, cloud computing enables an environment for data professionals to create custom online areas, depending on the needs of their patrons. The fast-changing digital world has provoked libraries into creating systems employing open-source software - something cloud computing makes accessible.
 - vi. *Adequate security:* Cloud services can provide libraries with the security they may not be able to afford with their own resources. Having a third-party provider who specializes in security is usually a better option for libraries than having to create their own security system.

Risks associated with cloud computing, information management and use in the 21st century libraries

The risks associated with cloud computing, information management and use in the 21st century libraries are as follows:

- i. *Security lapses:* One of the biggest worries stopping libraries from adopting cloud computing is safety and security for their resources. Libraries need to be aware of the risks of the online world once they switch to cloud computing as it creates a global village, bringing many security risks. Using cloud computing to manage information can present risks; if the system crashes, it can cause damage to the library's resources. Professional expertise has shown that data and resources that are sent out to be managed in the cloud are not always

reliable. On the other note, Awale (2012) reports that nearly 40 percent of organizations in East Africa are reluctant to adopt the cloud technology due to data privacy, legislation and security concerns. In addition, Thomas (2011) argues that, institutions with serious concerns about data security should build own private cloud services to keep costs down.

- ii. *System failure:* Cloud computing can have a negative impact on the library's operations and services if the machines malfunction. If the cloud system isn't working properly, then the library cannot access its resources and services.
- iii. *Transparent and ownership issues:* For cloud services to be successful and continue in libraries, it is important to be honest and clear during the orientation process. Even if cloud services are provided by external companies, it is still essential for libraries to inform stakeholders about the plans and ideas behind cloud computing. To be able to discuss and build on each other's experiences, libraries must be open and accountable when considering cloud computing.
- iv. *Policy and regulation issues:* When it comes to cloud services, it is important that libraries have the right policies, rules, and regulations in place to manage and protect data resources stored locally and across borders. Guidelines should also be established to help guarantee uninterrupted access to library information resources.
- v. *Connectivity and bandwidth issues:* In cloud computing, internet connectivity services are important and lack of the same is disastrous. In

traditional applications, lack of connectivity allows for some local function to continue until the services are restored (Kayeyia, 2010). Additionally, the issue of bandwidth plays crucial roles in the delivery of cloud services. Cloud computing companies have the potential to take advantage of the library's use of bandwidth and over-charge them. In an environment where they have a lot of control, such as in a business monopoly, these companies tend to charge based on average or peak usage instead of maximum usage.

- vi. *Dependence on outside agencies:* The cloud services being offered by third party services over the Internet, it is virtually difficult to have any control on the maintenance levels and the frequency. Also it is tough to assess the contingency procedures of the service provider in regard to backup, updates, restore and disaster recovery. Migration to other service provider is also an issue, if the uniform standards are not followed by the host

In Nigeria, cloud computing is still in its early stages when it comes to managing and using information. Libraries are attempting to offer users cloud-based services. However, there is a lack of service providers and knowledge among librarians on how to use cutting edge technologies to run the library in the cloud. Meanwhile, digital libraries, web documentation, and web 2.0 technologies are in operation in the country. Libraries could provide greater access to their services by moving them to the cloud.

Conclusion

Nowadays, libraries are shifting to cloud computing technology to process data correctly and quickly. Cloud based services are helping libraries by creating digital libraries, social networking and enhance information sharing. Though, problems regarding data security, privacy, reliability and legal rights have not been fully taken care of. All information personnel must be aware of these issues before choosing cloud based services. Despite these issues, Cloud based technology is an incredible development that can improve data management and usage in libraries and offer dependable, rapid services to its users.

The paper recommends that base on the importance and relevance of cloud computing technology in the 21st century, it should be applied in library services to manage and use information must especially university libraries in Nigeria.

References

- Armbrust, M., Fox, A., Griffith, R., Joseph, A. D., Katz, R., Konwinski, A., Lee, G., Patterson, D., Rabkin, A., Stoica, I. & Zaharia, M. (2010). A view of cloud computing. *Communications of the ACM*, 53 (4). <https://dl.acm.org/doi/pdf/10.1145/1721654.1721672>.
- Awale, M. (2012). Demystifying computing on the cloud. *Think Business*, 1 (3), 34.
- Boss, Richard W. (nd). Software as service <https://alair.ala.org/bitstream/handle/11213/258/Software%20as%20a%20Service.pdf?>
- Casonato, R., Lapkin, A, Beyer, M. A, Genovese, Y & Friedman, T (2011). Information management in the 21st Century. *Gartner Industry Research*. <https://www.gartner.com/doc/1781917/information-management-st-century>.
- Gosavi, N., Shinde, S. S. & Dhakulkar, B. (2012) Use of cloud computing in library and information science field. *International Journal of Digital Library Services*, 2(3), 51-60
- Joint, A., Baker, E. & Eccles, E. (2009). Hey, you, get off of that Cloud? *Computer Law & Security Review*, 25, 270-4.
- Khan, S., Khan, S. & Galibeen, S. (2011). Cloud computing an emerging technology: Changing ways of libraries collaboration. *International Research: Journal of Library and Information Science*, 1(2). http://irjlis.com/wpcontent/uploads/2011/11/7_IR032.pdf.
- Makori, O. E. (n.d). Cloud computing paradigm and libraries and information establishments in Kenya: any opportunities for operational resilience. <http://www.parliament.go.ug/aplesa/wpcontent/uploads/2015/08/cloudcomputingparadigm-and-libraries-and-informationestablishments-in-kenya-any-opportunities-for-operational-resilience.pdf>.
- Nimis, J. (2010). Library leadership for today: new challenges, new opportunities. *Proceedings of the 8th Annual Library Leadership Institute, held, Beijing, China, 23rd-27th April 2010*.
- Pandya, M. (2012). Cloud computing for libraries: A SWOT analysis. *8th Convention PLANNER-2012 Sikkim University, Gangtok*, 387-394.
- Ranganathan, S. R. (1988). Five laws of library science, 2nd ed., Sarada Ranganathan Endowment for Library Science, Bangalore.
- Reddy, T. R (2012) Digital era: Utilize of cloud computing technology in digital library. *International Journal of Digital Library Services*, 2 (3) 92-106.

- Sinha, A. K (1992). Information management in 21st century-new trends and technology. *Annals or Library Science and Documentation*, 39 (3), 106-112. [http://nopr.niscair.res.in/bitstream/123456789/27704/1/ALIS%2039\(3\)%20106-112.pdf](http://nopr.niscair.res.in/bitstream/123456789/27704/1/ALIS%2039(3)%20106-112.pdf).
- Suman, D. & Singh, P. (2016). Cloud computing in libraries: An overview. *International journal of digital library services*, 6 (1), 121- 127.
- Thomas, P. Y. (2011). Cloud computing: A potential paradigm for practicing the scholarship of teaching and learning. *The Electronic Library*, 29 (2): 214-224.
- Wikipedia (2012). Cloud computing. http://en.wikipedia.org/wiki/Cloud_computing.

.