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# A SWOT ANALYSIS OF CLOUD COMPUTING AS AN INNOVATIVE TECHNOLOGY FOR LIBRARY SERVICE DELIVERY

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***Abstract***

***Purpose:*** *The purpose of this study is to explore the systems of Cloud Computing by the method of SWOT analysis giving the strengths (advantages), weaknesses (disadvantages), opportunities (where it can be applied in library services and threats (challenges) experienced with the system especially with regards to effective service delivery in the library. These threats needs to be handled to enable the cloud technology play effective role in creating, processing, storing and disseminating information in a library.*

***Methodology:*** *The study adopted a conceptual review based on previous research, using a variety of databases to draw conclusion that only when the threats of cloud computing are properly addressed would there be better service delivery in the library. A wide range of sources were consulted to ensure a broad and balanced review. These include published academic works, academic journals and conference papers. Journals searched for includes: peer-reviewed national and international journals which includes: American Journal of Information Systems; Library Philosophy and Practice; International Journal of Computer Applications, Advances in Intelligent Systems and Computing, and many more. Also other materials for the review were gotten from Google Scholar and Researchgate websites.*

***Value/Originality****: Cloud computing has transformed the way people save, retrieve information and recover data, hence libraries should embrace it to enhance their library service delivery.*

***Keywords:*** *Cloud Computing; SWOT Analysis; Innovative; Technology, Library Service Delivery.*

## Introduction

One of the forms of modern development for library service delivery in this 21st century is cloud computing. Cloud computing according to Mell and Grance (2011) is defined as a model that enables convenient, on-demand network access to a shared pool of configurable computing resources, which includes storage, servers, networks, applications, and services that can be rapidly provisioned and released with minimal management effort or service provider interface. Cloud computing can also be explained as an IT service where a combination of hardware and software services are rendered on request to customers over a network in a mode that can be classified as a self-service which is autonomous of place and the device utilized. Hence, cloud computing is used to deliver innovative technology services which aids in solving challenges that users of the library encounter in their university libraries. A typical example of cloud system service is the Google app services where you don't need any device to save or store data on the internet. Such services are of great value in the delivery of efficient library services as the patron's need and urgency of need keeps increasing by day thereby supporting one of the laws of Ranganathan which states that the library should save the time of the reader, researcher or patron. Therefore, this paper intends to look at SWOT analysis of cloud computing as an innovative Technology for library service delivery.

## Objectives

The objectives of this study are:

- to examine the strengths of Cloud computing with reference to delivering services in the library;
- to find out the weaknesses of cloud computing;
- to study various opportunities where cloud computing can be applied to library services;
- to examine the threats of cloud computing especially in the delivery of library services by librarians and finally;
- to proffer strategies to overcoming these threats.

**The concept of SWOT**

The acronym SWOT stands for strengths, weaknesses, opportunities and threats. Organizations like the library can undertake a study to identify its internal strength and weakness as well as its external opportunities and threats. SWOT has four (4) elements which are Strength, Weakness, Opportunities and Threats as can be seen from the acronym above. SWOT ANALYSIS means a strategic planning technique used to help a person or organization identify strengths, weaknesses, opportunities, and threats related to business competition or project planning. However, **SWOT** analysis (strengths, weaknesses, opportunities and threats analysis) is a framework for identifying and analysing the internal and external factors that can have an impact on the viability of a project, product, place or person. One very effective tool for the analysis of environmental data and information – for both, internal (strengths, weakness) and external (opportunities, threats) factors is SWOT Analysis in the sense that it helps to minimize the effect of weaknesses in one's business, while maximizing one's strengths. SWOT analysis improves the viability of the library as an organization.

Markgraf, (2019) stated that a SWOT analysis identifies strengths and weaknesses within a company, and outside opportunities and threats. The most important parts of a SWOT analysis specify the actions that correspond to the elements one identifies. Markgraf, affirms that by using the results of the analysis to improve the situation of one's company, one can reduce the likelihood of developments that negatively affect the business while improving performance. SWOT elements are identified before performing an analysis. It means that SWOT analysis can identify the internal strength and weakness within the library settings and the outside opportunities and threats which are external.

**The concept of cloud computing**

Joseph Carl Robnett Licklider invented Cloud computing in 1960s to connect people and data from anywhere at any time (Mohamed, 2018). Anything that has to do with delivering hosted services via the internet is described as cloud computing, this is because access to information is found remotely in the cloud or a virtual space. It is a model that delivers different types of information services by which the resources include tools and application such as data storage, servers, databases, networking and software. In this regard, libraries that provide cloud services enable library patrons/clienteles to store their files and applications on remote servers, then through the internet (which becomes the cloud), they can access all the data remotely without boundary. Cloud computing is needed for saving cost, security, effective productivity, speed and efficiency, and great job performance as an innovative technology for library and information service delivery in this era of change. Cloud based storage enable files to be saved to a remote database and this saves the time of users as they can work from any angle in the world as long as there is internet connectivity and they have access to the data to retrieve them when the need arise.

Nevertheless, cloud computing can be described in three (3) forms namely:

i. Private cloud computing: this form of service is provided for certain number of persons without a fee (free based). It is hosted on a network to specific clienteles/library patrons.
ii. Public cloud computing: this form of service is provided over the internet for a fee. However, public cloud computing is fee-based.
iii. Hybrid cloud computing: this is an option that combines both private and the public cloud computing. These services as systems of networks, supplies the hosted services.

Effective application of cloud computing in developing economy will transform the traditional and distance education model to computer based virtual applications with a focus on e-library service delivery. The Cloud computing is the development of applications that provide a solution for the development of infrastructure for higher education at a lower cost and fewer time requirements (Adrees, Omer and Sheta, 2016). Cloud computing in library services can generate multiple features that will enable Universities to compete among themselves and contribute to the creation of knowledge generation for the development of

any nation. Accordingly, Investopedia (2019) opined that cloud computing services provide users with a series of functions which include: Email; storage, backup and data retrieval; creating and testing apps; analysing data; audio and video streaming; delivering and software on demand. Other newer forms of cloud computing services include community cloud, the big data cloud and multi-cloud (Frankenfield, 2018). ENISA, as cited in Adrees, Omer and Sheta, (2016) defined Cloud computing as a new way of delivering computing resources (network, services, servers, data storing), not a new technology.

**Types of clouds:**

Investopedia (2019) stated that there are various **types of clouds** that are different from each other. These clouds are deployment models and they include the following:

i. **Private clouds**: are reserved for specific library users/patrons. The library's data centre or Information and Communication Technology Centre (ICTC) host the cloud computing services which is provided on a private network.
ii. **Public clouds**: services are provided on servers and stored on the Internet. These are operated by third-party companies who handle and control all the hardware, software and general infrastructure. Only one person has access to the accounts and users can access the services.
iii. **Hybrid clouds:** is a combination of both private and public services. Users are more flexible with this type of deployment model and it helps to optimize the infrastructure and security of users.

There is need for ***cloud security*** that is, the need to protect data stored online against theft, leakage, and deletion. These can be provided through Virtual Private Networks (VPN), firewalls, penetration testing, avoiding the use of public network connections etc. All these will limit or eliminate the following; account hijacking, data loss, data breaches, service traffic hijacking, shared technology, insecure application program interfaces (APIs) etc, which could cause ***threats to cloud security***. Cloud security is key for patrons/ users of the library and other organizations who are concerned about their data safety stored in the cloud. Cloud security is the protection of data stored online from theft, leakage and deletion (Frankenfield, 2018).

Cloud computing has been broken up into three (3) main services which make up what Rackspace call the Cloud Computing Stack arranged accordingly by Giva (2019). They include Software-as-a-Services (SaaS), Infrastructure-as-a-Service (IaaS) and Platform-as-a-Service (PaaS) as can be seen in the figure below:

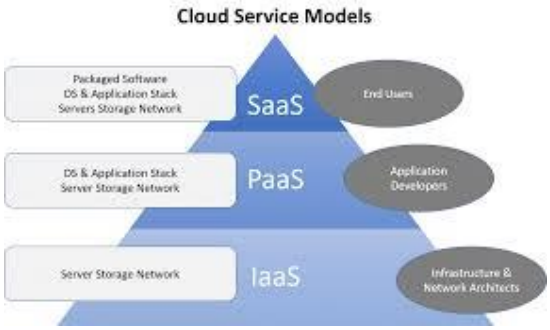



**Diagram adopted from GIVA (2019). The Cloud Stack**: SaaS is on top because users primarily interact with software hosted in the cloud, and not the platform or infrastructure on which it runs. PaaS allow users to create and deploy applications. IaaS is the infrastructure and hardware that powers the cloud. Accordingly, Azure opined that these three main types of cloud computing services are sometimes called the cloud computing stack because they build on top of one another. The first cloud computing type is Infrastructure-as-a-Service (IaaS) which is used for internet-based access to storage and computing power.

**Research Methodology**

In this paper, cloud computing systems were

measured by the method of SWOT analysis. The technique of SWOT analysis determines strengths and weaknesses of any technique, process, or state and is also a strategic technique used to identify the opportunities and threats resulting from internal and external environment. Various sources were consulted to guarantee a balanced review.

These works include published academic journals, academic works, and conference papers. The scope of the work was limited to the strength, weaknesses, opportunities and threats of cloud computing in libraries. The authors retrieved materials for this study between the periods of November 1 – November 18, 2019. Journals searched for includes peer-reviewed and international journals which includes: *International Journal of Computer Applications*, *159*(9), *National Conference on Library Information Science and Information Technology for Education*, 2018 (July), *International Journal of Library Management and Services*, *4*(2), 15–24, *Library Philosophy and Practice*, *2019*(October), *Advances in Intelligent Systems and Computing*, *654*(April), 727–737. Other materials were retrieved from Google Scholar and Researchgate websites. Mainly, the key words used for this study search includes SWOT Analysis, Cloud computing, Innovative Technology and library service delivery. Most of the resources consulted were Open Access materials, some of the materials had a Library and Information Science base while others did not.

**Characteristics of cloud computing**

The following key characteristics of Cloud computing are adapted from Chabrow, (2011).

i. **On-demand self-service**: the user can continuously monitor the server uptime, capabilities and chosen network storage, and also monitor the computing capabilities.
ii. **Broad network (Large Network Access):** the patron/library user can access data of the cloud or upload data to the cloud from anywhere with the help of a device and an internet connection.
iii. **Rapid elasticity**: in some cases, the capabilities available for provisioning appears to be unlimited and can be appropriate in any quality of time.
iv. **Resource pooling**: users do not have control or information over the location of the provided resources but can specify location at a higher level of abstraction (data flair training, 2019).
v. **Resource pooling**: users do not have control or information over the location of the provided resources but can specify location at a higher level of abstraction (data flair training, 2019).
vi. **Measured services**: resource usage can be monitored, controlled and reported. This provides transparency for the provider and consumer (the library patron).

**Application of Cloud Computing in Library Services**

The use of cloud computing to render services in libraries may be of huge benefit but yet it is not that common in the library environment. This technology may be offering the library the opportunity to impact their users with efficient ways of delivering services. The libraries may take advantage of this new technology to increase access to their collections and reduce human efforts and labour. Cloud computing has futuristic projections for the library. Libraries may also upload all the students' projects, theses, rare and historical documents to the cloud after scanning them thereby making them an easily accessible and searchable database to the users and other researchers from across the globe. In the views of Khan (2018) cloud computing services and applications may effectively be applied to the following areas in the library:

**Data Storage:** Libraries make information available to users hence data storage will be very important to them but most times the libraries encounter challenges storing large digital files because they stress their local server infrastructures. The files need to be backed up, maintained and reproduced for the use of their patrons hence moving data to the cloud may be of great benefit to the libraries.

**Library Automation:** For this purpose, Polaris offers variant cloud based services such as acquisitions, cataloguing, process system, and digital contents. It also supports a variety of standards such as MARC21, XML, Z39.50,

Unicode, etc. which are directly related to the field of library and information science. Besides this, currently many of the software vendors, like Ex-Libris and OSS Labs are also providing this service on the cloud and third party services offering hosting of this service (SaaS approach) on the cloud to save libraries from spending large amount in purchasing hardware for this reason. Besides the advantage of saving large amount of money, the libraries will also be free from taking maintenance viz. software updates, backup, etc.

**Hosting of Website:** Many institutions including libraries opt to host their websites on third party service providers instead of hosting and maintaining them on their own servers. Example of such service is the Google.

**Searching Library Data:** The Online Computer Library Center (OCLC) is one of the examples of cloud computing for sharing libraries data. OCLC World Cat service, which is one of the popular services for searching library data, is now available on the cloud.

**Searching Scholarly Contents:** Researchers are now using Knimbus which is a cloud based research platform that also facilitates in discovering and sharing of scholarly contents among peers. It stands for Knowledge Cloud dedicated to knowledge discovery and collaborative space for researchers and scholars. Researchers, Scholars and Scientists are currently using it in a many academic institutions.

**Use of Cloud Computing in Providing Information Services**

Many libraries, organizations, and information centers have adopted cloud computing technology for providing various effective information services to their patrons, users and customers. According to Khan (2018) some of these organizations includes:

**Library Thing:** This is a mixture of cloud computing and social networking facets. It authorizes patrons to contribute information and suggestions about books and allows them share their interests.

**Online Computer Library Centre (OCLC):** Member institutions enjoy sharing of cataloguing tools and catalogue records over the Internet.

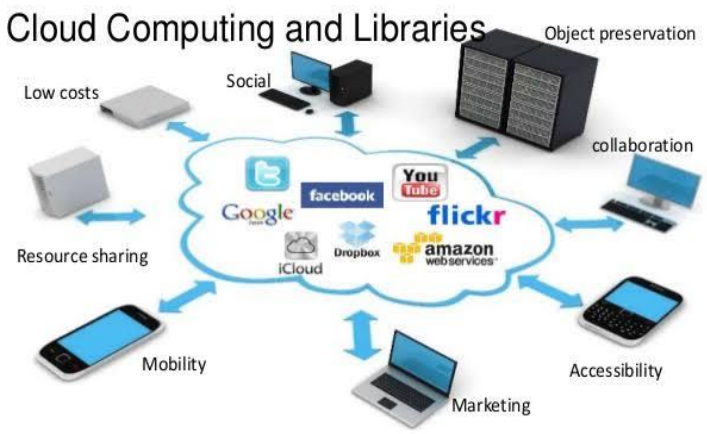
**Google:** It's known all around the world for its efficient search services. Its search engine is quite prominent. Together with its other various services as a part of providing library solutions, it has also implemented *App engine*, and this provides a hosted service for application within its server having massive and highly redundant storage.

**DuraSpace:** This works on Amazon, Sun, Rackspace, and other cloud services, for the purpose of helping organizations and the end users achieve effective utilization of public cloud. It is a hosted service of open technologies, built upon existing cloud services.

**Amazon:** They are in partnership with library automation vendors, develops large scale web services architecture and offers hosting of data services on actual use payment basis. They also provide e-book reading services with *Kindle*, with which a user having wireless Internet connection may download large amount of text and information in a short while.

**Cloud Computing examples in Libraries**

1. Library of Congress (LC)
2. OCLC
3. Exlibris
4. Scribd
5. Polaris
6. Discovery Service
7. Google Docs/Google Scholar
8. Worldcat
9. Encore




**Source: Google Images**

According to (Chudasma, 2019) Library and Information centre now creates institutional repository with duraclouds, duraspace and OCLC's Wordcat which is the best example of searching library catalogue online, Knibus is Cloud based Library Website and research platform used in searching scholarly content, storage services used for storing files and folders in Dropbox, Google drive and Skydrive etc, Other cloud based Library automation software also available are the likes of polaris and Ex-libris services.

**SWOT ANALYSIS OF CLOUD COMPUTING**

The term SWOT can be given as an abbreviation for Strengths, Weaknesses, Opportunities, and Threats. According to Dubey, Verma, Rizvi and Ahmad (2018) SWOT can be defined as a simple model that evaluates what an organization can and cannot do as well as its possible opportunities and threats. With regards to this definition, Strengths (S) and Weaknesses (W) are the internal factors over which an organization has some measure of control while Opportunities (O) and Threats (T) are measured to be external factors over which organization has basically no control over. SWOT analysis therefore is occasionally called Internal-External Analysis. Once this is achieved, SWOT analysis then determines what may help the organization in accomplishing its objectives, and what challenges must be overcome or brought to its lowest minimum to achieve expected results.

**Strengths:**

The strengths are internal factors which according to Albert S. Humphrey may include your organization's advantage over others, what your organization do better than others, any unique resource that you have but others don't have, and what your customers says about your organization with reference to others in the same industry, how do you see your organization among others. According to Pandya and Centre (2015) the strengths of Cloud Computing includes:

- Cost effective
- Flexible and innovative
- Round the clock access
- Simplified Cost and Consumption Model
- Enterprise Grade Services and Management
- Faster Provisioning of Systems and Applications
- Simplicity of Integration
- Highly Secured Infrastructure.
- Compliant Facilities and Processes
- Flexible and resilient in disaster recovery
- Reduces hardware and maintenance cost

Use of cloud computing systems in libraries have made service delivery cost effective in contrast to the traditional library service where the library has to purchase either latest books or subscribe to periodicals which involves huge budget and most times libraries are low on budgets making these library service delivery poor and inefficient. There's flexibility in library services whereby users can have access to resources from any geographical point making the library innovative in their service delivery. There's also round the clock access to the

library materials where 24/7 a user can have access to the library resources through cloud systems. Also one doesn't have to buy all the hardware or spend funds on maintenance of the hardware since both are not done from the user's end.


**Source: Google Images**

On the other hand, (Pal, 2015) listed the advantages of cloud computing as:

- Lower-cost computers for users
- Better performance
- Less IT infrastructure costs:
- Less maintenance costs
- Lower software costs
- Automatic software updates
- Increased computing power:
- Unlimited storage capacity
- Increased data safety
- Anywhere access to your documents
- Latest version availability
- Use your computer from anywhere

The users have access to their data anywhere 24/7/365 but this has to be with the availability of internet connection. Also, users can organize, secure and have full reliability over their data security. The software can be updated easily while users can have access to their data from remote locations.

**Weaknesses:** These are still internal characteristics that goes on to include the things you should avoid, those you could improve on, areas people in your industry are likely to see as weaknesses, these factors could be considered from an internal and external basis which in other words, are the weaknesses other people seem to observe which you don't see and are there areas your competitors do better than you. Some weaknesses of cloud computing include: Data privacy and security, High internet bandwidth, customer care support, Legal Issues, Technical Issues, Vendor Lock, Data handover policy etc (Chudasma, 2019).While in the views of (Sahu, 2018) the drawbacks of cloud computing includes the likes of enormous fear. People and organizations are afraid of putting their information in the hands of third parties. Part of this fear is as a result of issues like whether their information and data will remain confidential, whether they will be stolen or lost being that these data are stored in servers which the parties involved have no domain or ownership of.

On the other hand, Kumar (2018) listed some limitations to cloud computing as Network connection, Control of data security, Additional costs, Integration and Peripherals. Network connection is a big issue here as the client needs reliable network connection to do upload and download services. Any issue with network connectivity, accessing the cloud becomes a problem. Once it's a public cloud, the client does not have control over security of his or her own data and this could lead to hacking. Cloud computing offers cost benefits but it also has some hidden or additional costs as well. Clients are charged extra for data transfer or other services. Over cloud systems, applications needs to be integrated with those on cloud and most times this integration is not as easy as expected while most times peripheral devices like printers and scanners might not work with cloud as most of them require locally with the needed software.

**Opportunities:** Here the opportunities are external features which may include good chances of market growth, exciting trends that one is aware of, Useful openings in the industry which can emanate from Changes in

technology, industry and markets, new government policies affecting your field and industry, Social pattern changes, population profiles, changes in lifestyle and events happening around. Dubey, Verma, Rizvi and Ahmad (2018) gave cloud computing opportunities as:

- Market entry or application deployment is cheaper, quicker repayment of improvement charges, and superior return on investment Overcoming latency limitations.
- Customers will become more aggressive in dropping their cost of both business and personal computing, and will become far more accepting of lightweight client machines running free and open-source operating systems and applications.
- Improving bandwidth utilization.
- Dynamic network monitoring.
- Overall growth in development demand will expand the significance of high-leverage application frameworks that allow quicker development of higher quality products.
- Adaptive to future needs.
- Cloud provides an excellent back-end for mobile applications.
- Optimizing the usefulness and proficiency of cloud computing environments
- Expansion and growth.
- The more effective use of computer resources to help the environment and encourage energy saving.
- The organization can concentrate on serious tasks without having to experience additional costs with respect to IT staffing and training.
- The cloud computing approach speeds the deployment while preserving dynamic flexibility.
- Mitigating identity, privacy, security, reliability, and manageability risks in cloud-based environments, as they vary from traditional data centers.
- Most of the cloud providers replicate user's data in multiple places. This multiplies redundancy of data and data independence from system failure offers a level of disaster recovery.

Entry deployment of cloud computing systems is cost effective being that most times no infrastructure is needed thereby reducing cost of both business and personal computing. Bandwidth utilization becomes more efficient as one's system is not clogged with personal or institutions data. Data replication by cloud providers brings about a good level of disaster recovery service and system failure. Cloud computing provides room for libraries growth and expansion.

**Threats:** These are also external factors that includes the challenges one is facing, competitors' activities, changes in products, services and job standards or specifications, effects of trending technology, bad debt or cash-flow problems, effects of company's weaknesses on business. Hence this could be referred to as the challenges of cloud computing with regards to libraries. Some of them includes: security as the clients wants to be sure of the reliability of their data since the third party is actually in charge. Another point is lack of awareness of cloud computing systems as librarians as well as the stakeholders are not fully aware of this new technology (Anwar, 2019).

In the same view, Attiya (2017) listed challenges to cloud computing as : Security and Privacy, Possible Downtime, Interoperability and Portability (Data Lock-in), Service Availability and Reliability, Lack of Flexibility. Currently, cloud computing provides a wide range of policies, technologies, and standards to protect data, applications, and associated infrastructure of the cloud, still the data stored cannot be a 100% secure. Often times a client faces a situation in which the servers or services are out of our reach. This technical issue is called downtime which even the best service provider of cloud computing cannot absolutely guarantee. Cloud computing is a third party service where dependency on the service provider is one of the major concerns of cloud computing and at this point, there is a 'data/vendor lock-in' where by a user cannot move data or applications out from one service provider to another. Users expect the cloud computing systems to always be available and reliable but are measures put in place to always ensure this service is given as at when required, hence the availability and reliability of this technology becomes an issue of concern.

**Table 1: SWOT ANALYSIS OF CLOUD COMPUTING**

| **Strengths** | **Weaknesses** |
|---|---|
| Cost effective<br>Flexible and innovative<br>Round the clock access<br>Simplified Cost and Consumption Model<br>Faster Provisioning of Systems & Applications<br>Simplicity of Integration<br>Anywhere access to your documents<br>Latest version availability<br>Use your computer from anywhere<br>Compliant Facilities and Processes<br>Flexible & resilient in disaster recovery<br>Reduces hardware & maintenance cost<br>Cloud OPAC | Data privacy and security,<br>High internet bandwidth,<br>customer care support,<br>Legal Issues,<br>Technical Issues,<br>Vendor Lock,<br>Data handover policy<br>Fear of data loss and theft<br>Network connection,<br>Control of data security,<br>Additional costs,<br>Integration and Peripherals |
| **Opportunities** | **Threats** |
| Overcoming latency limitations.<br>Improving bandwidth utilization.<br>Dynamic network monitoring.<br>Technical issues resolution<br>Market entry or application deployment is cheaper, quicker repayment of improvement charges, and superior return on investment.<br>Adaptive to future needs.<br>Cloud provides an excellent back-end for mobile applications.<br>Optimizing the usefulness and proficiency of cloud computing environments<br>Mitigating identity, privacy, security, reliability, and manageability risks in cloud-based environments, as they vary from traditional data centers.<br>The more effective use of computer resources to help the environment and encourage energy saving. | Security and reliability<br>lack of awareness of cloud computing systems by librarians and stakeholders<br>Possible Downtime<br>Interoperability and Portability (Data Lock-in),<br>Service Availability and Reliability<br>Lack of Flexibility. |

From the SWOT Analysis table above, it showed that even though there are threats such as security and reliability issues, lack of awareness of cloud computing systems by librarians and stakeholders, possible downtimes; the opportunities with cloud computing systems cannot be overemphasized, such as using it to solve the challenge of sharing of resources and organization of resources, having access to digital materials from the library users remote sites and other different locations. Hence Cloud computing is a valuable tool for libraries and LIS professionals to provide an environment for effective and efficient library service delivery.

**Conclusion**

The emergence of Information and Communication Technology (ICT) has brought about the issue of information explosion in Libraries while librarians experience the effect of this ICT in their routine day to day library operations and services. One of this ICT revolution is Cloud computing which has transformed the way people save, retrieve and recover data and information. The internet have become a standard tool through patron's access and retrieve data and information available across the globe. With Cloud computing one can spend less on infrastructure by doing away with purchasing of computers and networks. A library with a cloud service provider, has no need to invest funds on information technology infrastructure or in buying hardware or software licenses.

While taking care of the security and privacy of personal information of cloud computing,

Libraries are making serious efforts to offer cloud base services to the users. In today's current information dissemination and retrieval status, libraries have the chance to improve their services with the help of cloud computing. Moreover, cloud computing will be helpful to solve the challenge of sharing of resources and organization of resources. Cloud computing will be concerned with the access of digital materials from the library users remote sites and locations, web tools application for libraries, consortium practices and internet usage which leads to the innovation in library profession.

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