

## Resource Sharing in Libraries on Cloud Landscape: Potentials and Paradoxes

Mayank Yuvaraj

Department of Library & Information Science, Banaras Hindu University.

---

### Article Info

#### Article history:

Received Apr 15<sup>th</sup>, 2013

Revised Jul 10<sup>th</sup>, 2013

Accepted Sep 22<sup>th</sup>, 2013

---

#### Keyword:

Resource Sharing  
Cloud Computing in Libraries  
Models  
Cloud Library products

---

### ABSTRACT

The initial hype of any development can eclipse its practical applications. The present paper attempts to separate the hype of cloud computing and explores the possibilities of resource sharing in libraries through Cloud Computing. The present study is based on the usage pattern of cloud computing in libraries and explores a model for resource sharing. It also proposes a cloud based resource sharing framework for libraries for moving from ground to the amorphous cloud. Although a lot of work has been done on cloud computing yet none of the works has been dedicated to the cause of libraries. The paper presents a comparative study on various library resource sharing practices, library cloud adoption framework as well as cloud based library products and cloud services providers.

Copyright © 2013 Institute of Advanced Engineering and Science.  
All rights reserved.

---

### Corresponding Author:

Mayank Yuvaraj  
Junior Research Fellow,  
Department of Library & Information Science,  
Banaras Hindu University,  
Varanasi, India.  
Email: mayank.yuvaraj@gmail.com.

---

## 1. INTRODUCTION

Commoditization of computing as service, consumerisation of IT and democratization of technology nurtured in cloud landscape has opened the Pandora box of opportunities in library sector. Cloud Computing offers libraries with an ample scope to free IT resources and services. Driven by this new technology trend and the benefits of cloud computing, an increasing number of libraries are shifting their key applications and services to the cloud [1]. Most of the libraries have same collections, services and user groups which coupled with ubiquitous Cloud Computing can be used for resource sharing. Resource sharing in particular is inevitable for the libraries that have limited budgets and can not procure all the library collections.

## 2. RESOURCE SHARING : PHASES OF DEVELOPMENT

The most common reason that libraries participate in resource sharing activities is to complement library collection in response to its user needs and demands for information. The winds of change brought out in the nature of resource sharing were not sudden rather it was catalyzed by various factors. Library is a social institution whose existence rests on the ability to serve the readers with information. The hardships suffered by rising prices of documents and stagnant budgets the concept of *library cooperation* came to light. It was merely confined to inter-library loans. With the coming up of internet and other networks at local and national level the concept of *resource sharing* emerged. Abrupt increase in e-resources catalyzed the pace of information exchange. Further, the onset of ICT opened new doors of library co-operation. One of the promising developments of resource sharing was the emergence of library consortia. However, the Twenty-first century witnessed certain changes where people never knew a world without computers, fast

and spontaneous communications as well as digital media and technologies. It also infested the mindset of library professionals and the users who became digital, always connected, experimental, immediate and socialized informally [2]. There are various driving factors for the changing nature of resource sharing [3]:

*Economic crisis:*

- Reduction in budget which precipitated the need of Inter library loans
- Increase in usage as well as prices of e-journals

*Influx of Active Web:*

- User preferences towards electronic environment
- Speedy and convenient information accessibility
- High depth and breadth of information available through databases

*Technology:*

- Labor intensive document delivery costs
- Reduction in network, system, equipment and software costs

Technology has to unceasingly vacillate and libraries are also infested by it. To keep pace with time and enjoy the flair of technology we need to learn to live with it. The metastasis of resource sharing can be divided into four phases of development:

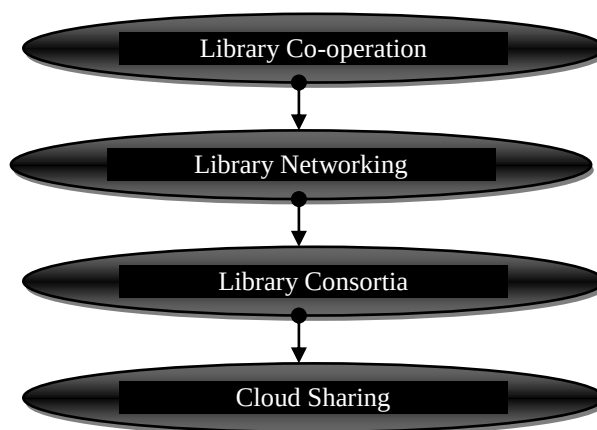


Figure 1: Transition of resource sharing

1. **First Phase of Development** (*Library co-operation*), with the sudden increase in the prices of the documents and the limited availability of funds several libraries came together for the mutual benefit of the respective users. It was a first attempt at library co-operation where library shared their resources.
2. **Second Phase of Development** (*Library networking*), with the development of Information and Communication Technology as well as Computer Technology (Processor, Software and Storage) the formulation, recording, processing and transmission of information process underwent sea changes. Libraries were also not left untouched with these developments and they started developing networks to share their resources.
3. **Third Phase of Development** (*Library consortia*). During the first decade of the 21<sup>st</sup> century, resource sharing continued to be inevitable even in the changing mission and functions of the libraries. The continually expanding availability of electronic resources and digitized materials led to cooperative arrangement among libraries called library consortiums. These consortiums were huge body of knowledge connected by tributaries like e-books, e-journals and e-databases.

- 4. Fourth Phase of Development (Cloud sharing).** Cloud sharing is the set of resources or services made available to the public through cloud which demands simply network connectivity. Cloud computing has offered a new outlook to the prevailing resource sharing problem. It offers efficient and effective information sharing and resources utilization capabilities. Although the concept of cloud computing is recent yet OCLC members were using the cloud for collective cataloging (1970<sup>s</sup>), resource sharing (1980<sup>s</sup>) and maintaining online databases (1990<sup>s</sup>). However, most of the activities practiced in the libraries were already available in the cloud prior to the term cloud computing which later became the front and centre of people consciousness.

According from Lynden [4] has put forth ten characteristics of “real resource sharing”. There is need to study the four phases comparatively with that of characteristics of “real resource sharing” to find out the method that satisfies the user needs the most. A comparative take of the same has been presented below:

Table 1: Compariave study of four phases of resource sharing in libraries

| Characteristics of “real resource sharing”                        | Library co-operation                                                                                                                                    | Library networking                                                                                                                                        | Library consortia                                                                                                                                                          | Cloud Sharing                                                                                                                                                                                |
|-------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Users requirements are most often satisfied                       | With the development of ILL and union catalogue it tried to satisfy the user needs.                                                                     | They developed various library networks at various levels to meet user needs through the network.                                                         | A common group of libraries associated together to provide similar interest group with information.                                                                        | It is a development of previous initiatives by offering ubiquitous platform for information at any place anytime ensuring highest satisfaction.                                              |
| Materials are ready when the user needs                           | To access the materials user has to come to the library during its working hours. There were few chances of getting the document as it might be issued. | To access the materials user has to come to the library and the use was restricted within a campus. There was misue and wastage of resources.             | To access the materials user has to come to the library and the use was restricted within a campus. There was misue and wastage of resources.                              | Information is always and anywhere available to the user. It is independent of library pratisie of providing one book to one user. Various majors are available to check wastage and misuse. |
| Materials are readily available when the user is looking for them | The materials were not readily available.                                                                                                               | The materials were not readily available.                                                                                                                 | The materials were not readily available.                                                                                                                                  | The materials are readily available.                                                                                                                                                         |
| It realizes savings                                               | Huge savings for the libraries and it checked the document as well as redundancy of library activities.                                                 | With the development of library networks it allowed library users to seek information held at other libraries saving the cost of procuring the documents. | With the development of library and publisher consortia there was huge saving for the libraries. Moreover, the consortia were open doors to access integrated information. | It is a blessing for the libraries who can embrace the cloud computing solutions for focusing on services then being involved in IT operations.                                              |
| It reduces costs                                                  | It involved very less use of IT skills and infrastructure so it was cost saving.                                                                        | With the involvement of IT it was a costly affair. Purchasing software and computer terminals increased the library budget.                               | With the involvement of IT it was a costly affair. Purchasing software and computer terminals increased the library budget.                                                | It has readuced the expenditure to procure computing capabilities substantially. Users pay for that much they use. However, most of the cloud infrastructure is open source.                 |
| Resources are increased locally                                   | It fascilitates local sharing of the                                                                                                                    | Resources are shared within a particular campus or over a                                                                                                 | Resources are shared within a particular campus                                                                                                                            | Resources are shared not only locally but globally.                                                                                                                                          |

|                                                                                         | resources                                                                                                 | network.                                                        | or over a network.                                                                                                                                                                       |                                                                                                                                                                              |
|-----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Resources are shared nationally                                                         | There is very less scope of sharing the resources at national level.                                      | It offers ample scope to share resources nationally.            | The resources in consortia are available nationally but they cater to similar needs and are dedicated to a particular subject.                                                           | It is limitless and can not be restricted within geographic boundaries.                                                                                                      |
| Resources of a monetary nature can be procured for the partners                         | It is significant and has high possibilities in all the four phases of resource sharing in the libraries. |                                                                 |                                                                                                                                                                                          |                                                                                                                                                                              |
| Retention agreements are kept in an effective resource sharing plan                     | There is an agreement among the participating libraries                                                   | There is also an agreement between the participating libraries. | It is a joint and collaborative product whose existence rests on sound base of an agreement.                                                                                             | There is no enactment of legislation and agreements in the cloud. For shifting the library services it is inevitable for the participating libraries to go for an agreement. |
| It remains in place and develops a common understanding of the purposes of the project. | All the participating libraries have a predefined set of goals and the purpose of the same is vivid.      |                                                                 | Till now there has not been any formal announcement of the libraries embracing resource sharing. However, in the future it has a high possibility in the library and information sector. |                                                                                                                                                                              |

It is clear from the discussion that cloud computing has lot in store for the libraries. Resource sharing in the cloud will meet the user expectations and ensure optimal user satisfaction. Libraries should realize the importance of the same and take initiatives in this direction and redesign its services and structure.

## 5. CLOUD COMPUTING

Cloud is used as a metaphor for internet. The “Cloud” element of Cloud Computing can be seen as an acronym that stands for C- *Computing resources*, L- that is *Location independent*, O- accessed via *Online* means, U- used as an *Utility* and D- *On Demand* availability. It is a bigger league of effortlessly usable virtualized computing assets (hardware, platforms and services) offered over internet. The cloud is largely a CPU bank on which a hypervisor runs and provides virtual servers on demand via network to users. The user is no more tied to his desk and can access the computing resource such as virtual server or its apps running on a virtual server through any thin/thick terminals, tablets or even handhelds [5]. As a collective term, cloud computing is [6] defined as a style of computing in which massively scalable IT-related capabilities are provided as a service to external customers using internet technologies. Cloud Computing is an epitome of the change in use of IT Infrastructure and Services as the consumers will not have to spend capital of owning or renting the Hardware/Software rather they can use the resources and expense is cut down to usage only [7]. Cloud computing is based on three important principles that depend on each other and can only provide additional value if implemented in concert [8]. These are: automation, virtualization and pay-as-you-go pricing model. Cloud computing has a number of different characteristics, cloud provider that control and hold the computing resource, cloud user access the computing resource over the internet by personal computer, smart phone, laptops, and personal digital assistants [9].

However, at its heart the concept of cloud computing is all about sharing resources, minimizing organizational expenditure and collaboration between networks and organizations which is highly fruitful to libraries. There are [10] three waves of computing: the mainframe wave, when many people shared a computer; the personal computer wave, when each person has their own computer, where each person shares many computers, most of which remain invisible. This was the foundation of the passage of cloud computing.

Cloud computing is an elixir of computing life offering centralization of computing issues & decentralization of computing power. In Cloud Computing an organization performs its task by approaching the required application through a web browser over internet. Somewhere over the internet the applications reside in the cloud which is unknown to the user. The Cloud Computing service provider carries all the computational work and users get the result. In a cloud computing paradigm organizations deals only with the software and does not have to bother about the hardware at all; unless the organization becomes a data centre service providers.

Empowered with cloud computing libraries can gaze a progressive future. We must get out of the business of buying, configuring, installing, and maintaining servers unless we absolutely must do so. We should be simply and easily requisitioning services from the cloud, and immediately and effectively putting them into service.

## 6. CLOUD COMPUTING & LIBRARIES

The advancement of libraries towards cloud is not a sudden phenomenon. The shift of computing strategies and resources from desktops to the cloud was brought by various pre-cursor technologies [11]. Some of the enabling technologies that aggravated the cloud phenomenon are:

1. Inexpensive storage and CPU power.
2. Broadband widely available to the public.
3. Commercial grade virtualisation.
4. Technologies such as Software-Oriented Architectures, HTML, Ajax, UNICODE and CSS

These factors played a pivotal role in allowing cloud service providers to offer their services to the enterprises and organizations. There was a substantial impact on library sector with the influx of IT. It shook the very foundation of the libraries and brought winds of change leading to virtual services. It has been dominant to such an extent that most of the people don't want to come to libraries instead prefer to get services through internet. In such a situation libraries need to adept it to keep pace with the changing needs and to serve people with information in a global cloud ecosystem. The introduction of the internet to libraries was part of a significant shift from print/in-house-focused services to online externally provided services [12]. A lot of researches have been conducted for developing cloud –based digital libraries and information services. Some of them have proposed various models for the same. National agencies like JISC in UK have put forth various flairs of cloud based information services for sharing content and ICT infrastructure in the cloud. A comparative study of existing IT system in the libraries with that of cloud based system has been presented below:

Table 2: Comparative study of existing system to cloud based system in libraries

| Infrastructure        | Existing IT System | Cloud based System    |
|-----------------------|--------------------|-----------------------|
| Server Cost           | USD 19,050         | USD 4,500             |
| Backup Server Cost    | USD 18,900         | USD 3225              |
| Operating System Cost | USD 5,400          | USD 200 (Pay Per Use) |
| Storage Cost          | USD 480            | USD 30 (Pay Per Use)  |
| Networking Cost       | USD 1500           | No significant cost   |
| Total Cost            | USD 38,800         | USD 6500              |
| Complexity            | Complex Network    | Simpler Network       |

Libraries which are service oriented and non-profit institution can benefit largely if they jointly participate in shifting to cloud based systems for their IT needs. Librarians are faced with the challenge of providing better services with shrinking budgets [13]. Fortunately, the developments in information technology (IT) created new opportunities for librarians where they can now provide access to networked information sources that their libraries do not even own. One of the enabling technology for the realization of the same is cloud computing. Moreover, with the increase in server utilization along with data centre efficiency through cloud computing will make the libraries green [14].

To imply cloud computing in the libraries there is need of a holistic approach. There is a limited uptake of cloud solutions in libraries for which there is a need to make choices between where it can be

applied and what can be accomplished. However, it is a strong driver for collaboration and efficiencies that checks system and services redundancy. The library goals to serve users with information needs to be replaced with content. Researchers do not get exact information by searching with journal title or keywords. There is a need for libraries to create joint platform for offering the content as service or platform or infrastructure. A conceptual cloud computing landscape for the libraries has been presented below:

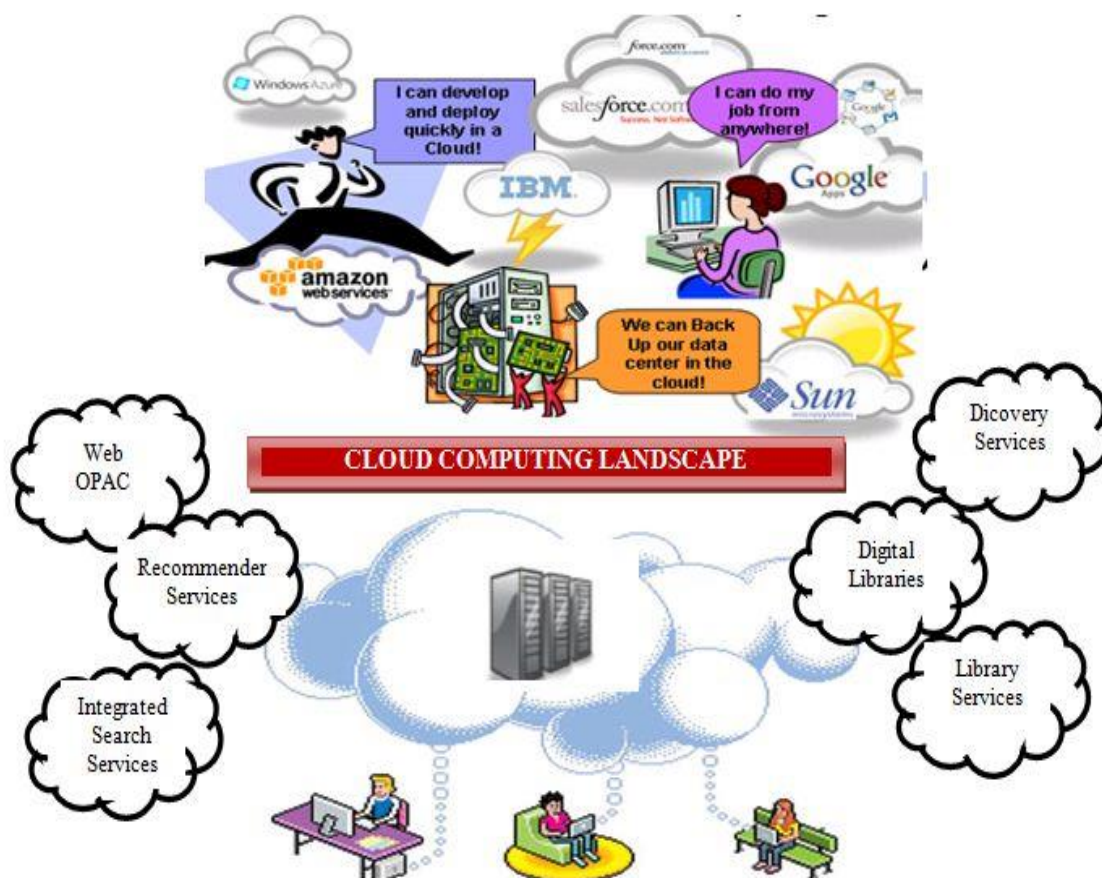


Figure 2: Conceptual framework of cloud computing landscape in libraries

More often with the coming of Google era there is a need to bring all the libraries to the web of data to make the content retrievable. In the coming future libraries need to replace cataloguing with catalanking of documents in the cloud and creating linked data. Linked data could help to uncover the holy grail of library technologies- smart federated search. For years we have been talking about having a "Google-like" search for library resources, well, semantic search could take us far beyond the current string-matching capabilities of search engines like Google [15].

Moreover, library users have shifted their interest from ground towards cloud. There is a tendency among users to remain connected to the Web through cloud services like Web mails (Gmail, Yahoo mail, Sify mail), online storage systems (Skydrive, Idrive, Box.net). There has been sharp increase in the usage of Web-based office tools (Google Docs and Zoho) in the recent times. Further, to keep themselves abreast of recent developments users are using Web-based RSS readers (Bloglines, Google Reader). All these activities are performed in cloud which can be used through a Web browser with internet connectivity. Cloud has evolved as a global entertainment (YouTube, Flickr, Hulu) as well as Social network (Orkut, Facebook, hi5) also. Various platforms in the cloud are offering Web based useful applications: Pando (sharing large files), Adobe Photoshop Express (online photo editors), and Jumpcut (edit videos online). Above all, cloud is being used as open source development network to share the source codes (Drupal).

According to the 2011 Cloud Computing Outlook Survey there has been significant shift in the usage trends of the cloud.

- 61% organizations are in the information gathering or planning stages or have an approved cloud computing strategy (but no implementation), 20% have cloud implementations and 20% have no cloud computing plans at this point.
- Hardware savings was cited as the most popular reason for using cloud-based storage and platform-as-a-service.
- Open source usage is pervasive among cloud computing users with 69% using open source software whenever possible while 3% claim not use open source software at all.
- 59% users use compute cloud, 47% cloud storage and 47% cloud platforms
- Of all participants surveyed the prevalent use for cloud computing was to host websites (57%), followed by document management (39%)
- The top factor influencing the use of cloud computing is scalability (61%), followed by overall cost savings (54%) and easier management (53%)

## 5. NEED OF CLOUD COMPUTING SERVICES IN LIBRARIES

It is an act of bravery to keep pace with the technology which has always an element of dynamicity. Cloud computing in particular has been identified as a method for libraries to embrace new advances in technology both now and into the future [16]. Unconsciously, librarians and users are effectively making use of cloud computing to fulfill their needs. Further, majority of library collections now includes electronic content and the practice of providing one book at a time to the user is not feasible. Through Cloud computing libraries can put their data indefinable which can be accessed from anywhere. Cloud simply offers a bunch of services provided through various universal centers and built on servers [17]. It enables users a facility that often appears as single point of access for customers computing needs and specification.

There is an utmost need to understand the intricacies of cloud computing and the competencies on offer which can be applied in libraries. There is also a need to see the feasibility of the concept. The growing internet usage among library users and the time these users spend on the internet has made it imperative that libraries offer their services online. Users of information have more attractive ways of finding information than using the traditional library. Today, library users are accessing the information needed from the comfort and security of their homes or in their own personal or customized spaces [18]. However there is a futuristic essence in cloud computing for libraries. Cloud computing is beneficial when expertise is lacking and where future computing needs are unsure. It enables libraries to stop dealing with technical issues that have nothing to do with their day-to-day mission and services. [16]

Cloud services allow for more optimal resource utilization, easier access, and more effective cost reduction [19]. The growing internet usage among library users and potential users, plus the time these users spend on the internet, has made it imperative that libraries offer their services online. Today's consumers of information have more alternative and attractive ways of finding information than using the traditional library [20].

The future of computing lies in cloud computing, whose major goal is reducing the cost of IT services while increasing processing throughput, reliability, availability and flexibility and decreasing processing time [21]. Cloud computing will bring an end to the ILS server [22]. Majority of the library core concerns can be solved by shifting to cloud computing and participating in resource sharing. Some of them have been mentioned below:

Recently, OCLC started Web scale management services which can perform the in-house library operations through mutual co-operation. It will provide all its web-scale subscribers with a vendor database which will list their details avoiding data redundancy in libraries. Libraries can work cooperatively in a flexible environment where they can share solutions to problems instead of having to reinvent the wheel at each library [23]. Migrating to a cloud-based application may turn out to be cost neutral but at the same time still have the benefit of allowing staff to concentrate on library-specific issues [16].

Other vendors can take advantage of the cloud. Vendors can provide a remotely hosted service which allows for the creation of modular content, which many libraries wouldn't be able to create on their own. It also lowers the technical skills needed to create web pages. Like other cloud applications it is accessible from any internet connection, so you don't need a client on your local PC [24]. Moreover, through cloud computing instead of having own servers and employing personnel for its maintenance libraries can hire a vendor on a monthly charge and enjoy the benefit of same server function.

A brief list of potential areas of improvement could include [23]:

1. Most library computer systems are built on pre-Web technology
2. Systems distributed across the Net using pre-Web technology are harder and more costly to integrate
3. Libraries store and maintain much of the same data hundreds and thousands of times.
4. With library data scatter across distributed systems the library's Web presence is weakened
5. With libraries running independent systems collaboration between libraries is made difficult and expensive
6. Information seekers work in common Web environments and distributed systems make it difficult to get library into their workflow
7. Many systems are only used to 10% of their capacity. Combining systems into a cloud environment reduces the carbon footprints, making libraries greener

Table 3: Library concerns and its solutions in the cloud.

| No | Library concerns                                        | Solutions in Cloud                                                                                                                                                                                                                                                                                                  |
|----|---------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | Information services                                    | Libraries provided bibliographic and full text databases and stored foreign journals in digital form in the cloud.                                                                                                                                                                                                  |
| 2  | Library networking                                      | Internet and web technologies offered the infrastructure in the cloud to communicate with each other.                                                                                                                                                                                                               |
| 3  | Remote services                                         | Web browsers served as an intermediary in the cloud and enabled libraries to access the pool of resources available remotely.                                                                                                                                                                                       |
| 4  | Data and information monopoly and wastage               | Multiple copies of information to the user anytime could be offered breaking the boundaries through electronic document delivery services. Information and data misuse can be checked through userids, passwords, digitized handwriting, biometrics, voice prints, finger prints and face recognition in the cloud. |
| 5  | Failure of library catalogues to meet user expectations | Creating linked data in the cloud and replacing cataloging with catalinking of the content.                                                                                                                                                                                                                         |

## 6. STANDARDIZATION OF UBIQUITOUS ELECTRONIC LIBRARIES IN CLOUD

There are three active bodies working towards standardizing cloud computing practices in every domain:

- Cloud computing Interoperability Forum
- Open cloud consortium
- DMTF Open Cloud Standards Incubator

There is also a document called the open cloud manifesto in which various stake holders express why open standards will benefit cloud computing [25]. Grossman [26] asserts that the current state of standards and interoperability in cloud computing is similar to the early Internet era where each organization had its own network and data transfer was difficult, which changed with the introduction of TCP and other Internet standards. These were resisted by the vendors just like the fate of cloud computing. Some scholars have [27] has enlisted the difficulties of developing standards. However, cloud computing can benefit from standardized API interfaces as generic tools that manage cloud infrastructures can be developed for all offerings. However, achieving standardized API appears to be rather politically than technically challenging [26].

## 7. GLOBAL CLOUD COMPUTING RESOURCE SHARING MODEL

Models are mental or pictorial representation of an event or phenomenon. Generally models are employed to study such phenomenon which cannot be seen or felt. Models focus on more specific problems than do theories [28]. Cloud computing provides for a cognitive abstraction, providing a collection of geographically dispersed and technically diverse IT resources appear as a seamless single resource [29]. Existing model was developed with a need to figure out to resource sharing process in a cloud landscape. The model is based on three impressions:



- **First impressions:** What users expect from cloud resource sharing?
- **Deeper impressions:** How can library personnel interact with users and provide services?
- **Lasting impressions:** How can libraries develop the cloud computing solutions?

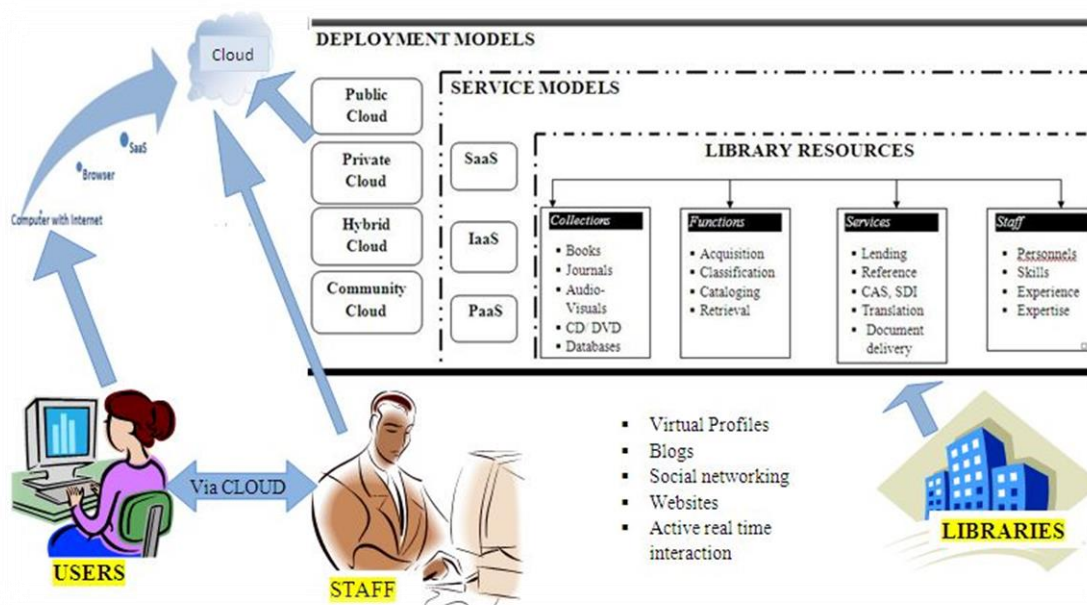


Figure 3: Global Cloud Computing Model for Resource Sharing in Libraries

Library is considered as a trinity of books, users and staff. Whether in the case of digital library or cloud library these elements are elemental to it. In the cloud landscape libraries can make their collections, functions, services as well as their staff available in cloud. A cloud Library services can be grouped into three categories:

1. Documents as a Service (DaaS). In this model, library documents are offered to the customer as a service on demand on a Pay per use basis. Users need to access the library cloud to get the document.
2. Retrieval as a Service (RaaS). Librarians and users are now constantly being bombarded by plethora of information choices. With the seepage of information on the web people are now drowning in a sea of information. For those who feel a drift, libraries are developing metasearch engines, subject gateways or cloud repositories to retrieve the authentic and accurate information. It will be available in the cloud independent of any software requirements.
3. Library Functions as a Service (LFaaS). Library functions and activities are available in the cloud for co-operative, collaborative and coordinated endeavor among participating libraries with a common objective. It keeps a check on duplication and the professional manpower is developed more efficiently.

Network connectivity is a pre-requisite to access the clouds and connect with the library. The term services in Cloud computing is the concept of being able to use the reusable, fine-grained components across a vendor's network. This is widely known as "as a service" [30]. Different service models of cloud computing [31] "renders a variety of possibilities for libraries to engage in this technology" [32].

Three ranges of services are available in the cloud by the cloud providers: (i) Software as a Service (SaaS). In SaaS model, the end user purchases the ability to access and use an application or service that is hosted in the cloud. For example email and few other services offered by Google, Hotmail, Yahoo, Sify, Skype etc. (ii) Platform as a Service (PaaS). In PaaS model, the end user purchases access to the platforms, enabling them to deploy their own software and applications in the cloud. Operating systems and network access are not managed by the consumer. Special platform or application infrastructure is also being provided to the clients. Moreover, client does not require knowing programming language, database management systems, etc. to run applications. Windows Azure, Google App Engine and Force.com are the finest examples of PaaS and (iii) Infrastructure as a Service (IaaS). In IaaS model, consumers control and manage the systems in terms of the operating systems, applications, storage, and network connectivity,

but do not themselves control the cloud infrastructure. In IaaS, clients are being offered with storage, networking and processing of data. Amazon's Elastic Compute Cloud (EC2) or Simple Storage Service (S3), VMWare vCloud are some of its examples.

Any organizations can deploy applications on Public, Private, Hybrid and Community Clouds. There are four main categories of cloud computing [33]:

1. **The public cloud** – IT resources and services are owned by a third party, located off-premise and made available to anyone on a commercial basis as metered services
2. **The community cloud** – IT resources and services are owned and operated on behalf of a community of organizations
3. **The private cloud** – IT resources and services are owned/leased by a single company for its own use. *The internal cloud* – A private cloud where all resources remain on-premise
4. **The hybrid cloud** – A combination of two or more cloud models

A library can opt for any for the models for deploying its services in the cloud. A user can connect with the internet and through web-browser can access the library in the cloud. Further users and library staffs can interact with each other in cloud through blogs, social networking as well as email services.

#### 4. CLOUD RESOURCE SHARING ADOPTION FRAMEWORK

Technology means different things to people at different times, and it can be difficult to imagine what the future has in store for us and the technologies that we are currently using in the libraries [34]. Any organization like libraries when decides to move its services from ground to Cloud there is need of strategic planning and decision taking. To imply cloud computing in resource sharing there is need to frame adoption strategies and framework. A cloud based resource sharing adoption framework has been presented below:

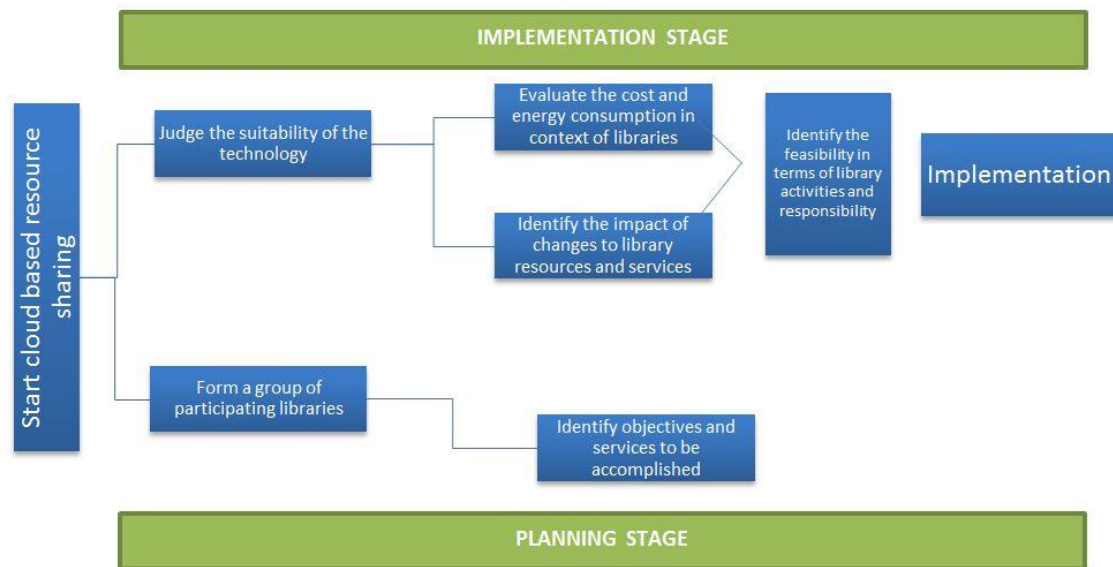


Figure 4: cloud resource sharing adoption framework for libraries

The cloud resource sharing adoption framework is divided into two stages: planning and implementation. In planning stage a group of participating libraries for resource sharing is formed. This group then drafts the objectives and the services that they want to accomplish through resource sharing. After planning of the course for resource sharing we come to the implementation stage. The first step in the implementation stage is to judge the suitability of cloud technology and the library user's satisfaction level. Then an estimate of costs and energy consumption in offering library services in the cloud is found out. Also, the impact of shifting the library services in the cloud is properly evaluated by the participating libraries. Lastly, a feasibility study of cloud based resource sharing is comparatively studied with ongoing library activities and responsibilities in a brick-and-mortar based library. In case of satisfaction the resource sharing activities of libraries are initiated in the cloud otherwise libraries again focus on planning stage and redesign their goals and concern areas.

## 5. KEY CLOUD SERVICE PROVIDERS FOR LIBRARIES

Over a period of time various companies have come to light that attempt to harness the competencies of cloud and apply the same in various services sectors. Some of the dominant ones in the computing world are [35, 36]:

1. Google: Google is the pioneers of cloud landscape which has developed useful utility tools based on Software as a Service (SaaS) and Platform as a Service (PaaS) model to be used in various environments. Varied facets of applications as ad-ons or plug-ins are on offer through google webstores
2. 3 Leaf System: It is being considered as the next generation server solutions for implementing cloud computing. It offers a terabyte of DRAM at a nominal cost leading to a virtualized CPU and memory
3. 3 PAR: It provides infrastructure for storage in the cloud.
4. 3 Tera: It provides the necessary provisions for deployment of scalable clustered applications from anywhere in the world. It is successfully working in seven countries (United States, Japan, Singapore, Argentina, United Kingdom, Netherlands and Serbia) and four continents (North America, South America, Asia and Europe)
5. 10 Gen: It is a commercial entity offering innovative platforms for data storage on web and other applications fast and easy.
6. Adaptivity: It offers integrated solutions that automate IT delivery optimization across enterprise computing environments. Rapid adoption of cloud computing renders a broader perspective. Emphasis is laid on the IaaS type resources managed externally from the enterprise who deliver and consume IT resources.
7. Agathon group: It is a dedicated grid computing environment offering scalability and a charitable character
8. Akamai: It is dedicated to the cause of building a global cloud computing platform making the cherished goal a reality. The cloud optimization services are now a vital part of the company's total offerings. It offers content delivery network (CDN) cache-based technologies. It marks the transition of Akami from CDN to full-fledged cloud computing player.
9. Amazon EC2: Introduction of Amazon Elastic Compute Cloud (EC 2) single-handedly brought virtual computing environment or cloud computing to the very forefront of public awareness by using web services. It runs on Amazon's network infrastructure and allows customers to pay only for what they use
10. Appirio: It acts as catalyst to accelerate the adoption of on-demand cloud computing solutions by offering products and services
11. Appistry: It offers a grid-based application platform that makes it easy to scale-out CPU and data-intensive applications across a virtualized grid of commodity servers.
12. Aptana: It has released its beta version AptanaCloud architected to complement cloud infrastructure providers like, Amazon, Google and Microsoft.
13. Arjuna: It is positioned to help IT towards a world in which internal IT infrastructure can overtime be increasingly subsumed into the cloud.
14. Asankya: It specializes itself in the high speed delivery of Internet-based applications. It provides an Application Delivery Network (ADN) service for leading SaaS companies, cloud storage providers, internal enterprise cloud users and key government entities
15. AT&T: Launched in 2008 it offers next-generation utility computing service with managed networking, security and storage
16. Bluewolf: It is a leading provider of on-demand software deployment services. It offers remote database management and cloud storage infrastructure. It allows users to economically store a virtually unlimited number of files of all sizes through the Salesforce interface.
17. Boomi: It is an integrated SaaS platform that does not require software or appliances.
18. Callidus Software: It is a scalable, secure, subscriber-based model that does not require additional IT resources.
19. Cisco: They are firmly into the Cloud Crowd with the acquisition of WebEx and PostPath.

20. Citrix: They are offering an integrated portfolio of Citrix delivery infrastructure products packaged and marketed to the cloud service provider market.
21. CloudBerry Lab: These organizations are dedicated to the cause of adopting cloud computing technologies by closing the gap between Cloud vendors propositions and consumer needs through development of innovative low cost solutions.
22. Microsoft: One of the leading giants of cloud computing has put forth varied segments of offerings like, online storage (Microsoft skydrive)
23. Open Nebulla: It is used as a reservoir in cloud projects. It is open-source tool for efficient, scalable and dynamic management.
24. Rackspace: It delivers computing power-as-a-service, combining best technologies into a flexible service offering, making computing more affordable and reliable.
25. HyperOffice: It is the first company to offer software-as-service.
26. Jamcracker: It empowers service providers, cloud providers and IT organizations to unify cloud management and delivery of services for their users and staffs.

## **6. CLOUD LIBRARY PRODUCTS**

In cloud landscape a library can offer a range of products. Some of them have been enlisted below:

1. Cloud-based access to library collections through the OPAC
2. Delivery of services as well as documents as an utility
3. Just-in-time during need on demand library services
4. Cloud based recommender system to make user friendly retrieval strategy, for example Bibliocommons
5. Cloud based discovery layers to make the special collections of the library accessible to users which are not catalogued.
6. Cloud based software of citation management enables users to share content, form communities and recommend a resource.
7. Cloud based efficient management and organization of scholarly communications.
8. Cloud based library apps enrich user to access the library data.
9. Cloud based Stack Map, shelf-mapping software enable users in mapping the physical location of a book.
10. Appealing feature of Cloud libraries services includes global accessibility to vast library resources and the inherent resilience to failures.
11. Cloud library services are metered that integrates telemetry as a part of service offerings.
12. CAS and SDI services through emails, RSS feeds or web feeds, Social networking websites and blogs
13. Cloud based self-service for real time queries
14. Global Cooperation in maintaining bibliographic and authority records
15. Global collaboration on decision on collection development, preservation and digitization.
16. Collaborative management of Cloud resources

## **7. BENEFITS OF CLOUD RESOURCE SHARING**

1. Improvement of the library services offered to the users
2. Ubiquitous availability of library resources irrespective of time constraints
3. Increased user satisfaction level
4. Huge saving of efforts and time avoiding duplication of the library resources
5. Overcome budget constraints
6. Focus on library mission and services
7. Freedom of users from visiting the libraries
8. Better interaction and reference services with the users in the universe 2.0

## **8. IMPEDIMENTS OF CLOUD RESOURCE SHARING**

Although, the concept of cloud based resource sharing is in its infancy and has promises of future yet it suffers from certain impediments. These are:

1. Ego of librarians
2. Rigid procedures
3. Lack of awareness of the value of such programs among librarians
4. Closed cloud policy
5. Lack of National guidelines
6. Legal, political and administrative issues
7. Lack of infrastructure
8. Inadequate financial support
9. Low speed of internet connectivity
10. Less prioritization
11. High uncertainty of storing the information on hard disks in the Cloud

As every technological concept, cloud computing is not an exception in terms of trust and security issues. Once data are outsourced to a third-party cloud provider, several concerns arise about security, availability and reliability of data. [37]. The services that libraries can acquire through the use of cloud computing platforms may indeed be valuable, but the cost of internet access, even if bandwidth is not currently at a premium, can become a considerable hurdle to effective provision of services [16].

## 9. CONCLUSION

Cloud Computing is now front and centre of public consciousness. People are using the cloud resources at its utmost unconsciously. Henceforth, there is a need to change according to the winds of change brought by technology. Cloud computing is the future and by 2020 everything is supposed to be in the cloud. For a library, resource sharing seeks to fulfill the greater mission of the library by helping individual libraries. Under such a circumstances there is a need to rethink the structure and nature of library services to ensure optimal user satisfaction and information consumption.

## REFERENCES

- [1] Liu W, Cai H H. Embracing the shift to cloud computing: knowledge and skills for systems librarians. *OCLC Systems & Services: international digital library perspectives*. 2013;29(1): 22-29.
- [2] Oblinger D, Oblinger J. Is it age or IT: first steps toward understanding the net generation. In: Oblinger D, Oblinger J, editors. *Educating the Net Generation*. Boulder, CO: Educause; 2005.
- [3] Kress N, Leon L. A New look at Resource Sharing costs [Online]; 2011. ILDS 12th Conference. [cited 2013 Jan 24]. Available from: [http://www.ilds2011.org/presentations/Leon\\_ResourceSharingCosts\\_ILDS2011\\_2011-09-19.pdf](http://www.ilds2011.org/presentations/Leon_ResourceSharingCosts_ILDS2011_2011-09-19.pdf)
- [4] Lynden F. Will electronic information finally result in real resource sharing?. In: Lee SH, editors. *Emerging Patterns of Collection Development in Expanding Resource Sharing, Electronic Information and Network Environment*. New York: Haworth Press; 1996. pp. 47-72.
- [5] Xoriant corporation . Cloud computing- its feasibility and emerging paradigms. Xoriant blogs. [Online]. Available from: <http://www.xoriant.com/blog/cloud-computing-for-isvs/cloud-computing-its-feasibility-and-emerging-paradigms.html>
- [6] Gartner. Cloud computing inquiries at Gartner. [Online]; 2009 [cited 2013 Feb 3]. Available from: [http://blogs.gartner.com/thomas\\_bittman/2009/10/29/cloud-computing-inquiries-at-gartner](http://blogs.gartner.com/thomas_bittman/2009/10/29/cloud-computing-inquiries-at-gartner).
- [7] Xoriant corporation. "Impact of cloud computing on various domains". Xoriant blogs. [Online]. Available from <http://www.xoriant.com/blog/cloud-computing-for-isvs/impact-of-cloud-computing-on-various-domains.html>.
- [8] Kossmann D, Kraska T. Data management in the cloud: promises, state-of-the-art, and open questions. *Datenbank Spektru*. 2010; 10: 121-129.
- [9] Rahimli A. Factors influencing organization adoption decision on cloud computing. *International Journal of Cloud Computing and Services Science (IJ-CLOSER)*. 2013; 2(2): 140-146.
- [10] Weiser M, Brown JS. *The coming of Age of Calm Technology*. Palo Alto, CA: Xerox PARC; 1996.
- [11] Lyons C. The urban cloud: the feasibility of using a cloud computing infrastructure for urban traffic control systems. [Online]. Available from <https://www.cs.tcd.ie/publications/tech-reports/reports.09/TCD-CS-2009-50.pdf>
- [12] Mitchell E. Using cloud services for library IT infrastructure. *Code4lib journal* [Online]. 2010 Mar. [cited 2013 Feb 4]; (9). Available from: <http://journal.code4lib.org/articles/2510>
- [13] Tonta T. Cooperative Collection Development of Electronic Information Resources in Turkish University Libraries. *Proceedings of 66th IFLA Council and General Conference international federation of library association and institutions*, August, 2000, Jerusalem.

- [14] Abidi F, Abidi H J. Cloud libraries: a novel application of cloud computing. *International Journal of Cloud Computing and Services Science (IJ-CLOSER)*. 2012;1(3): 79-83.
- [15] Byrne G, Goddard L. The strongest link: libraries and linked data. *D-Lib Magazine* [Online]. 200 ; 16( 11/12). Available from: <http://www.dlib.org/dlib/november10/byrne/11byrne.html>
- [16] Moulasion HL, Corrado EM. Perspectives on cloud computing in libraries. In: Corrado EM, Moulasion HL, editors. *Getting started with cloud computing*. UK: Facet; 2010. pp. 3-11.
- [17] Scott HN. Cloud Computing: providing shared resources via internet [Internet] [cited 2013 Feb13]. Available from: <http://ezinearticles.com/?Cloud-Computing:-Providing-Shared-Resources-Via-Internet&id=5423797>
- [18] Beharilal R. Libraries in the clouds? Libraryspace blog [Online]. Available from: <http://libwebteam.blogspot.in/2011/11/libraries-in-clouds.html>
- [19] Vaquero L, Roderio-Merino, Caceres J, Lindner M. A Break in the Clouds: Towards a Cloud Definition. *ACM SIGCOMM Computer Communication Review*. 2009; 39(1): 50-55.
- [20] Sadeh T. Time for a change: new approaches for a new generation of library users. *New Library World*. 2007; 108(7/8): 307-316
- [21] Hayes B. Cloud computing. *Communications of the ACM*. 2008; 51: 9-11.
- [22] Wolf R. Cloud computing. *North Carolina libraries*. 2010; 68(2): 30-31
- [23] Goldner M. Winds of change: Libraries and cloud computing. [Online]; 2010 [cited 2013 Jan 18]. Available from: [www.oclc.org/multimedia/2011/.../IFLA-winds-of-change-paper.pdf](http://www.oclc.org/multimedia/2011/.../IFLA-winds-of-change-paper.pdf)
- [24] Wolf R. Cloud computing. *North Carolina libraries*. 2010; 68(2): 30-31
- [25] Sriram I, Khajeh-Hosseini A. Research agenda in cloud technologies. In 1st ACM Symposium on Cloud Computing [Internet]; 2010 [cited 2013 Jan 27]. Available from: [arxiv.org/pdf/1001.3259](http://arxiv.org/pdf/1001.3259).
- [26] Grossman RL. The case for cloud computing. *IT Professional*. 2009; 11(2): 23-27.
- [27] Keahey K, Tsugawa M, Matsunaga A, Fortes J. Sky computing. *Internet computing*. IEEE. 2009; 13(5): 43-51.
- [28] Case DO. *Looking for Information: a survey of research on information seeking, needs and behavior*. USA: Academic Press; 2007.
- [29] Zissis, Dimitrios and Lekkas, Dimitrios. Is cloud computing finally beginning to mature?. *International Journal of Cloud Computing and Services Science (IJ-CLOSER)*. 2012;1(4): 172-175.
- [30] Velte AT, Velte TJ, Elsenpeter R. *Cloud computing: a practical approach*. New York: Tata McGraw-Hill; 2010.
- [31] National Institute of Standards and Technology. The NIST definition of cloud computing [Online]; 2011[cited 2013 Jan 25]. Available from <http://csrc.nist.gov/publications/nistpubs/800-145/SP800-145.pdf>.
- [32] Lili L. Reference Librarians' Adoption of Cloud Computing Technologies: An Exploratory Study, *Internet Reference Services Quarterly*. 2013;17(3/4): 147-166
- [33] Craggs S. Cloud computing without the hype; an executive guide. [Online]; 2009 [cited 2013 Feb13]. Available from: <http://www.slideshare.net/LustratusREPAMA/cloud-computing-without-the-hype-an-executive-guide-100-slideshare>
- [34] Moulasion HL. Linked data in the library cloud: technology of the future. *Academic library services through cloud computing: moving libraries to the web*. Pre-conference volume. Delhi: Indo American Books, 2013, pp. 24-29.
- [35] Geelan J. The Top 150 players in cloud computing. *Cloud Computing Journal* [Online]; 2009 [cited 2013 Feb 10]. Available from: <http://cloudcomputing.sys-con.com/node/770174>
- [36] Geelan J. The Top 250 players in cloud computing. *Cloud Computing Journal* [Online]; 2009 [cited 2013 Feb 13]. Available from: <http://cloudcomputing.sys-con.com/node/1386896>
- [37] Tsaravas C, Themistocleous M. Cloud computing and Egovernment: a literature review. *European, Mediterranean & Middle Eastern conference on Information system*. 2010: 154-164.

## BIOGRAPHY OF AUTHOR



**Mayank Yuvaraj**, an arts graduate from Delhi University did his post-graduation in Library and Information Science from Banaras Hindu University. He secured the BHU Gold medal in 2011 for securing the highest marks. Presently he is a Junior Research Fellow and doing his research on implication of Cloud Computing in Indian Academic Libraries in the Department of Library and Information Science, Banaras Hindu University. He received the Second best Poster Paper Award on Cloud Computing at ICAL 2013. He was also invited to deliver his lecture on Cloud Computing at 13<sup>th</sup> annual research symposium at University of Kelaniya, Sri Lanka. His research interests include Cloud Computing, Knowledge Management, Social Networking, Information Retrieval and Webometrics.