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# **The Impact of Cloud Computing on Academic Libraries**

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## **Abstract**

With the introduction of computers and other forms of communication technology, library services have undergone a significant transformation. Libraries have been automated, networked, and are currently being converted into virtual or paperless libraries. This article is dedicated to many aspects of cloud computing, including different kinds and applications. There is a discussion about the advantages and drawbacks of cloud computing in academic libraries. The article also includes recommendations for professional librarians and academic libraries across the globe on how to take advantage of cloud computing resources. This article may be of use in the development of cloud-based services for university libraries. The article claims that cloud providers' high quality of service, the expansion of Internet bandwidth, and the rapid transfer of information should all contribute to improving academic library services in the future. Cloud computing is essential for today's information innovation, and it is vital for university libraries.

**Keywords:** Academic Libraries, Cloud Computing, Cloud Based Library Services, Components of Cloud, SaaS, PaaS, IaaS, Models of Cloud Computing, Storage, Security

## **1. Introduction**

Because information and communications technology (ICT) has had a significant effect on library users and the way they seek data. Kids are very familiar with their personal computers, laptops, mobile phones, and tablets with intelligent capabilities in today's world. A fascinating survey was recently conducted by ACCENTURE, a well-known IT management consultancy, to determine what kinds of e-products and facilities society wants to use or purchase in the upcoming year. The results revealed that users are expected to buy fewer but multi-function gadgets such as smartphones, and a significant rise in the use of cloud-based services and applications, such as virtual mailboxes. If one examines the success of Facebook with a critical eye, one may discern why Facebook succeeded, whereas MySpace failed. "Sharing and Innovation" is the motto for achieving success. When we talk about Cloud Computing, Dr. Ranganathan's fourth principle is very applicable. By making information available at any time and from any location, you save the reader's time.

If a user has an excellent internet connection, the services should be designed to be available 24 hours a day, seven days a week. Currently, Dell, an American multinational computer technology company, is working on a project called "Ophelia," which may change the way people interact with computers in the future. Ophelia is a virtual computer that can be accessed from any location. While it is already possible for a person to access their online electronic mail account or update their Facebook status from any computer, this project, Ophelia, would enable users to access their computer and its apps from any linked device. As a result, it is now necessary for librarians to concentrate on delivering proactive services and moving away from standard services to customize information facilities for the benefit of academic society, rather than focusing on finding new technologies to provide services to users.

## **2. Brief History of Cloud Computing**

The ARPANET, a "very" early forerunner of the Internet, was developed by J. C. R. Lickliter in 1969. In the 1990s, companies started providing a cost-effective "Virtual" private network. In the 1990s, virtual computers became popular, and the current cloud computing infrastructure was developed. With the Internet, virtualization has developed and currently defines the construction of a virtual machine that functions as a real computer. CloudCloud was used to represent the blank space between the end-user and the supplier in the early phases. Salesforce pioneered the concept of utilizing the Internet to provide software for end-users. In 1999, Salesforce was a prominent example of the effective use of cloud computing. Companies across the globe are increasingly using CloudCloud for cloud services. For

research initiatives that need fast processors and massive data sets, Amazon, Google, IBM, and numerous institutions have created a Server Farm. In 2007, Netflix introduced its cloud-based video streaming services and supported the "binge-watching" habit. In 2006, IBM and Google created the cloud computing infrastructure concept. It enables users to rent virtual machines and utilize their apps and programs. In support of Smarter Planet, IBM created the IBM SmartCloud framework (a cultural thinking project). Apple has introduced iCloud to store more personal data (photos, music, videos, etc.). Microsoft started promoting the Cloud over TV and made it known to retrieve pictures or videos for the public quickly. The Oracle Cloud was launched in 2012 with IaaS (Infrastructure-as-a-Service), PaaS, and SAAS, the three business foundations.

Two types of public clouds are primarily available. People are served for personal use, and companies are served. Data saved on the CloudCloud may be communicated with friends using smartphones or intelligent computers, including pictures and music. It is simpler and quicker to utilize CloudCloud for many commercial tasks. It comes with ample storage volumes, various project management capabilities, and greater availability.

### Key Players in Cloud Computing Platforms (softwaretestinghelp 2021)

Company	AWS Inc.	Google Cloud	Azure Microsoft
Launch year	2006	2008	2010
Geographical Regions	25	21	54
Availability Zones	78	61	140 (countries)
Key offerings	Some of the technologies addressed include computation, storage, database, analytics, networking, machine learning, artificial intelligence, mobile devices, developers' tools, the Internet of Things, and security.	All of them are technological examples of computing, storage, data databases, networking, big data, cloud AI, tools for ID, security, the internet of objects, and an API platform.	The following examples include computing, storage, mobility, data management, message management, media services, CDNs, machine learning, and artificial intelligence.
Compliance Certificates	46		90
Annual Revenue	\$33 billion	\$8 billion	\$35 billion

## 2.1 Ideas of Cloud Computing

Cloud computing "is a phrase that is being used today to describe the act of storing, accessing, and sharing data, applications, and computing power in cyberspace." -Pew Internet Trust.

A Web Service "is a software system designed to support interoperable machine-to-machine interaction over a network"-w3c.org In common terms, Cloud computing containers are well-defined as "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction." (NIST) "cloud computing as a style of computing in which scalable and elastic IT-enabled capabilities are delivered as a service using Internet technologies" -Gartner IT Glossary.

It is a system that uses virtual servers as the infrastructure and makes them accessible to third parties through the internet.

## 2.2 Types of Cloud Computing Services

- ◆ The raw computational capabilities of Infrastructure-as-a-Service. IaaS clients are typically technology firms with a lot of IT knowledge. The objective is to have access to computer power without installation or maintenance obligations.
- ◆ PaaS enables the writing of computer systems software that is needed. This cloud-based solution allows companies to build software to integrate current apps. The surroundings of PaaS include.NET, Python, Rails, Ruby, and Java.
- ◆ Software as a service is not a computer's hard disc but a cloud program or application suite.
- ◆ Desktop as a Service is a business model that licenses the software. DaaS is a slightly improved model of SaaS, mostly involving the use of multiple services at the same time necessary to complete the work. It was first introduced in the early 2000s.

The IaaS service providers entrust:

1. Hardware for computer systems
2. Internet protocol (IP) is used to communicate between computers (including routers, firewalls, internet-users load balancing etc.)
3. Internet access is available.
4. Service level agreements, among other things.

Rather than buying servers, software, network equipment, etc., librarians may rent them. The service is usually paid monthly, like phone or power. Rackspace, Amazon, VMware, and

Digital Commons.

### 2.3 The main advantages of IaaS include

- Quickly gain access to a pre-configured natural environment often created on the Information Technology Infrastructure Library framework, a custom-built outline of best practices intended to encourage high-quality computing essential services in the information technology industry.
- One may get the advantages of the most recent technologies accessible for infrastructure kits.
- More minor expenses that enable you to depreciate facility charges rather than creating investment expenditures are desirable.

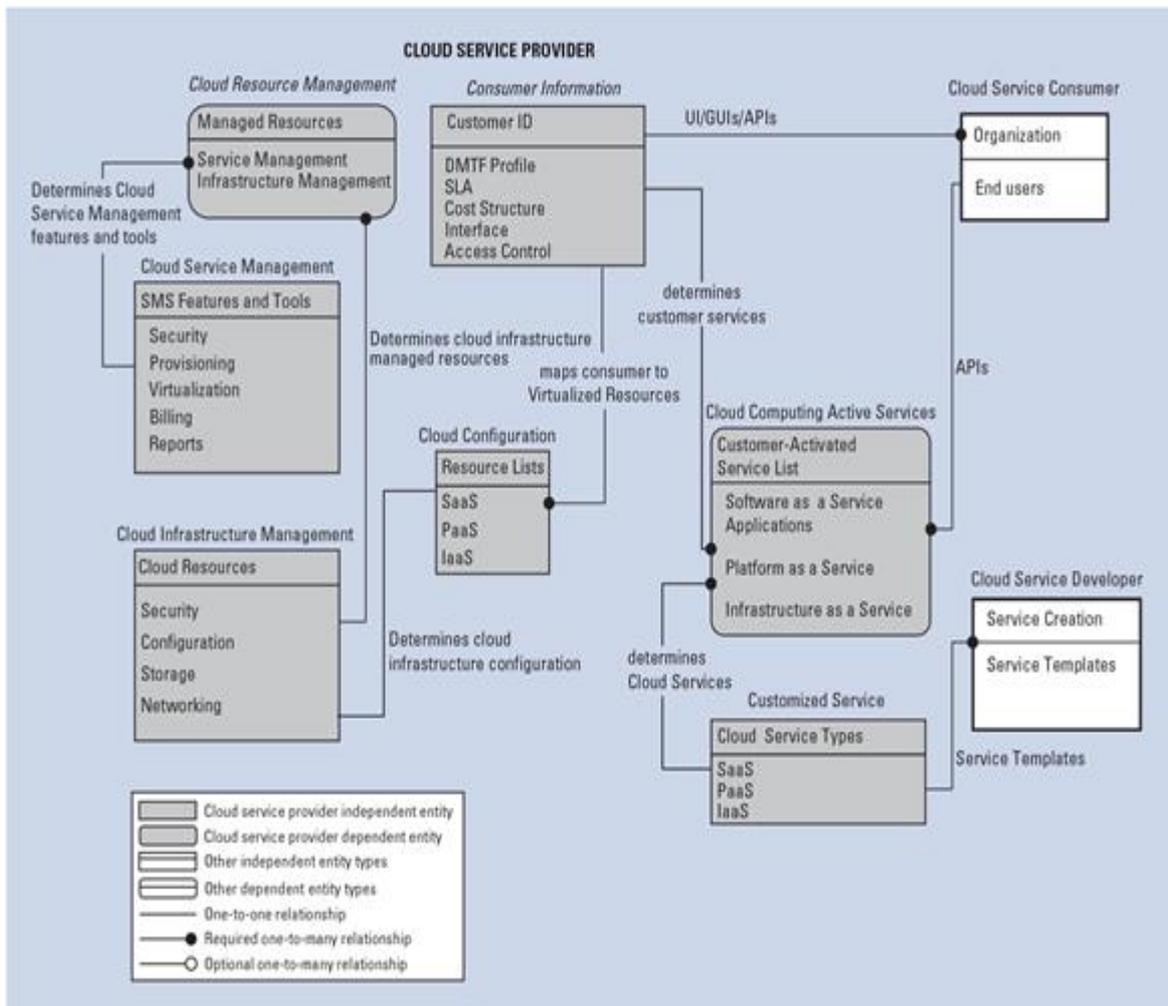


Figure1: Cloud computing logical diagram (Samba, A. 2011).

### 2.4 Cloud Deployment Models

In other words, Cloud deployment models define the kind of access to the Cloud, i.e., where the Cloud is physically situated. You may access the Cloud in four ways: public,

private, hybrid, or community based. The Cloud is available in all four kinds of access. The most significant distinctions are found in the breadth and accessibility of cloud services and how they are produced accessible to end-users.

**3. Cloud Computing in the Public domain with** the use of the Public Cloud, it is possible to make systems and services readily accessible to the public by making them available via the internet. Because of its openness, the public Cloud, for example, e-mail, may be less secure than other types of cloud computing.

### **3.1. Cloud Computing in a Private Environment**

Systems and services inside an organization may be made accessible to other organization members via a Private Cloud infrastructure. It offers a greater degree of security because it is private.

### **3.2. Community Cloud**

The Community Cloud makes it possible to make systems and services accessible to many organizations simultaneously.

### **3.3. Cloud Computing in a Hybrid Environment**

A hybrid cloud combines public and private cloud resources. Non-critical operations are performed in the public Cloud, whereas essential activities are performed in the private Cloud.

### **3.4. Characteristic of Cloud Computing**

- **On-demand self-service:** When needed, users may utilize cloud computing services without the participation of any provider. Computing services should be fully available on-demand to meet changing needs.
- **Broad network access:** Network-wide access to cloud computing services and anybody with selected tools (e.g., laptops, desktops, smartphones, etc.).
- **Resource pooling:** One of the most attractive features of cloud computing is the capacity to scale computer services. Requirements rely on resource consumption such as storage, memory, processor, and bandwidth.
- **Rapid elasticity:** Flexible allocation of resources is necessary. The ability to absorb significant spikes and decreases in demand is needed without service interruption or quality decline.

- **Measured service:** Cloud computing services are assessed using a utility model and measured. This measurement enables the service supplier (and customer) to monitor expenses according to resource requirements and consumption.

#### **4. Cloud Computing and Academic Library Services are two topics that have come up recently.**

- **Data:** Preservation, scientific and managerial aspects of digital technology; bibliographic information; licensing access; and other aspects.
- **Content:** Collections, subscriptions, digital print, and publishing are all examples of what we do.
- **Services:** The library is essential for a physical location, material access, content production, teaching, research, and preservation.
- **Experience:** Research, study assistance, peer-to-peer cooperation, and information technology exploration

##### **4.1. Cloud-Based Library Services**

Cloud computing is receiving considerable attention because it can alter how librarians provide users with new technologies and information needs. According to recent research, the number of Cloud Storage Subscribers would reach 1.3 billion by 2017. Cloud computing not only changes library service models but also affects hardware and maintenance. Unless a real need exists or data security is a top concern, Cloud Computing eliminates the need to purchase, configure, deploy, and manage physical servers. So, the main aim of Cloud Computing is to enable you to focus on the study and growth of new essential services rather than knowledge to provide them to customers. Before using the Cloud, one needs to understand the storage and service expenses. Currently are several standard storage services (price).

The Cloud has created considerable interest in library applications. Within five years, all library collections, systems, and services will be cloud-based. We may create or construct new services or assist academic services. Cloud Computing's most important benefit is to free libraries from a load of dealing with technological problems that do not relate to their mission and services. Cloud-based apps are included, and users are invited to investigate and deploy them according to their requirements. We have chosen some cloud computing applications and services that our library community believes will improve its offerings.

#### 4.2.Storage Service Comparison on an Annual Basis

Cloud Storage Providers	Storage space plans	File Upload Limit	Price
pCloud	10GB to 2TB	2TB	Free storage of 10GB. Annual Plans: \$3.99 per month for 500 GB and \$7.99 per month for 2TB. Lifetime Plans: One-time fee of \$175 for 500GB and \$359 for 2TB.
Sync.com	1 TB to 10 TB per user.	Any size	Standard: \$5/user/month,
Livedrive	Unlimited cloud storage.	--	Business Express:\$50 per month. Business Standard: \$160 per month.\$1.67 /month for 150 GB.
Icedrive	150GB, 1TB, 5TB.	No limit.	
Polarbackup	1TB, 2TB, 5TB.	4GB for basic plan &unlimited with the advanced plan.	1TB: \$39.99, 2TB: \$59.99, 5TB: \$99.99/all lifetime
Zoolz BigMIND	100 GB to 10 TB	No limits	Starter: \$15/month, Standard: \$20/month, Premium: \$37.5/ month, & Smart Archive: \$40/month.
IBackup	10 GB to 10000 GB	2 GB	It starts at \$9.95.
IDrive	5GB, 2TB, 5TB,250GB, 500 GB,& 1.25 TB.	2GB	Free: 5GB IDrive Personal 2TB: \$104.25. IDrive Business: \$149.25.
Amazon Cloud Drive	100 GB, 1TB, etc.	--	The storage plan starts at \$19.99 per year for 100GB storage
Dropbox	2GB,1TB, 2TB,3TB,	Unlimited	Plans for Individuals starts at \$8.25/ month. Plans for teams start at \$12.50/user/month
Google Drive	15GB,100GB, 200GB..Till Unlimited.	5TB	Free for 15GB. 200GB: \$2.99 .2TB: \$9.99. 30TB: \$299.99/per month.
OneDrive	5GB,50GB, 1TB,6TB,& Unlimited.	15GB	Free: 5GB.The paid plan starts at \$1.99 per month.
Box	10GB.	5GB	Free for 10GB.The paid plan starts at \$10/month.

#### 4.3.Google Apps

As a robust cloud service provider, Google today rivals Amazon and Microsoft in terms of cloud computing and apps that the community may use to improve their essential services.

- **Sites:** Create a fully functional website using Google Sites. A rare collection can be scanned into searchable papers and made available to researchers. Any news item or institutional document can be scanned and uploaded to Google Sites for free.
- **Calendar:** You may build a year-long library calendar with events.
- **Form:** Organize events, distribute surveys, quiz students, or gather data using Google Form. Forms and spreadsheets may be linked. If the form is connected to a spreadsheet, answers are immediately transferred there. "
- **Chat:** A reference librarian may utilize this chat service to help people find information ONLINE.
- **Doc:** You may build your papers and share them with others. Subscribe, modify, or see it.

**4.4. Mendeley (Reference Management Software)** Reference management and social networking for academics that is completely free. Mendeley is a research organization tool that also allows you to interact online and discover fresh research.

**4.5.**Dropbox enables you to store, synchronize, and retrieve files in the cloud using customer apps. To ensure consistency, Dropbox enables employers to run on each computer a specific folder that Dropbox then syncs, making it seem to be the same folder, regardless of which machine it is used to run (with the same information). The contents of this directory may be accessible via a website and mobile applications. (Wikipedia)

**4.6.**YouTube has become the most popular site for online, mobile, and email viewing and sharing of videos. It allows you to produce and distribute YouTube videos efficiently. Using the YouTube API, you may also use YouTube video content on your website, app, or device. YouTube is used for most NPTEL videos.

**4.7.**The Client for Windows, Mac OS, and Linux desktops is a free, open-source email and calendar client. It works online as well as offline and can be synchronized with the iPhone and BlackBerry.

**4.8.**Your library is iBookshelf. A complete book database that people like you have created and maintained. Select how to display books. You may browse your library for books and track whom you lent or borrowed from them. The manual or automated entry of a new book (by entering the ISBN). It also says where to purchase it, how much it costs, and where to get it at a library! It even informs you.

**4.9.**On Facebook, users may create profiles, post pictures, send messages, and stay in contact with family, friends, and colleagues. The website is accessible in 37 languages and includes public features. You may also build and sell your own page. The library may communicate news and events using the Facebook application. A library may provide a chat service live via Facebook.

**4.10.** Microsoft Office 365 *Microsoft Office* is a subscription service that may be accessed from anywhere at any time. Audio, Video Conference and IM are available. The website offers a free trial.

## **5. An Example of Cloud Libraries**

**3.1.OCLC:** Cloud computing enables quick application processing and data collection across server clusters. These apps use cutting-edge technology. Our Hadoop/Hbase library databases. It distributes Web applications and APIs across global data centers. It uses WorldCat, the largest bibliographic database. Because it has a database of over 3 billion library items, it allows libraries and developers to improve "big data" applications. Tech helps library workflows. Due to the widespread use of OCLC services, our application developers deal with a wide variety of software. 600+ institutions use our cloud-based library management service. We also have a user-friendly library search engine called WorldCat Discovery.

**3.2.Library of Congress:** Libraries are using cloud-based storage systems to manage their data. The Library of Congress has unveiled a hybrid cloud storage strategy. Librarian In the cloud, "we are looking at a range of storage capabilities." Google's Library Project scans rare and out-of-print books. If the book becomes public domain, it will appear on Google Books. Patrons may see 700,000 free photos on 80 NYPL websites.

**3.3.ExLibris:** A new open architecture from Ex Libris®, a ProQuest business, allows applications developed by Ex Libris community members and partners to operate within the Ex Libris higher-ed cloud platform. Ex Libris Alma® library services platform will include the first Cloud Apps in August. Since the Ex Libris App Center launched last year, the community has contributed over 60 applications, helping users fulfill important and evolving institutional requirements. Cloud Apps' open architecture enhances the openness, agility, and flexibility of the Ex Libris higher-ed cloud platform.

**3.4.Polaris:** Polaris may now display e-books alongside print items in the PowerPAC or MobilePAC online catalogues, together with the necessary services. In other words,

the results of a catalogue search will include both print and electronic versions. You may put holds or requests for items that are presently charged out to another customer. If an e-book is found in the search, the patron may instantly check it out or request notice if no copies are available.

**3.5.Scribd:** With Scribd, you can access over 1,000,000 eBooks and audiobooks from any location. It is a cloud-based service. Scribd provides access to a limitless number of books, audiobooks, periodicals, and other resources. Science and technology. Titles that are not fiction. A trial for 30 days is free. Maintain Children's Interests—titles in the workplace and money. Anxiety should be managed.

**3.6.Discovery Science:** Discovery Science Channel is a pay television channel in the United States that Discovery, Inc. owns. A wide variety of programming is available on the channel, including programs concentrating on wilderness survival and ufology, manufacturing and building, technology, space exploration, prehistory, and animal science.

**3.7.Google Doc and Scholar:** Higher education has a significant role in preparing students to learn online. Nowadays, education is internet-based. The Internet empowers students to own their education. Cloud computing is based on sharing. Google Docs allows online document sharing. Students must comprehend the potential of cloud collaboration and the rules of teamwork. Online collaboration applications allow students to work in teams from anywhere and anytime. It also benefits pupils' education. Lessons can be shared via Google Docs. Online collaboration tool for group assignments, seminars, review presentations, documentation, and dataset creation (Nithya, P., & Selvi, P. M. 2017).

**3.8.Encore:** The *Encore feature* is a tag cloud based on library subject headings and community tags that helps users to conduct related searches for items. Encore 3.3 and higher libraries can use deep article integration, whereas Encore 4.0 showcases the newest functionalities.

## 6. Advantages

**6.1.Back up and Restoration:** Cloud Backup helps safeguard your library information from fire, flood, or other natural or artificial computer disasters. If backed up and securely preserved, your data may be quickly recovered.

**6.2.Better Movability:** library personnel and customers may connect to the library servers from anywhere instead of being connected through a PC and internet connection to their workstations.

**6.3.Cost Saving:** Organizations get paid gradually for cloud computing technologies. It provides price reductions because of economies of scale, with organizations paying solely for their resources. The infrastructure costs may also decrease from 70% to 30%, say experts—Cloud computing.

**6.4.Easy installation and maintenance:** no separate server room and no UPS batteries or air conditioners. Easy installation and maintenance. Library employees may use the additional time to build creative new services. It also reduces energy use since actual servers do not reside on your premises. The service is free.

**6.5.Flexibility:** Cloud computing is more flexible than local network computing and saves time and money for businesses. For instance, libraries may request more server capacity at any time.

**6.6.Highly Automated:** As new versions are available; a cloud service provider upgrades the program. When you update the server, everyone who uses the service receives the latest version without any changes. Australia, Ireland, and New Zealand.

**6.7.Increased Storage:** You need more storage space and retrieval as your collection is growing. There is limitless storage space. You can store more data on the cloud than on your network. In an emergency or emergency, it's a good idea to have a backup plan.

**6.8.Shared Resources:** Cloud computing enables you to share resources and build collaborative strength. They all have comparable subscriptions when you look at ten university libraries in an individual state. Cloud computing enables individuals in and out of organizations, if they have access to a high-speed Internet connection, to access resources anywhere and at any time. Several libraries may pool their resources to enable the use of additional resources by their users.

## 7. Issues

The Internet and electricity are essential. Here are some significant cloud computing challenges:

**7.1.Bandwidth and Network Connectivity:** Cloud Computing is an internet-based cloud computing service. It wanted to operate services on Cloud computing. 1 MBPS internet bandwidth since the connection to the Internet can not be run at a low speed.

You may not be able to access your application, information, or services for some time when issues arise.

**7.2.Connaissance and integration:** For many companies, cloud computing represents a new method of working. Equipment used in data centers to host data with peripheral systems such as printers, USB drives, etc., is tough to integrate. Cloud computing expertise is vital since the service depends on the operator.

**7.3.Cost:** According to a study from Scotland, companies may wind up paying higher costs in the future.

**7.4.Dependence on external agencies:** third-party services are challenging to manage cloud services via the Internet. According to a study from the Department of Homeland Security, it is almost challenging to monitor maintenance levels and the frequency of maintenance of service providers.

**7.5.Limited flexibility:** The new study from the Department of Works and Pension states that all clients will utilize the cloud in the future to offer services of the same quality as other businesses, such as Google and Facebook. Limited flexibility:

**7.6.Long-term service provider stability:** If the service provider disconnects or discontinues its services, data migration from cloud to cloud may be problematic because of compatibility concerns. According to IT experts, the service provider also plays an equal role in its stability. All data will need to be moved to another provider if the service provider ceases.

**7.7.Safety of data and confidentiality:** The security and privacy of cloud computing are two of the significant issues. Cloud data is susceptible to malware assault, theft, etc. Due to incorrect backups and the breakdown of systems, there is also a danger of data loss.

**7.8.Unavailability of service due to power outage:** It is hard to access the application and services without a power supply. Entire library activities may be interrupted because of power failure. The service cannot be used for up to hours if there is a power failure.

## **8. Conclusion**

Security and privacy are important issues for cloud computing, especially when dealing with sensitive information such as consumer credit card information. If there is still no appropriate security template, the data saved in the cloud may be assaulted by viruses, theft, and other kinds of fraud and identity theft. In addition, because services are delivered via the Internet,

the reallocation of servers and software can not be identified, and a security audit can not be carried out. In addition, owing to inadequate backup and system failure, there is a risk of data loss.

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