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Cloud technologies and its impacts: An useful research analysis

R Krithika**Abstract**

Cloud computing is a next-generation technology based on the internet and network. It has emerged as a new paradigm of computing that provides services to the user over the internet. The user accesses these services from anywhere, at any time, using a variety of devices. This technology has a lot of advantages such as reduced cost, on demand services, high speed, etc. Cloud computing technologies have grown rapidly over the past few years and are being used as the solution in many fields. Public services linked with Cloud Computing grew from \$9 billion to \$40 billion over the last five years [2]. In businesses, cloud technologies provide a way to manage the resources online. Therefore, data can be accessed anytime and anywhere. Social media applications like Twitter and Instagram use cloud technologies in one way or the other. Shopping, health care, education and communication are some other the fields that cloud technology has left a positive impact on. The impact of cloud technologies is almost everywhere and it continues to evolve. This research paper talks about cloud computing and contains a brief information on cloud technologies and its impacts.

Keywords: Cloud computing, cloud technologies, impacts of cloud, SaaS**1. Introduction**

Cloud computing is the practice of storing, managing and processing data using a network of remote servers on the internet, instead of using a local server or a personal server [1]. The technologies that use cloud computing in them are known as cloud technologies. "Cloud computing is a model for establishing ubiquitous, convenient and on-demand network access to a shared pool of computing resources that can be configured and rapidly provisioned and released with minimum management effort or interaction with service provider" (Mell & Grance, 2011) [3]. A load of service is handled by the networks which forms the cloud and that's why the load on computers is not heavy while running the application [4]. It recognized as a self-service system among the already available internet platforms [5].

Cloud computing technologies have been quickly evolving over time and have been changing the nature of various sectors such as business and social media. . It is a revolution in the world of technology. They are used in many application domains because of their pay-per use model which offers scalability and cost-effective solutions [6]. A huge number of organizations, governmental and non-governmental agencies, etc were expected to depend on cloud technologies for more than half of their services by 2020. Cloud technologies represent a transformational shift in Information Technology and is rapidly changing the way in which organizations and agencies deliver IT services over the internet. Many companies have started using cloud technologies nowadays because it offers them with dynamic and scalable resources using internet-based services and a lot of benefits such as-better collaboration between business units, geographic expansion, and improved services for customers, increased agility and time to market and process efficiency. A brief introduction about the different sections in this research paper is given below.

- A) **Why should we use cloud technologies?:** This section discusses about the characteristics and the advantages of cloud technologies.
- B) **Objective:** This section discusses about the objective or goal of cloud technologies.
- C) **Cloud service models:** This section talks about the different service models in cloud i.e., SaaS, PaaS and IaaS.
- D) **Types:** This section explains about the different types of cloud such as the public, private, community and hybrid cloud.
- E) **Background:** This section talks about the past of cloud technologies and how cloud technologies developed over the years.

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- F) **Cloud service providers:** This section is about the different cloud service providers and mentions about the different services that are offered by them.
- G) **Impact of cloud technologies on various sectors:** This section discusses about the impact that cloud technologies on different sectors.
- H) **Challenges faced by cloud technologies:** This section explains about the different challenges that are faced by cloud computing technologies and provides with solutions for these problems.
- I) **Future of cloud technologies:** This section discusses about the trends in cloud computing technologies that might be increasingly used in the near future.
- J) **Conclusion:** This section gives an overall conclusion for the paper.

2. Why should we use cloud technologies?

Companies and organizations generally prefer cloud computing technologies because of its following characteristics ^[7]:

- A) **On demand self-service:** Customers are able to provide themselves with the computing capabilities, without any human interaction with the service provider.
- B) **Broad network access:** It does not require any special devices to access its services. The services are available over the internet and can be accessed from any place, through any kind of device such as mobile phones or laptops.
- C) **Resource pooling:** The services are pooled together in order to serve multiple customers using a multi-tenant model, with different kinds of resources assigned and reassigned dynamically. These resources include storage, virtual machines, memory, etc.
- D) **Rapid elasticity:** The services are elastic and hence can be provisioned and released easily on demand. It can also be done automatically to quickly scale in and scale out.
- E) **Measured service:** Cloud systems can automatically control and manage the resources by leveraging a metering service at some level of abstraction.

Apart from the characteristics that are mentioned above, it also has the following advantages ^[2, 8].

- A) **Low cost:** The expenses for the company while using cloud technologies are far lesser than the traditional methods since the resources are acquired only when needed, and paid for when used. There are no up-front expenses since the infrastructure is not purchased, thus reducing the cost for building the infrastructure and maintenance cost .
- B) **Flexibility:** Cloud technologies are very flexible. The customers can decide which services they want and pay for it accordingly. The cloud takes care of the changing demands of its customers by providing them with different types of resources. If the customer is not satisfied with any type of cloud, then they can shift to a different cloud environment. The testing and deployment of the cloud is also easy .
- C) **Scalability:** The companies do not have to worry about the demands of the future since cloud technologies are easily scalable. The companies can easily scale down the available services and scale up if any additional services are needed. Thus, they will be easily able to

manage the increased demands of the future. This is one of the major advantages of cloud technologies.

- D) **Better mobility:** Cloud services can be accessed from a variety of devices as long as they have an active internet connection. This leads to easier and flexible work culture since the employees can work from anywhere without having to be present at the office physically.
- E) **Easier upgrades:** The cloud providers take care of the upgrades in the infrastructure and the cloud services. It is made sure that the new trends and solutions are always available to the customers. Therefore, the customers do not have to worry about adopting to latest technologies.
- F) **Ease of communication:** Collaboration among the employees is increased because of services such as instant messaging, audio and video conferencing. Hence, they can work on the documents together, which will enhance the teamwork and cooperation among the team members.
- G) **Disaster recovery:** The cloud service providers take care of the security and any issues that clients put forward. Thus, the companies do not have to worry about planning for disaster recovery.
- H) **Environment friendly:** Since the cloud technologies are flexible, the businesses are able to use only the required space. Hence, the carbon footprint is decreased thus making it environment friendly.

3. Objective

The objective of the cloud technologies was to provide computing as a basic utility, in the same way like how other public utilities such as gas, water, sewerage and electricity are provided. This idea of utility computing has been around since 1960s ^[9]. Cloud computing moves computing and data away from the desktop computers and portable personal computers into large data centers and manage the work from remote locations. It comes with a lot of benefits from both customer point of view and business point of view ^[10]. It offers faster innovation, flexible resources and economies of scale ^[11]. Cloud technologies have been evolving ever since it has been invented and is continuing to evolve. A lot of companies have started to be a part of the cloud environment by migrating from the existing systems, apps, data and services to the cloud.

4. Cloud service models

The services provided by the cloud have been divided into three types – IaaS, PaaS, and SaaS. The three models have been discussed in detail:

- A) **Software as a service (SaaS):** SaaS service model involves deployment of software over the internet so that it can be accessed by various organizations as a pay-per-use model. The users do not have access to the infrastructure which is being used to host the software. Google docs is one of the most popular examples that uses this type of model ^[9].
- B) **Platform as a service (PaaS):** In this type of service model, cloud computing providers deploy the infrastructure and software framework and businesses can run their own applications. It uses a high level of abstraction which allows them to focus on their applications and not on the infrastructure. Like SaaS mode, even PaaS model users do not have control or

access to the underlying architecture. This is ideal for business environments where multiple developers are working on a single project. Microsoft Azure is one of the popular examples that uses PaaS model [9].

- C) **Infrastructure as a service (IaaS):** It provides us with on demand flexible increase or decrease in the capacity of the server, according to space [12]. It provides us with the fundamental infrastructure of virtual servers, data storage devices, memory and operating system. It has a low level of abstraction when compared to PaaS model which enables the users to use the infrastructure using virtual machines. IaaS has more flexibility when compared to PaaS but the users are responsible for updating and patching the operating system. Amazon web services is one of the popular examples for this type of model [9].

5. Types of cloud

- A) **Public cloud:** It is exclusively used by one organization [9]. It is available through internet, from a third party service provider. It is very cost effective to deploy IT solutions [2]. Many enterprises are moving sections of their computing infrastructure to the public cloud since public cloud services are easily scalable and flexible in meeting the demands of the changing workload. It is usually owned by large companies like Microsoft, Amazon or Google [9].
- B) **Private cloud:** It is used and managed within one organization. It is apt for large enterprises where the workload deals with large amount of confidential or sensitive data [9]. The services can either be operated by the company itself or a third party. The Concur technologies is one of the examples for private cloud [9].
- C) **Community cloud:** It is controlled by a group of companies or enterprises, who have shared interests [2]. The open Cirrus cloud testbed is an example for this type of cloud [9].
- D) **Hybrid cloud:** It is a combination of public cloud, private cloud and the community cloud. It connects an organization's private, public and community cloud into a single and flexible infrastructure for running the company's application and workload.

Among the above four types, the word "Cloud Computing" commonly refers to public cloud. The other types are said to be the variations of public cloud. But they share similar kind of technology [7].

6. Background work

Back then, the users were able to concurrently access and share a centralized system through several computers. Since purchase and maintenance of such computing capacity was so expensive, there was a need to share resources for various reasons. This was when the idea of cloud computing first came into the picture. The very first talk about cloud technologies took place in 1999 after the coming of salesforce.com, which lead the way of delivering business applications in the form of a website. This initiative by the company paved the way for the specialist as well as mainstream software corporations to develop and deliver apps on the internet. Later, Amazon started working with cloud technologies starting with AWS and launching their Elastic Compute Cloud. This way, the use cloud technologies slowly started increasing [13]. Some major reasons why cloud technologies grew at a rapid rate are [10].

- A) Increasing growth of computer and communication technologies, increased the need for advanced technologies like cloud computing.
- B) With increase in global competition, most of the organizations adopted to technologies that consumed less time and work so they can focus in improving the business and to outsource their IT requirement.
- C) Availability of cloud technologies through big corporations such as Amazon, Google and Microsoft.

7. Cloud service providers

This section talks about some of the popular cloud service providers [15]:

- A) **Amazon:** It is one of the most popular cloud service providers. It is the most comprehensive and broadly adopted cloud platform which offers over 200 fully featured services from global data centers. Many startups, enterprises and leading government agencies use Amazon web services because of its advantages such as low costs, agility and faster innovation [16].
- B) **Google:** It joined the cloud market on 2007, where it provided simple services such as calendars, emails and online documentation. Currently, it has developed various cloud services such as cloud storage, cloud SQL, cloud datastore, BigQuery, app engine and compute engine [15].
- C) **Microsoft:** Microsoft had introduced a cloud platform known as the Azure cloud platform in late 2009. It has more than 200 products and cloud services which can help businesses to build, run and manage applications over multiple clouds from any place, using their tools and frameworks [11]. It offers services such as Mobile development platform, media, storage, Big data cloud and Identity and access management [15].
- D) **Salesforce:** Salesforce [17] provides a specific type of cloud environment known as CRM or Customer Relationship Management. It is helpful for businesses since it helps them connect with their customers in a different way. [15] It:
 - Manages and tracks customer information actively
 - Helps to connect with the entire team
 - Simplifies tasks
 - Easy customization
 - Captures customer emails.
- E) **HP:** [15] It is one of the most popular cloud service providers. It offers services such as, HP cloud compute, HP cloud storage, HP cloud relational database, HP cloud CDN, HP cloud DNS, HP cloud Identity service and HP cloud application platform.
- F) **Rackspace:** The Rackspace [15] company focuses on cloud computing as core business. They provide around eleven different services such as: Cloud servers, Cloud DNS, Block storage, Load balancers, Cloud files, Cloud databases, Cloud backup, Cloud data platform, Cloud networks, Cloud queues and Cloud monitoring.
- G) **AT & T:** AT & T [15] provides cloud computing services with major services being cloud storage, cloud compute, PaaS (Platform as a service) and network emblems.

8. Impact of cloud technologies on various sectors

- A) **Business organizations:** Cloud technologies leaves a positive impact on business organizations since it boosts their revenues and helps them achieve their

business objectives. Companies opt to employ the services provided by cloud technologies instead of building their own technology. It is mainly because of the advantages of cloud technologies such as ease of usage and convenience, reduced cost, disaster recovery, reliability, security, privacy and ease of sharing and collaboration [2]. Even small businesses are able to access high-end applications that were not available to them earlier [18].

- B) Industries:** Cloud technologies have prevented industries from having various technical and business related problems that might have occurred if they had used their own data centers. It also saves money by adopting pay per use facility. As a result, it lowers the additional expenditures of running their own data centers, resulting in cost savings. Cloud technologies have efficient data management which makes it very easy for the industries to maintain records [19].
- C) Banking:** Adoption of cloud technologies in banking sectors is quite low when compared to other sectors because of the security issues that banks might face. But with increase in new measures which are being taken to improve security in cloud technologies, this sector is also increasingly employing cloud technologies so as to reduce the cost of the ownership [19].
- D) Education:** Cloud technologies have revolutionized the education sector. The conventional way of face to face classroom teaching is being increasingly replaced by cloud based technologies like - smart classrooms using pictorial and auditory illustrations which will increase the interest of children towards education. It also enables remote access of study materials which are useful for both students and teachers [19].
- E) Healthcare:** Hospitals use cloud storage to save, retrieve, update and manage records of patients. It helps doctors and other professionals in procuring patient's information which allows them to access the data remotely, even if they are not in the hospital [19]. Researchers have advocated cloud technologies as a new paradigm for exchanging biomedical information [20]. Telemedicine/ teleconsultation, Medical imaging, Therapy, hospital management, secondary use of data, public health analysis and patients' self-management are some of the areas where cloud computing is used in the healthcare sector [20].

Hence, we can see that cloud based technologies have made a positive impact on various sectors ever since it has been found. In the upcoming sections we will see about the challenges faced by cloud computing, and the trends of this technology in future.

9. Challenges faced by cloud technologies

Some of the challenges that are being faced by cloud technologies are discussed below.

- A) Data residency:** One of the main challenges faced by the cloud technologies is lack of security. Data residency and security of the data in cloud are the key concerns raised in cloud computing [21].
- B) Data leakage:** There is a chance of leakage of data when an organization migrates to the cloud server. Therefore it requires the necessary skills to handle and manage the migration process [10].

- C) Portability:** In cloud environment the software that is to be used must be portable with the other cloud environment [10].
- D) Interoperability:** It is the ability of computer systems to communicate. In order to be a part of cloud environment, the software that is migrated must be compatible with more than 1 cloud service provider [10].

There are many ways through which the above problems can be solved. Using encrypted file systems, backups when necessary, hiring highly skilled and experienced professionals and taking service from cloud security service providers are some of the ways through which cloud technologies will be able to face the above challenges. Encryption of data and providing only the necessary access to different people are some of the ways through which data residency can be prevented.

10. Future of cloud technologies

In future, cloud computing will be at the top of all technologies to solve all the major business problems and challenges. With the ongoing pandemic, the shift towards cloud has proceeded to increase at a rapid rate yielding more business value. The percentage of worldwide IT spending on cloud technologies will continue to accelerate in the upcoming years. As per a report around 83% of company's work load will be saved in the cloud since companies continue to shift from private to public cloud. Some of the cloud technology trends that will be increasingly used in the future are [22]:

- A) Artificial intelligence engineering:** As the technology advances, AI is one of the common cloud computing trends that we have to look forward to. Computing platforms are increasing their efficiency by using AI. This framework also helps them to easily scale and adapt to the changing business requirements.
- B) Cloud security:** Data security is one of the major challenges faced by all of the IT infrastructures. With more companies shifting to cloud platforms, cloud security has become a necessity rather than just being a trend.
- C) IoT platforms:** An IoT (Internet of Things) platform is a cloud enabled platform which works with standard devices to gives access to cloud based applications and services on it. It functions as a medium by collecting data from devices with a remote device configuration and smart device management. This system sends out real-time alerts in order to keep track of errors and troubleshoot them. It also supports a variety of industry standard protocols to deliver smart forecasts through monitoring the organization's process.
- D) Edge computing:** It is the method of improving the cloud network system by processing data the edge of the network. It processes less time-sensitive data in real time on the cloud. Continued convergence of Information Technology and telco will push edge computing at the forefront opening up a huge number of opportunities for organizations to use new technologies. Edge computing will play a critical role in providing real time information and data analysis as well as streamline the flow of traffic from IoT devices.
- E) Open source:** Open source is a type of service which can be customized by anyone. That is, it allows the organizations to customize the underlying infrastructure

as per their needs. It has many benefits. The scalability of the services is increased and addition of features are much simpler when compared to a closed source platform. The security of the platform is also high.

F) DevSecOps: The cloud technologies might provide a lot of facilities with many advantages. But, the main concern regarding this technology is security. There are possibilities of cyber-attacks, network eavesdropping, virtualization vulnerabilities, etc. These issues might lead to bigger problems that might put the organizations in danger. This is where DevSecOps helps. It is the process of thinking about the security of the infrastructure from the start. The core security tasks are automated by embedding system controls and its processes into the workflow. According to a report, about forty five percent of information technology security stakeholders accept that adopting this method helps in improving the security of the cloud environments ^[22].

G) Multi cloud solutions: Multi cloud solutions or hybrid cloud solutions means to combine the private cloud and a third-party cloud service. Using this, the workload can be moved from private and public clouds, whenever necessary. This increases the flexibility of the services provided by the cloud. It also provides advanced security, server reliability and top performance ^[23-40].

As technologies develop over the years, it is to be expected that many more trends will be developed in the future to contribute towards the growth of cloud computing.

11. Conclusion

This paper has discussed in short about the technological aspects of cloud computing, highlighting its trends and its impacts on different sectors. Cloud computing is an innovative trend. It is a name for an old concept of using computing services from remote locations. Nowadays, all kinds of applications are being deployed and are being run in cloud platforms. Cloud technologies have a lot of advantages when compared to the traditional methods. They are easily affordable since are used in pay per use basis. We can see impact of cloud technologies is almost everywhere. All businesses, whether they are small or large, depend upon cloud technologies in one way or the other. The security issues that this technology puts forward are continuously being worked upon to make the services provided by cloud technologies more safe and secure. Several researches are also being done in various states and sectors to explore the cloud. The application of cloud computing in different sectors will continuously keep increasing in the future since it has changed the style of work in many ways. It is known to be a revolution in the world of technology.

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