Studying the Challenges in the Adoption of Cloud Computing

*Dr. Srinivasa Suresh S, **Dr. Asha Kiran
*Associate Professor, Kirloskar Institute of Management, Pune
**Associate Professor, Dr. D.Y.Patil – B School, Tatawade, Pune.

ABSTRACT

Computing in the cloud is the current trend for effortlessly storing data in modern times. Its accessibility, low cost, and other advantageous characteristics contribute to its meteoric rise in popularity. It is quite unusual to come across a company that does not utilize cloud computing these days. Cloud platforms make their software and services available on an as-needed basis. The introduction of cloud computing is presenting management with a number of hurdles despite the numerous benefits it offers. Before committing to using tools and services provided by the cloud, one must first weigh the benefits and drawbacks. This article begins with a brief introduction to the cloud, followed by a classification of clouds according to their deployment models, a review of relevant literature, a discussion of common research subjects, and a discussion of the limits of the study before drawing a final conclusion. In general, the results of this study will provide the groundwork for more advanced research.

Keywords: *Cloud challenges, cloud adoption, Cloud Technical challenges, common cloud research areas.*

INTRODUCTION

One of the most exciting and cutting-edge developments in cloud computing that have taken place in recent times. The great majority of technological solutions are now stored on the cloud, and those that aren't are working hard to get up to speed with their competitors in this regard. Because of the incredible advantages that it offers, it has attracted individuals working in the information technology industry at every level, as well as experts working in related fields and proprietors of their own companies. A phenomenon is known as "cloud computing" takes place when a large number of computers are linked to a network that enables real-time communication. This creates the conditions necessary for the phenomena to take place. The most fundamental definition of the term "cloud computing" describes it as "a network of remote servers that are hosted in the Data Center and that are further able to be accessed through the internet from any browser." Any machine with an internet connection can connect to these servers. Consequently, utilizing the cloud to store data, administer that data, and do analyses is an easier process than using a local server or a personal computer. According to the National Institute of Standards and Technology (NIST) [1], "Cloud computing is 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.". This explanation is broken down into its component parts, which include cloud designs, security measures, and deployment methodologies, among other things. To be more explicit, the list that follows provides an in-depth explanation of each of the five key components that are accountable for the operation of cloud computing:

1

On-demand self-service: It provides the customer with the ability to access real-time, remote computer resources (including CPU time, network storage, software use, and so on) in accordance with customer requirements and without the intervention of a human in the process.

Broad network access: Every resource must be made available to the user on a worldwide scale, must be simple to access and must be made available across the network (for example, the Internet). This need applies regardless of the medium in which the consumers engage in the utilization of the resource (mobile phones, laptops, PDAs, and workstations).

Resource pooling: Either the multi-tenancy or the virtualization model may be utilized in order to pool the computing resources of the provider together with the goal of servicing several clients at the same time. This enables a wide variety of physical and virtual resources, including both time and space, to be dynamically ascribed to and reallocated in line with the specifications of the individual clients. The networking that takes place in the cloud, as well as the safety of cloud computing, is based on the following three things:

1. Safeguarding user accounts in the cloud
2. Safeguarding the information stored in the cloud

3. And, then the third aspect is application security.

Cloud computing offers more than just a place to store data and tools. Numerous chances for study are becoming available as a result of the cloud's rapid development. From a technical point of view, the following are some of the issues that need attention:

Virtualization: The idea of virtualization forms the foundation of cloud computing in and of itself. Rather than using the actual server, network, or storage space, a virtual representation of those things is built using this method.

Encryption: It refers to the method of safeguarding data by transmitting it in a format other than its original one. Cloud computing makes use of a variety of sophisticated encryption techniques to ensure that your data is kept private at all times.

Denial of service: It is a form of cyber-attack in which an intruder attempts to prevent people from accessing the resources they have paid for by interfering with the services provided by the internet.

DDoS Attacks: Distribution Denial of Service is what the acronym stands for. It is a form of DoS attack in which hostile traffic arrives from a variety of different devices. As a result, it is becoming increasingly difficult to discriminate between legitimate traffic and malicious traffic.

Cloud Security Dimensions: Software known as Cloud Access Security Brokers (CASB), which is located between cloud applications and cloud users, is given the responsibility of monitoring and enforcing all of the restrictions that are associated with cloud security. This software is located between cloud applications and cloud users.

Data Security: Encryption is the approach that is employed in preserving and maintaining the privacy of the data since the focus of cloud-based service security has always been on securing sensitive information. It is possible for data to become accessible via the public cloud due to various vulnerabilities and gaps.

Data Separation: Geolocation is an essential component in the data separation process. When it comes to storing data, companies want to be certain that the geographic location in question is a reliable one. The primary considerations in data separation are the geographic location and tenancy of the data.

Cost reduction: From the perspective of management, one of the components necessary to maximize profits and minimize losses is the elimination of unnecessary costs.

In order to address the problems outlined above, companies need to fill open positions with skilled workers. On the other hand, management might not be aware of these issues until much later. If one uses the cloud, one should be familiar with the various cloud deployment models.

Types of cloud models:

Without understanding the cloud models, implementing cloud services will not be possible. These 3 cloud models are well-known. These are:

Instead of providing users with cloud capabilities directly, Software as a Service (SaaS), often known as "programs as a service," makes available to user's applications that run on cloud infrastructure or platforms. That is, programs, software, or packages are developed specifically for consumers and distributed through the internet. With a software as a service (SaaS) plan, it is not essential for the customer to have a physical copy of the program installed on a personal computer (PC), laptop (or any other client device). The term "Software as a Service" (SaaS) is also sometimes referred to as "Service Clouds" or "Application Clouds." In most cases, it is a form of functionality that is supplied by conventional application software stored in the cloud. Google Docs and Google Calendar, SAP Business by Design, and Salesforce CRM 3 are some examples.

PaaS Stands for "Platform as a Service," and it refers to a collection of software development tools and services that, when utilized by a client, may make the process of creating and delivering web-based applications more rapid and effective. The customer does not have access to the underlying cloud infrastructure, which may include the network, servers, operating systems, or storage. However, the customer does have control over the deployed tools and services, as well as the configuration settings for the environment in which the application is being hosted. This gives the client access to a variety of development environments, which they may use to construct their apps without needing to have any knowledge of the underlying workings of the service. PaaS stands for the platform as a service. It offers a setting for the creation, testing, and utilization of software applications. Google App Engine, Force.com, Microsoft Windows Azure, and Java are just a few examples. 3.3.

IaaS is an abbreviation that stands for "infrastructure as a service," and it describes the physical layer of a cloud computing environment. This layer is made up of the various hardware resources that are necessary to support the cloud services that are being provided. Components of servers, storage systems, operating systems, and networks are typically included in this category of resources. The interplay between a computer's operating system and its applications is what makes the cloud work. The customer has control over the operating systems, storage, and applications that have been deployed, but they do not have access to the fundamental infrastructure of the cloud. In addition, the client probably has a restricted amount of influence over the selection of networking components. Besides Mosso, some more instances are S3 from Amazon, SQL from Microsoft Windows Azure, and Mosso.

CLOUD DEPLOYMENT MODELS

There are four primary subcategories that can be used to classify cloud computing in accordance with its deployment or usage. These subcategories are public cloud computing, private cloud computing, community cloud computing, and hybrid cloud computing. Public cloud computing refers to cloud computing that is available to the general public. Private Clouds Typically, a company or an individual will own and/or lease their own private cloud infrastructure for their own use. It is possible for the organization to manage and run it, a third party, or a mix of the three, and it may take place either on or off the grounds of the organization. Example: eBay.

Community Clouds (That Are Domain-Specific) A collaboration of many companies is responsible for the upkeep of these clouds to fulfill particular needs. It refers to a set of computer resources that are made available through the internet to a certain community of users coming from organizations that have common interests. The use of these resources is restricted. Users are often a group of people that have a history in common with one another or who have similar issues within the community or society as a whole. Community clouds are a type of cloud computing that sit between public and private clouds. It is possible for it to be administered and operated by one or more of the organizations that are located inside the particular community, by a third party, or by any combination of the three of them, and it is possible for it to exist either on the premises or off the grounds.

Public (General) The public is provided with various services through the utilization of clouds. Cloud computing may be broken down into a few categories, the most common of which is the public cloud. Computing resources are made available in an on-demand fashion through the internet in a public cloud environment. They are located on the infrastructure of the cloud service provider. It is possible for a corporation, academic institution, government body, or some combination of these, to own, manage, and operate the facility. Amazon, Google Apps, and Windows Azure are some examples.

When two or more different kinds of clouds come together, the result is a cloud phenomenon known as a hybrid cloud. It is a mix of private and public cloud infrastructures, with the intention of achieving the maximum potential cost savings through outsourcing while still achieving the desired degree of control. The purpose of this strategy is to make the most of what outsourcing has to offer.

Cloud adoption increasing day by day. Fig 1 and Fig 2 show the adoption during covid-19 and possible adoption rates till 2023. Due to the pandemic, cloud usage increased drastically. The following figure shows the usage percentages.
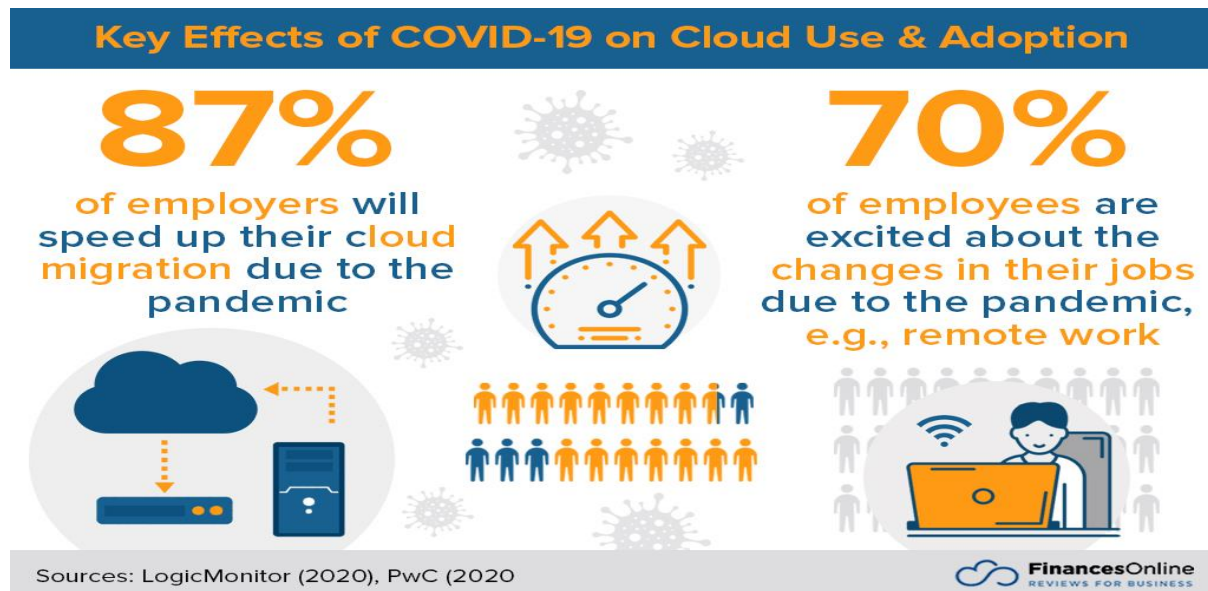
Source: Google images   Fig.1 Cloud Use & Adoption
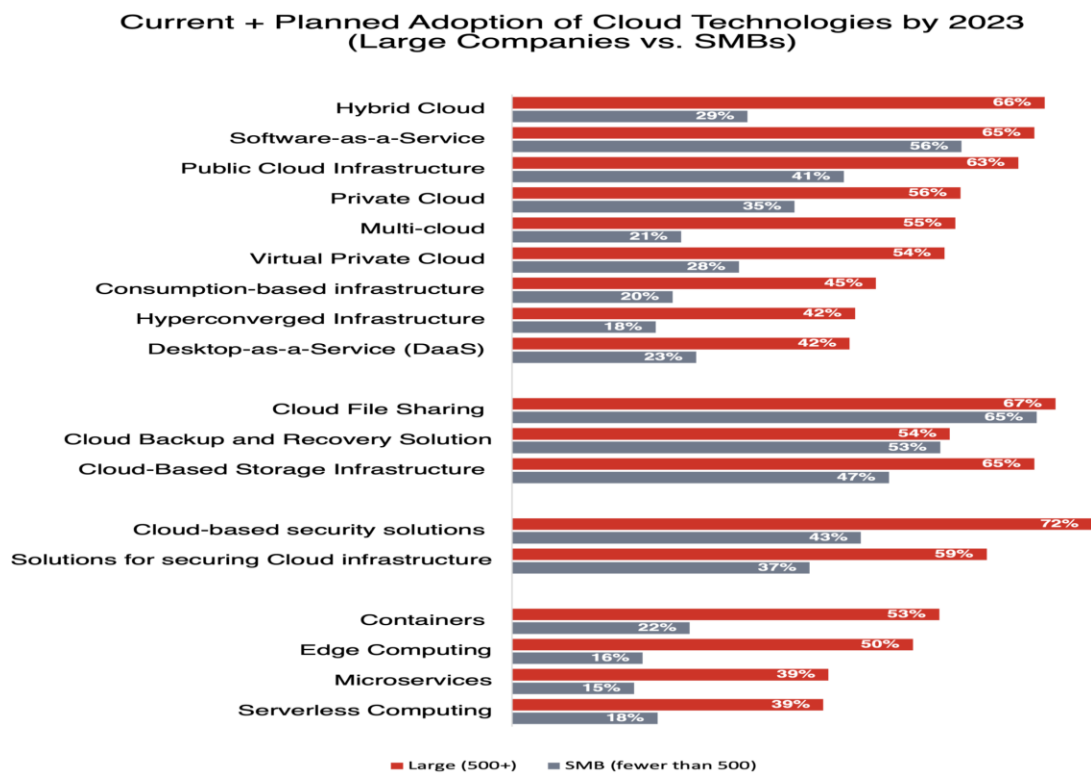
Source: Google images fig.2. Adoption requirement

Fig2 shows cloud adoption requirements till 2023 w.r.t to the various features in the cloud.

Section II covers the literature review.

For identifying the challenges, some of the computer science topics are taken into consideration like data privacy techniques, architectures, algorithms, etc. The period of coverage of this literature review is 2020 to 2021. This literature review covers the following challenges in view:

1) Cost
2) Changing the environment
3) Data loss or data security
4) Quality of service.

PROBLEM STATEMENT

Companies that wish to move their IT services to a Public Cloud face several challenges. The uncertainties about the challenges and issues involved in this technology have been reasons for not accepting. Well-known companies like Google, AWS, IBM, and Microsoft Azure are constantly thriving to provide reliable services. Technologically these companies are doing good. However, adoption rate is slow. The primary reasons are cost, reliability, awareness, data security, data privacy and data migration from one region to other region are the primary challenges hindering cloud adoption. Sectors like Manufacturing, E-commers, Mobile operators, Banks are rapidly using cloud platforms. However, Universities and colleges are far behind the cloud adoption due to various confidentiality reasons. Hence, a detailed study pertaining to adoption problems related to the universities and colleges are required.

OBJECTIVES

Primary Objectives:

The objective of this study is to identify the primary reasons which are obstructing the cloud adoption through literature review.

Secondary objective:

Study and analyse private and public cloud adoption challenges through interviews and questionnaires in the domain academic institutions including universities and colleges.

The current paper address the primary objective.

METHODOLOGY

The methodology to achieve the primary objective is as follows:

a) Search the web databases to find the concept clarity
b) Review not less than 10 papers during the 6-7 years' period of time. Subsequently identify the primary reasons.
c) Conduct interviews to collect data from at least competent personnel
d) Design questionnaire to collect the data from at least 2 universities and 2 colleges.
e) Compile the data in Microsoft Excel tools
f) Analyse the data using statistical tools and hypothesis.
g) Study the influencing factors which are hindering the cloud adoption

The current paper covers only primary objective.

LITERATURE REVIEW

Mohan et al. [2] propose COMPAC (A Community Cloud Pricing Model) depending on the cost of services being offered. It was suggested to utilize a web-based pricing tool, which is now made accessible for use by other vendors. Launching the first public cloud in the country is a collaboration between Indian Banking and our pricing strategy. The utilization of the group cloud has resulted in an expansion of the facilities.

Shirazi and Iqbal [3] focus on analysing m-commerce-related privacy problems. It is one of the obstacles that must be overcome in order to use cloud systems. It takes into account the various facets of privacy as well as the various expectations around privacy. The authors provide an explanation of the currently used models, including recent developments that are designed to improve privacy. The outcome demonstrates that it is possible to do it through sociocultural solutions in order to solve privacy issues. Technology and company practices can work together to create an environment of trust and security.

Yoro and Ojugo suggest the implementation of a client-trusted security mechanism in order to increase user interest in cloud computing. A user-centric virtual process paradigm is included in the recommended architecture as a means of providing security for cloud computing. The results show the ability of the proposed framework to increase the user's trust level by 67% [4].

According to R. Baig et al. [5,] the wireless networking service has shown itself to be an efficient and cost-effective IP networking infrastructure service in places that are not as developed. It is possible that consumers would benefit greatly from the provision of services and applications by making it possible for them to be made accessible in these locations through the utilization of a wireless network. This would lead to an increase in the number of consumers who make use of cloud computing technologies.

6

In a separate piece of work, Hao et al. [6] present a social cooperation model for a two-layer multi-community cloud, with the goal of allocating subtasks to community clouds for mobile edge computing. According to the findings, the proposed algorithm will reduce the total number of monetary charges, the number of access fees, and the amount of power that is spent while concurrently boosting the degree of protection. [citation needed] In this study, we looked at the many advantages of utilizing the cloud, paying special emphasis to the cost reductions that may be accomplished via its deployment. Before cloud computing can be utilized, this is one of the challenges that must first be conquered.

M. Giacobbe et al., [7] mentioned that in large-scale distributed infrastructures, the most significant procedure is cloud computing. When implemented in a community cloud environment, the adoption and use of an energy-aware brokering algorithm have the potential to result in enhanced performance as well as increased sustainability. A number of different parameters were taken into consideration. This will also take into account the cost savings that may be achieved via the utilization of this technology. Like the paper [7], cost reduction is considered an important element. When cost is reduced Cloud adoption becomes easy.

The Multi-Community-Cloud Social Collaboration Model, abbreviated as MC3, is a model that determines which activities are the most trustworthy, efficient, and safe in order to do difficult jobs. The model is improved in the following four ways: reducing the cost of access as well as financial costs, while simultaneously maximizing the agreement of the level of security and confidence between group clouds [8]. It is also focused on cost reduction.

In terms of information technology systems and applications, the globe is making significant strides forward. When it comes to large corporations, many of them are forced to face issues because of the way the environment is changing [9]. The use of cloud computing has been shown to improve the IT infrastructure of a number of different enterprises. By making strategic investments in their capacity for collaborative problem solving, the enterprises may enhance their ability to integrate their operations into the supply chain.

The purpose of the model that was proposed by Al-Mashat et al. [10] is to work as a mediator between service providers and consumers in a community in order to deliver the most beneficial help that is available to both parties. End consumers will be able to pick the services that are best suitable for their requirements and preferences if they make use of this system. In addition to this, it was established that the level of service that was provided was of a high enough quality that it could be depended upon by the customers.

Container-based virtualization, as stated by Aplonia et al. [11], is utilized to establish a multifunctional execution environment on a single computer in order to address the issue of resource sharing in low-capacity systems. [11] This is accomplished by using a single computer. By constructing a single system that provides the user with a single point of contact while simultaneously providing the community with a multipurpose environment, it is possible to provide both the user and the community with a multipurpose environment for the purpose of isolating the community cloud resources and ensuring their safety. The study demonstrates that community networks are not being utilized to the full potential that they possess and that resources may be redirected to give more services to a wider number of people, which would result in a reduction in costs and an improvement in service.

The use of cloud computing was one of the recommendations made in the Garlick study proposal for the storage of data. An unexpected occurrence that causes a firm to lose data can be extremely detrimental to the business. The community cloud functions similarly to the public cloud, but like the public cloud, it has both advantages and disadvantages. Therefore, getting data restored after it has been damaged by a catastrophe is the primary goal of business resilience. [12]. The problem addressed in this paper [12], is the loss of data. It is one of the challenging issues of cloud adoption. Many management personnel often raise questions related to data security. Data loss is also considered data security or data preservation.

The study conducted by Keung [13] aims to enhance BIM with the help of the cloud community. It offers BIM solutions to a wide variety of issues. To begin, they will maintain their position as a competitive player in the building business. Second, issues with both privacy and face-to-face communication may be easily addressed and

rectified via the use of virtual contact. Finally, online communities that are centered on the cloud have the potential to boost both productivity and cooperation. It can ease storage and increase the efficiency of BIM [13].

Khan et al. [14] made use of a wide array of valuation instruments, ranging from writing to the transfer speed designation problem of cloud applications in the local community network. The second thing that they did was look at the impact that these instruments had on social government aid and honesty.

Web 2.0 is utilized in the process of transmitting patient information from the attending physician to the nurse or other caregiver. A home care system (HCC) is proposed in the research carried out by Shirazi [15], which makes use of a cloud computing system and transfers information with the assistance of various sensors. This method is not without its share of flaws and limitations.

The difficulty of establishing community-based cloud computing is discussed in Zhao et al[16] .'s paper. More specifically, the study focuses on the problems associated with exchanging resources. One-on-one contact may be provided to a large number of people all at once using the community-based platform. The findings demonstrated that using multiagent optimization to improve decision-making throughout the trade selection process is beneficial.

TECHNICAL CHALLENGES IN CLOUD

Customers' worries about their data being stored in the cloud provide the most significant barrier to the cloud's widespread adoption.

The most important problem that has inhibited the broad adoption of cloud computing is a worry over the safety of the data stored in the cloud. Cloud computing poses a variety of possible security difficulties, including those relating to availability, integrity, confidentiality, data access, data segregation, data privacy, data recovery, accountability, multi-tenancy concerns, and a great deal of other potential security issues. Some of the solutions that can be implemented to address the various cloud security issues include cryptography, in particular public key infrastructure (PKI), the use of multiple cloud providers, standardization of application programming interfaces (APIs), and improved support for virtual machines, and legal support.

According to Ullah etl in 2013, "availability of Service Since many systems have crashed on the cloud, like Amazon, so using only one Cloud Computing Service Provider (CCSP), services can result in a drawback as when a shutdown event happens on a cloud the service disappears and user cannot find that service. CCSP promises to provide infinite scalability for the customer but due to the fact that millions of users are now migrating to cloud computing so much promise is not fulfilled Third Party Dependence Customers have no control over their own data as data is lost in the hands of the cloud computing service provided"

at the level of the company, the availability of human resources for the purpose of designing and implementing cloud services. When it comes to cloud adoption, cloud-certified experts are often given preference.

MANAGEMENT CHALLENGES IN THE CLOUD

1) Managements of the organizations often need to monitor the service level agreements.
2) Data storage is in the third part of vendors. Moving the data from one region to another region is a daunting task. Some cloud providers do not have the facilities to move the data from one location to another location.
3) Internet connectivity is essential. Without an Internet account, organizations cannot provide services. Good connectivity will generate good business.

4) International laws will be applicable for cloud services. One should read the terms and conditions carefully before cloud adoption

5) Organizations often face the issues of data loss or data theft. Customers must be educated on Cloud storage

6) Cloud services incur additional costs due to automatic billing.

LIMITATIONS OF THE STUDY

The fundamental objective of this specific line of research has been to conduct an exhaustive literature review covering a wide range of selected subjects, the most important of which are data loss, data security, and services. The major limitation of this research is that during the preliminary search, only few papers were reviewed; this is by far the most important limitation (15 articles considered in the literature review). However, there should be a substantial increase in the number of search items over a wide range of well-chosen subject areas. This expansion should take into consideration both the aspects of the community cloud and those of the private cloud.

In the future, we intend to focus the majority of our efforts on resolving issues that are specific to certain industries, such as those concerning the adoption of cloud computing in educational institutions, the adoption of cloud computing in academic institutions such as universities, the adoption of cloud computing in financial institutions such as banks, the adoption of cloud computing in mobile data storage, and so on.

CONCLUSION

In the future, we plan to concentrate our efforts on resolving issues that are unique to particular industries, such as those concerning cloud adoption in educational institutions, cloud adoption in academic institutions such as universities, cloud adoption in financial institutions such as banks, cloud adoption in mobile data storage, and so on. Our analysis covers the period of review between 2010–2020. We made the observation that the primary concerns or difficulties that management professionals experience while adopting cloud computing are related to the costs, levels of service quality, and protection and availability of data. Following the review of the relevant prior research, a total of fifteen articles were selected for inclusion in the study. These articles were selected due to their significance to the research field, as determined by the initial search, as well as their conformity to the paper criteria that we had previously outlined. These published works were considered for inclusion in the research.

REFERENCES

[1] The NIST Definition of Cloud Computing, available at https://csrc.nist.gov/publications/ detail/sp/800-145/final, published September 2011.

[2]S. L. Mohan, Y. R. Reddy, and G. R. Gangadharan, "Compac—a pricing model for community cloud," in *Proceedings of the 2017 International Conference on Advances in Computing, Communications and Informatics (ICACCI)*, pp. 2033–2039, IEEE, Manipal, Mangalore, India, September 2017,

[3] F. Shirazi and A. Qbal, "Community clouds within M-commerce: a privacy by design perspective," *Journal of Cloud Computing*, vol. 6, no. 1, 2017.

[4] R. E. Yoro and A. A. Ojugo, "An intelligent client-trusted and dependable security framework to ease smartphone portability on community cloud-computing," *Journal of Computer Networks*, vol. 6, no. 1, pp. 1–7, 2019, .

[5] R. Baig, F. Freitag, A. Moll, L. Navarro, R. Pueyo, and V. Vlassov, "Cloud-based community services in community networks," in *Proceedings of the 2016 International Conf on Computing, Networking and Communications (ICNC)*, pp. 1–5, IEEE, Kauai, Hawaii, USA, February 2016.

[6] F. Hao, G. Min, J. Chen et al., "An optimized computational model for multi-community-cloud social collaboration," *IEEE Transactions on Services Computing*, vol. 7, no. 3, pp. 346–358, 2014.

[7]M. Giacobbe, M. Scarpa, R. Di Pietro, and A. Puliafito, "An Energy-Aware brokering algorithm to improve sustainability in community cloud," in *Proceedings of the SMARTGREENS - 6th International Conference on Smart Cities and Green ICT Systems*, pp. 166–173, Porto, Portugal, April 2017.

[9]S. Bruque-Cámara, J. Moyano-Fuentes, and J. M. Maqueira-Marín, "Supply chain integration through community cloud: effects on operational performance," *Journal of Purchasing and Supply Management*, vol. 22, no. 2, pp. 141–153, 2016

[10]T. M. Al-Mashat, F. A. El-Licy, and A. I. Salah, "Semantic cloud community framework for services provision," in *Proceedings of the International Conference on Advanced Intelligent Systems and Informatics 2017*, pp. 222–231, Springer, Cairo, Egypt, September 2017.

[11] N. Apolónia, R. Sedar, F. Freitag, and L. Navarro, "Leveraging low-power devices for cloud services in community networks," in *Proceedings of the 2015 3rd International Conference on Future Internet of Things and Cloud*, pp. 363–370, IEEE, Rome, Italy, August 2015.

[12] J. Li, Z. Lu, W. Zhang et al., "SERAC3: smart and economical resource allocation for big data clusters in community clouds," *Future Generation Computer Systems*, vol. 85, pp. 210–221, 2018.

[13] Y. Liu, V. Vlassov, and L. Navarro, "Towards a community cloud storage," in *Proceedings of the 2014 IEEE 28th International Conference on Advanced Information Networking and Applications*, pp. 837–844, IEEE, Victoria, BC, Canada, May 2014.

[14] A. M. Khan, X. Vilaça, L. Rodrigues, and F. Freitag, "Towards incentive-compatible pricing for bandwidth reservation in community network clouds," in *Proceedings of the International Conference on the Economics of Grids, Clouds, Systems, and Services*, pp. 251–264, Springer, Napoca, Romania, September 2015

[15] F. Shirazi and A. Qbal, "Community clouds within M-commerce: a privacy by design perspective," *Journal of Cloud Computing*, vol. 6, no. 1, 2017