EMPIRICAL REVIEW ON ROLE OF CLOUD COMPUTING IN EDUCATIONAL SECTORS IN COVID-19

Hager.R.Mekaeel [1], Ayoub Salim [2]

1-Omar Al-Mukhtar University /Faculty of Education,

2-The Libyan Center For Research and Development Of Saharin Communities

hager.alalwany@omu.edu.ly

الملخص

نظراً لما له مر به العالم من أغلاق عام و حظر تجوال نتيجة لتفشي وباء كوفيد 19 كان اللجوء إلى التقنيات و التكنولوجيا أمرا إلزامياً و هو الحل المناسب لهذه الظروف و خاصة في قطاع التعليم الذي أصبح تعليماً إلكترونياً و عبر شبكة الأنترنت. وكانت الحوسبة السحابية إحدى هذه التقنيات التي تم الاعتماد عليها في عديد من التجارب في عدة مؤسسات تعليمية. وتهدف هذه الدراسة البحثية إلى تحديد دور تقنية الحوسبة السحابية في قطاع التعليم في فترة وباء كورونا من خلال تقييم لهذه التجارب ومراجعتها و النظر إلى التحديات التي واجهتها. بشكل عام، ستلقي هذه الورقة نظرة على نطاق تقنيات الحوسبة السحابية وتكاملها لإبتكار أنظمة التعلم الإلكتروني.

الكلمات الدليلية: الحوسبة السحابية. قطاعات التعليم؛ كوفيد -19 دور السحابة في قطاع التعليم والاستفادة السحابية.

Abstract:

Coronavirus (Covid-19) has shattered the global world led to the lockdown where the technologies have become our life saviour. The aggregate count of positive cases is increasing worldwide, and thus, social distancing is an effective strategy to control the spread of the virus. As a result, education sectors remain closed until returning to their normal state. All educational sectors have adopted the online

learning mode. Cloud computing is an emerging technology being considered effectively in this pandemic. The research study aims to determine the role of cloud computing technologies in education sectors by an empirical assessment. Initially, the current crisis of Covid -19 explains the importance of the pandemic period. The fundamental concepts of cloud computing and e-learning systems are explained. The quantitative and technical elements of the latest papers are collected and reviewed from their merits and demerits. The quantitative elements portray the usage of cloud platforms, whereas the technical elements portray the usage of cloud technologies. It is assessed from both teachers' and students' perspectives. It is observed that some challenges like optimal ease of use, network service support, enhancing resource sharing and technological resources are to be still focused. Overall, this paper will give an insight into the scope of cloud computing technologies and their integration to innovate e-learning systems. It will motivate the other researchers to explore new principles and designs in this research field.

Keywords: Cloud computing; Education sectors; Covid-19; Cloud's role in education sector and cloud benefit.

1. Introduction

The advancements made in web technologies have increased the arrival of information. The information flow and structure are categorized into structured, unstructured, and semi-structured. Technology frequently changes from information access to intelligent models to gain insights from shared information [1]. Cloud-based technology has been mounting exponentially in the latest years. The advent of cloud computing supports the innovation and expansion of the data generation's industry, offering a simple approach to handle diverse set of information processing systems. Many organizations use cloud- oriented data storage solutions that include simplified real-time connectivity with cost-effective storage heading to the idea of on-demand delivery, variety of resources and putting together into the delivery environment. In the light of the COVID-19 crisis, the technologies have rescued the companies and educational institutions from this outbreak [2]. One of the solutions

is that the learners and workers are operated at a remote location. However, the academic sectors face obstacles and find it difficult to cope with the remote learning process.

The highlights of the research study are:

● The importance of cloud computing platforms in one of the real-time applications, education sectors, is an active tool for business goals and growth.
● The analytic study is carried out on the global challenge, Covid-19 crisis.
● Explores and evaluates the current education scenario in these exceptional circumstances.
● Assisting the decision-makers imbibe with the new technology for the future.
● This study is essential to the researchers interested in evaluating the experiences of e-learning with the cloud computing technologies and their integration.

The research paper is parted as follows:
Section 2 elucidates the "Research Method" that dictates the technical review study of cloud elements in e-learning during the Covid-19 crisis; Section 3 presents the "Covid-19 crisis- An overview" in the current scenario; Section 4 presents the "Overview of cloud computing" wherein the fundamental concepts of cloud computing; Section 5 presents the "Overview of E-learning systems" that portrays the ideologies of traditional and cloud integrated learning modules; Section 6 presents the "Conclusion" that summarizes the findings of this study.

2. Research Method:

The research method aims to find out the role of cloud computing concepts in education, especially in the Covid-19 pandemic period. The research papers are collected from the 2020-2022 periods. The technical analysis is conducted on the latest 20 research papers from the two aspects, namely, qualitative aspects and technical aspects. The quantitative elements portray the data analysis performed on the

impact of cloud technology adoption on the online learning system for teachers and students. The technical elements illustrate the utilization of cloud computing and storage models for the benefit of teachers and students. The research method consists of three frameworks, namely, research definition, research methodology, and research analysis, shown in fig.1.
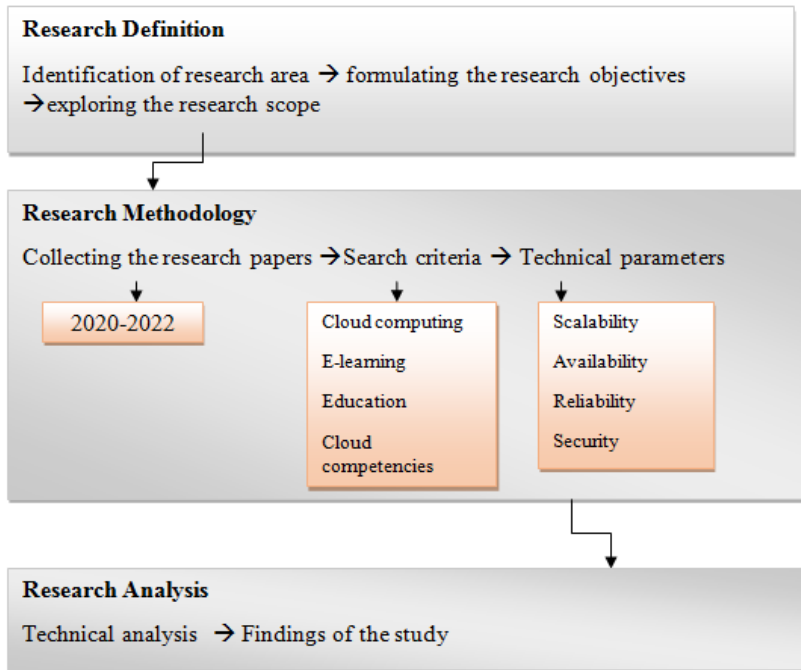

Research Definition

Identification of research area → formulating the research objectives → exploring the research scope

Research Methodology

Collecting the research papers → Search criteria → Technical parameters

2020-2022

Cloud computing
E-learning
Education
Cloud competencies

Scalability
Availability
Reliability
Security

Research Analysis

Technical analysis → Findings of the study

Fig.1 Methodological framework

2.1 Research analysis:
A)   Quantitative elements of cloud computing in education:

In [16], the negative influence of the Covid-19 in the Spanish education system was studied. The quantitative study has been conducted on different aspects, school dropouts and academic failure; poor culture of networking and collaboration; and the loss of digital competencies. The study has stated that the content and delivery of education needs to be more focused on fundamental practices. In [17], online teaching in Peking University was studied

to present more about the role of instructional strategies in online education. The survey reported that the quality of teaching content should match the behavioural characteristics of students learning online. The principle of effective content delivery and high-quality participation in online classes with digital technologies are to be studied. In [18], the adoption of cloud technologies in e-learning was studied in the Indian Public Universities. An integrated framework comprising the Technology Acceptance Model (TAM), Technology-Organization Environment (TOE), and Diffusion of Innovation (DOI) was studied using structural equation modelling (SEM) and confirmatory factor analysis (CFA). The technology assisting factors like Competitive Advantage (CA), complexity, senior leadership support, usability and vendor support has been playing an essential role in the cloud-based e-learning system.

The author in [19] studied a dual pathway model for medical institutions to examine the Task Technology Fit (TTF) and Learning Technology Fit (LTF). The positive effects of the tasks using the Expectation-Confirmation model (EC) were studied. It was tested on the 600 questionnaires submitted to 6 hospitals in Taiwan. The study has proven that cloud-based learnings like TTF and LTF are enhanced. The role of cloud computing in Malaysian Universities [20] was studied using the TAM model. A survey was conducted among 265 cloud-based learning participants and tested using SEM. It is concluded that usability and technological need satisfaction are the two factors driving the growth of cloud-based e-learning. The author in [21] studied the adoption of the e-learning model from a Chinese student's perspective. The quantitative study was explored using the Push-Pull Mooring model. It was conducted on push effects like Perceived security risk, Learning convenience, and Service quality and pull effects on Usefulness, Ease of use, Teacher's Teaching Attitude, Task-technology Fit. During emergency management, the study has influenced users' factors switching to online learning platforms. It helped to serve as a reference to several service-related applications.

In [22], the role of cloud models in higher education was studied using a qualitative approach. The study stated that the students were

accepted the cloud platforms to grow, learn, and flourish continuously. The author have explored certain factors like vulnerability, safekeeping and extensive work. The analysis stated that the data security and reliability parameters slow down the effective content management process. In [23], the authors established the online learner's behaviours in prosthodontic education. The participation of the learners to complete their courses was studied. The behaviour data like speaking time, total audience time, viewing time and completion time were collected and analyzed using Pearson Chi-Square and Likelihood ratio. The authors concluded that the low learning progress and completion rates were observed based on the individual lectures. A learning behaviour change is required in this pandemic. The authors in [24] have studied the impact of Covid-19 in Bangladesh's education to know about the challenges faced by online learners and the services sector. The combination of cloud and IoT technology has significantly reduced individual communication. Reliability and validity are the two most research instruments explored by different participants. The results stated that the education sector is more likely to use the technologies. However, students intend to preserve time by avoiding traffic jams.

B) Technical elements of cloud computing in education:

A user experience with online learning in China [25] was studied using a comprehensive evaluation method. The authors reviewed the response of online websites during the pandemic regarding access speed, reliability, timely transmission technology of video information, course management, communication and interaction, and learning and technical support. Overall, the findings say that Chaoxing Learning had the poorest user experience and DingTalk performed best. Real-time 3D rendering and cloud storage management are essential for experimental education in virtual reality (VR) [26]. The high computational costs have deliberatively ended the computing models. Therefore, the background and interactive are the two design metrics that support for an efficient rendering services. In video stream data, image content display is improvised for lightweight rendering services. The author in [27]

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has explored the impact of mobile cloud computing for further development. The traditional mobile technologies have consumed ample storage space and high information processing ability. The adoption of cloud technologies in mobile education has leveraged the information sharing process and the learner's knowledge.

In [28], Artificial Intelligence (AI) based cloud e-learning was designed to improve the student-centred teaching mode. The adoption of data mining technology i.e. cloud adaptive compression mining algorithm, eliminates the data interference during the association mining of large video streams. Along with that, Ant Colony Optimization (ACO) was employed to locate the position of data, and thus, it was arranged before the streaming process. In [29], a case study is done to determine education quality with cloud technologies. A virtual portal with a cloud computing model is considered a centralized controller. The quality factors like knowledge retention, engagement, collaboration and individual learning were analyzed from both students and teachers. This portal has helped them to a certain extent. However, scalability and reliability are not tested.

The authors in [30] have studied the cloud virtualization and data center concepts on universities' ideological and political guidance. The main intention was to collaborate the online resources with the virtualization for practical mining of cloud concepts. The teaching activities are collected and then fed into the political network. It helped the universities to make wiser decisions over the learning data analysis system. In [31], the college English online examination system was studied using a cloud computing platform. It was designed integrated and the intelligent exam modules by open-source Hadoop framework. Though it ensured reliability, the scalability of the teaching modules is not trained and tested. The authors in [32] have studied the IoT-cloud concepts with Virtual Reality (VR) technology for college physical education. The problems of teaching methods for physical education are still in the developmental stage. Therefore, VR technology has integrated the IoT, cloud platform and mobile client. The relevant data are collected, and the scenes are designed and evaluated. Through the

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virtual rendering screen, the teaching methods are easily adopted by the students.

In [33], interactive cloud learning modules using experiences for STEM education was designed. In the case of K-12 education, an engaging platform is required to improve the inquiry-based learning concepts on earth and environmental sciences. It was hosted and tested on the Amazon Elastic Compute Cloud platform that demonstrated the teacher's functionality in engaging classes. The authors in [34] have studied the curriculum design using cloud competencies for the software related courses. The Panel aimed to resolve the teaching challenges while preparing instructional design. These resources were accessed in "AWS educate", which provide an opportunity to learn and access the resources. 5G+ smart education [35] was studied to mitigate the challenges related to speed, information cache and other services. Augmented/ Virtual Reality has replaced the traditional e-learning methodologies. In addition, computing technologies like cloud, big data, fog and edge systems are combined with each aspect of education modules designed between teacher and students.

C) Findings of the study:

From the previous section, the role of cloud computing in education sectors is detailed from the aspects of techniques suggested merits and the demerits. In coordination with that, some analysis has enlightened the scope of this research area. They are framed into the research questions such as:

a) Is the suggested CC techniques are accurate for educational requirements?

b) What features drive the design of content management systems?

c) Is it feasible to maintain the reliability rate during a high number of participants?

d) Is it possible to ensure the cloud network availability all the time in educational sectors?

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e) How far is the sensitive educational data maintained in the cloud platform?

f) Does the integration and adoption of other computing technologies correctly imbibe with the CC platform with special reference to educational content?

These six questions motivate to explore the challenges in this field. The covid-19 situation is still pertaining in many countries. The education sector is entirely relying on the online learning system. The behavioural characteristic of the teachers and students concerning the CC platforms are to be more focused. The factors like Competencies, Complexity; Leadership support; Usefulness; Usability; Reliability; Scalability; Security and Adoption intention is to be encountered during the CC platform adoption. Though the CC platform has dramatically benefitted the education sectors, some observations made out of this study are:

a) Enhancing the service support:

The positive attitude of the learners needs to be maintained consistently by providing timely, convenient and faster service support to the learners. Online learners face problems in improper video transmission, slow platform access and the untimely response between communicators. Online feedback submission must ensure a minimized delay. Different sectors make use of other clouds, like a public cloud (Universities), private cloud (Schools and colleges) and hybrid cloud (online examination services). Due to the poor internet connection, it might affect the cloud interfaces shared between teachers and students. Therefore, there is a need to enhance the service support by covering the cloud integrations.

b) Enhancing the communication convenience:

Many online platforms lack from providing interactive communication between teachers and students concurrently. The cloud learning platform must be interactive to make online classes more engaging. Effective screen sharing is required to make participants more engaging in online courses.

c) Optimal ease of use:

Data security must be addressed at the earliest. The compatibility with different platforms affects the submission of homework and the arrival of the pop-up question in video learning. This brings instability and a lack of interest during online classes. Henceforth, it should be optimized.
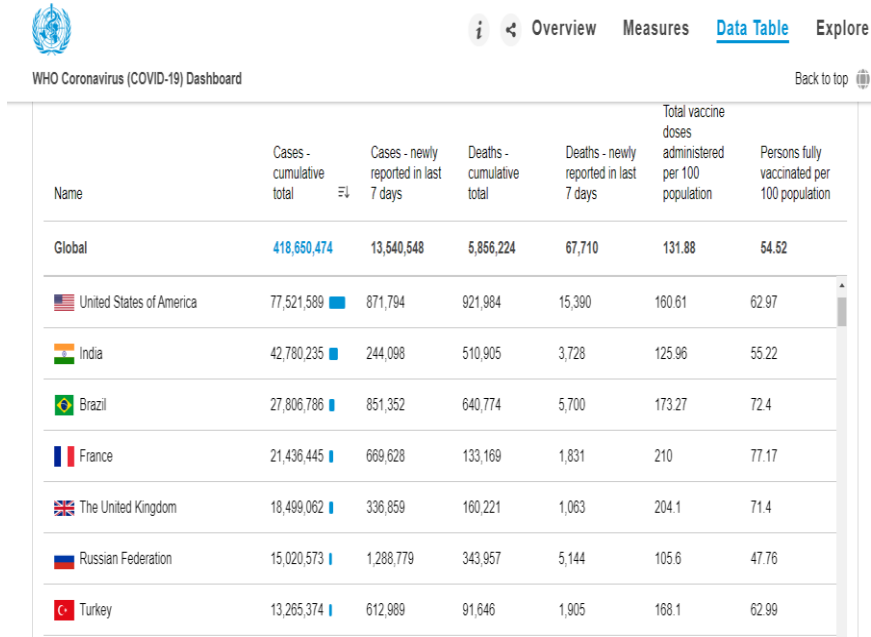
d) Enriching the shared resources:

The technology platform imbibes shared learning resources for all users. Likewise, more course-related projects need to be added to engage the learners consistently. Many disciplines are not enriched with the fundamental learning resource that demotivates the learners to participate regularly.

3. Covid-19 crisis- An overview:

The novel coronavirus (COVID-19) was originated on 31 December 2019 in the Wuhan city of China [4]. It spreads rapidly and grows exponentially across the world. In light of the fast-growing nature, World Health Organization (WHO) has declared the COVID-19 as a pandemic. Similar incidents named SARS-CoV- 2 also rapidly increased in the 196 countries wherein France is the most affected country. Spreading quickly through human contacts is the primary attribute of all detected viruses. The report [5] says COVID-19 is more dangerous to the weak immune, and old-aged people with cancer, diabetes, neurological conditions, coronary heart disease and HIV/AIDS are more vulnerable [6]. By keeping this in mind, a pandemic outbreak is followed in every country to slow down the spread of the virus through 'social distancing'. Coronavirus is a single-stranded RNA virus with a coat of 0.1μm in diameter. This virus spreads through droplets during coughing, face to face contact with the affected person, or hands touching on contaminated environments [7]. The Covid-19 pandemic is a severe crisis and the most major threat faced by the world More than a health crisis, this pandemic develops stress in many countries. Owing to that, it creates devastating consequences on societal, economic and political for a long-last time. The whole

world is not sure about the end of this pandemic at that time. The World Health Organization (WHO) announced in its daily Sunday newsletter that 418,650,474 cases were registered in the 24 hrs. According to the WHO report, the EUROPE account for confirmed cases (170,033, 672). It is followed by America (144, 596,557 cases) and South East Asia (54,832, 387 cases). The fig. 2 displays the latest edition of Covid-10 reports as of 15, February, 2022.

WHO Coronavirus (COVID-19) Dashboard

Name	Cases - cumulative total	Cases - newly reported in last 7 days	Deaths - cumulative total	Deaths - newly reported in last 7 days	Total vaccine doses administered per 100 population	Persons fully vaccinated per 100 population
Global	418,650,474	13,540,548	5,856,224	67,710	131.88	54.52
United States of America	77,521,589	871,794	921,984	15,390	160.61	62.97
India	42,780,235	244,098	510,905	3,728	125.96	55.22
Brazil	27,806,786	851,352	640,774	5,700	173.27	72.4
France	21,436,445	669,628	133,169	1,831	210	77.17
The United Kingdom	18,499,062	336,859	160,221	1,063	204.1	71.4
Russian Federation	15,020,573	1,288,779	343,957	5,144	105.6	47.76
Turkey	13,265,374	612,989	91,646	1,905	168.1	62.99

Fig. 2 Latest edition of Covid -19 WHO (2022)

3.2 Covid-19 on education sector- Impacts:

As stated earlier, Covid -10 pandemic is the first and foremost health crisis. Several countries have settled to close schools, colleges and universities. This pandemic is challenging to the politicians whether to keep open or close the educational institutions. Open the education sectors from workers' perspective to preserve the economy (or) close it to protect the lives and reduce the interaction. Henceforth, education is going online in unprecedented and untested ways. It provides solutions in the short

term, but there is a need for the long term to mitigate the consequences on knowledge development. The followings are the impact [8]:

a)   Schools: Children improve their fundamental skills in school. It lowers the development of social skills and knowledge obtained from the school.

b)   Family's side: The amount of time being spent on the child's activities is becoming high, which devastates the parent's patience.

c)   Graduates: They have significant effects on searching for jobs and disruption in their later stages.

4. Overview of Cloud computing:

4.1 Concepts of cloud computing:

Cloud computing is an emerging technology that provides hosting and delivery services with internet facilities. Cloud computing is beneficial to education-oriented business owners as it removes the user's requirements on resource provisioning. It permits the enterprises to increase the assets only at the time for services needed. In simpler terms, cloud computing provides services on-demand basis. The theme behind cloud computing is not a new one. In the 1960s, John McCarthy envisioned that the computational services would behave like a utility to the owned users. The word 'cloud' was depicted as large ATM networks in the 1990s. Conversely, Eric Schmidt, Google CEO, used the word describing the business model yielding services across the web in 2006. Since then, cloud computing has been extensively explored in different service contexts.

In recent decades, the concepts of cloud computing are bloomed everywhere limitlessly. It has many new operations that set a different way to run a business [9]. The cloud computing technologies integrates with the today's demand from Information and Communication Technology (ICTs) to satisfy the technological and economic requirements. Based on the cloud user's needs, there are three clouds:

A.   Public cloud: It is available to all types of users and provides the services as per their demands.

B.   Private cloud: It is available to restricted users by encountering their requirements to run privately.

C.   Hybrid cloud: It combines the public and private cloud models. The services are provided to the defined set of roles and permissions.

4.2 Service Delivery models in Cloud:

Three types of cloud services models are introduced with the growing number of online activities. Since the service models are designed according to the functional and the capabilities of the business requirements, which are termed as "Anything-as-a-Service (AaaS), pertaining to it, the available cloud services are [10]:

A)   Software–as–a–Service (SaaS): The software is managed for remote computing services using third-party vendors.

B)   Infrastructure-as-a-Service (IaaS): It provides hardware, storage, virtual machines and data centres as services to its cloud users.

C)   Platform-as-a-Service (PaaS): It acts as middleware of the service that supports cloud framework, software and IDEs.

4.3 Cloud Computing - Core component:

The fundamental modules of cloud computing to provide the services via the web are [11]:

a)   Virtualization: It is one of the vital components of CCs. It proportionates the physical resources by aligning with the OS, servers and network modules. It executes the applications from several environments.

b)   Multi-tenancy: Multiple clients/ customers share the data in the cloud network. Thus, the roles and their permissions are defined at each level. It assists for the efficient use of hardware resources.

c)   Cloud storage: It preserves, maintains and administers the shared data at the local or remote server.

d)   Hypervisor: It plays an essential component of virtual machines. It shares the physical system via different OSs.

e)   Cloud network: Thousands of data centres perform at an instant of time. Henceforth, it manages the shared data under a secured network infrastructure. It also combines with the Virtual Private Networks (VPNs) to securely access the files, printers etc.

5. Overview of e-learning systems

5.1 Traditional e-learning systems

An E-learning system is growing adaptively with the advancements of information technologies in the current decades. It is generated from different resources with different media formats. The traditional e-learning networks are designed with the university network or the internet network. It has six major network infrastructure components: IP usage, curriculum design and development, content construction, content organization, learning administration, delivery and product [12, 13]. The architecture of traditional e-learning system is shown in fig.3.
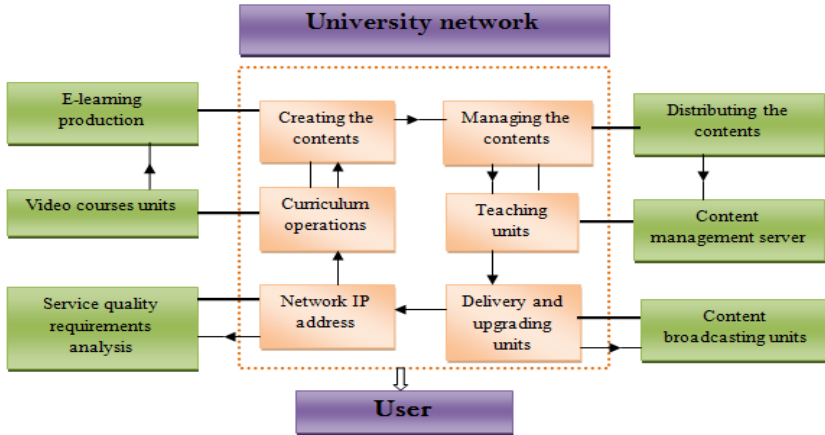

Fig. 3 Traditional e-learning system

5.2 Cloud architecture in e-learning systems

The rapid growth and usage of cloud computing architecture have transformed from investing to renting the processing power from a specialized vendor. The education field is one of the best real-time

applications in this pandemic scenario. In general view, e-learning systems use several hardware and software resources. The implementation of cloud platforms on e-learning systems has enabled the demand for applications. The intent is to execute the applications as services with a scalable infrastructure over the web. In the current period, cloud computing suggests a scalable mechanism that renovates the construction of e-learning systems to its vendors and promotes the new e-learning mode [14]. Henceforth, e-learning system, with the advent of cloud computing infrastructure, has dramatically improved vendors' investments and management power. It also transforms the e-learning system into the next higher level. The fig.4 represents the cloud architecture in e-learning systems.
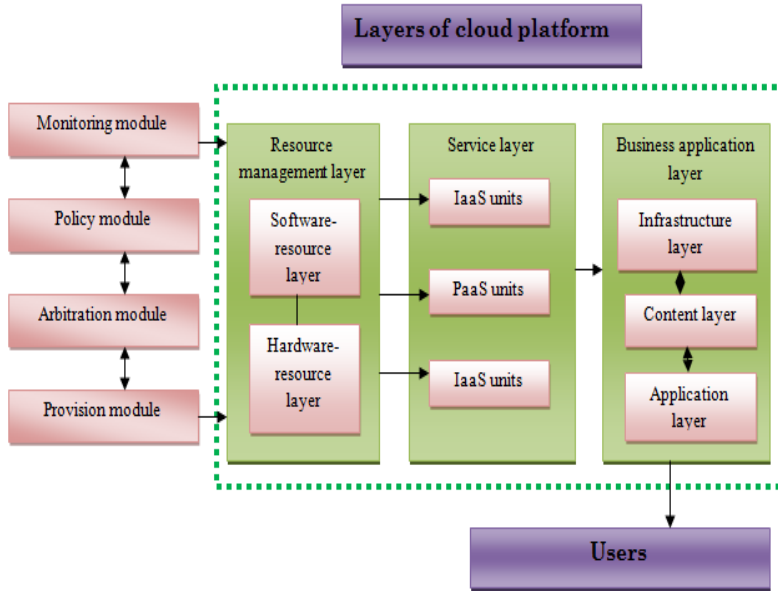

Fig. 4 Cloud based e-learning architecture

5.3 Advantages and Challenges of cloud based e-learning systems:

Let's discuss the advantages and confronts of cloud integrated e-learning systems relevant to the pandemic period.

Advantages:

Initially, it brought several changes to the online learning system between students and educators. Either of them can access the data from home at their comfort level. Students are permitted to submit their assignments in the cloud and receive feedback instantly. The loss of data is significantly reduced. In case of data loss, the virtual server concept will help regain the lost information. An online proctoring and examinations system has benefitted a lot for students. The teachers can provide feedback online via video conferencing or feedback forms that help create live interaction, thus making the learning experience approachable and friendly. Data sharing concepts has been demonstrated effectively to perk up the superiority level of accumulating data.

Challenges:

Although many opportunities are presented, cloud integrated learning systems have some limitations [15]. The poor internet connection between the cloud users and cloud servers and the low data security are still in the developmental process. The significant challenges are:

i)   Data security schemes:

Privacy is being compromised at all stages, leading to data loss and low security. There is no control unit in higher education institutions to preserve sensitive information.

ii)   Less knowledge on cloud computing usage:

Many cloud users are not aware of the technical process involved in teaching and learning. This could lead to a lack of trust among the shared entities like educators, staff and administrators.

iii)   Poor integration of technological resources:

The speed of internet could disrupt the functioning of cloud systems. It makes the users to eliminate the e-learning platform on the cloud. The limited access of cloud computing usage leads to the declined rate of technological resource usage and internet facilities.

6. Conclusion

The epidemic disease Covid -19 has drastically changed people's social habits and continues to change. The present situation represents that one of the most significant impacts of Covid-19 is imposed on the education sector. It has numerous impacts on educators and learners. Cloud computing technology has played a substantial role in mitigating the pandemic effects. In this paper, an attempt is made to explore the significance of CC technology's role in the educational sector. An empirical assessment is done to find out the technology integration in the institutions. It is observed that the Covid-19 spread is still in a critical stage. The fundamentals of cloud computing and the traditional e-learning concepts are demonstrated to begin the analysis. The scope of cloud-based e-learning systems in this pandemic period is discussed. A review analysis from quantitative and technical elements of the CC platform in different universities and schools is explained to determine the technology integration among online learners. The design and usage of the CC platform for educators and learners are reviewed. The involvements of CC platform on each article are presented that helps for better understanding and gaining of domain knowledge. It is observed that some challenges like optimal ease of use, network service support, enhancing resource sharing and technological resources are to be still focused.

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