Campus Cloud Computing for Universities: State-of-the-Art

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Abstract: This paper tries to depict the role of cloud computing in the education sector mainly in higher education institutes (HEI). HEIs are swiftly taking the adoption of cloud generation to lessen the carrier value, provide extra productivity in the learning and administration system, offer higher responsiveness for statistics retriever, and assist in decision –making. Accordingly, this paper illustrates the meaning of Campus cloud computing (CCC) and related services and it defines the adoption strategic plan of cloud computing that is consists of nine stages. Likewise, this paper builds a practical harmony questionnaire among Iraqi universities. It focuses on the rate of using IT among the academic and university staff. The obtained result shows that more than 68% of university staff are impulsive to use internet family applications. However, they don't have enough knowledge about the term of cloud computing despite using it in their daily work. Finally, this study provides an Illustrative example and analytical analysis for the cloud adoption in HEI.

1 INTRODUCTION

Higher education in the world is a fundamental pillar of the progress of people and the development of countries because of its active role in the dissemination of different sciences in all fields. Accordingly, it must parallel the development of technology to maintain this place in society. Therefore, Higher education institutions (HEI) must allocate adequate cost to provide resources to provide educational services with the latest technology (Njenga, 2019). Nevertheless, due to the economic crises experienced by the countries, the financial support for higher education institutions has decreased. Thus, higher education institutions in front of great challenges to face these crises and continue to keep pace with technology by Available resources (Gao, 2019; Kozák, 2012).

Consequently, due to strong communications infrastructure and the widespread of the Internet with the services provided to the communities. One of the samples, Services offered by higher education institutions for students, teachers, and researchers. Pushed by large companies to exploit these possibilities and thinking to provide technology equipment, infrastructure, and various applications to the beneficiary institutions with the least Costs, high accuracy, high speed, and security of personal data with the advent of new technology cloud computing (Restivo, 2009).

Cloud computing is a modern technology that provides various resources of technology from servers, networks, storage, and various applications for large and small enterprises via the Internet or intranet. Consequently, to utilize the available resources and exploit them to keep pace with the rapid development of technology with the lowest costs. Where students, teachers, and researchers can benefit and access resources via the internet from anywhere without worrying about any maintenance or management (Sohaib, 2019; El-Haddadeh, 2020).

This paper aiming to deliver high quality and consistent services, reduce associated costs, offer a cloud architecture in HEI with various delivery

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models, propose a strategy in HEI for an efficient cloud environment, and provide recommendations to HEI for successful and efficient move to cloud system from its traditional system.

This paper is organized as follows; Section2 surveys the existing studies of Campus cloud computing (CCC) and its implementation in HEI. While Components of the Campus Cloud Computing are illustrated in Section 3, Section 4 explains the roadmap for successful cloud computing and the proposed solution. Then, the main building block of CCC is depicted in Section 5, besides; Section 6 discusses the theoretical obtained result through the analytical analysis. Finally, Section 7 summarizes the conclusion and future work.

2 REVIEW

Recently, various papers have been issued related to the role of cloud computing in the education sector. However, no holistic solution for this topic has been forthcoming yet.

For instance, Vaishali H. (Pardeshi, 2014) proposed cloud architecture for Higher Education with all architecture constitutes like deployment Models, Service Models, and user Models. This study proposed five steps for the migration process to cloud computing environments such as preparation, analysis, migration, cloud migration concluding, maintenance, and provider management. Also, it presents a collection of recommendations for a successful and efficient migration process. However, this study suffers from an extensive theoretical analysis.

Safiya Okai et al. (Okai, 2014) holistically identified the adoption roadmap by announcing the seven stages for the migration process from a traditional environment to a cloud one. The effecting of such stages is summarized in transcending enterprises' concerns over the security of their data, overriding fears of mistrust of the cloud service provider, and then develop a clear roadmap to move to the cloud. Moreover, it discussed the main challenges faced by this technology. Finally, this study tested two practical samples for universities; however, this study does not explain the real cloud environment used in the work and does not discuss the obtained results in detail.

Massadeh and Meslah (Massadeh, 2013) illustrated the standard cloud adoption model for Jordanian universities by describes the importance and the challenges facing higher education in Jordan. Also, the authors consider the implementation of cloud computing in the education sector will be a good financial support model for the universities in Jordanian that do not have sufficient infrastructure resources to manage the required IT support for development, educational, and research activities (Okai, 2014).

Mohsen A. et al. (Attaran, 2017), shows the main philosophies and possibilities of the cloud, as applied to the current education era. This paper discussed the main benefits of cloud technology and offered some ways to adapt it and evolving trends. Additionally, this study pinpoints key adoption factors and clarifies some of the rules that might be taken to run the cloud technology in education. Finally, two universities, Bryant and Roger Williams have been taken as a sample to implement the education based on cloud technology. However, this study does not examine the obtained results in detail and computes the performance of the cloud.

Qiuyan GUO (Guo, 2013) proposed the cloud-computing platform for the education sector to reduce the problem of developing the university management system and the cost of maintains. This paper utilized the Google plugin for Eclipse and Java Web and built a sharing teaching resources platform for the university network. The obtained result shows that the high stability and scalability noted with the cloud platform of teaching resources comparing to the traditional system. Furthermore, this study provides a new idea for online sharing teaching-resource using a cloud model. However, it lacks in result interpretation and analysis.

Iñaki B. et al. (Bildosola, 2015) developed a cloud adoption tool that is used to move enterprises from traditional work to use the cloud era. This tool is embracing a Software as a Service (SaaS) solution to use the diagnosis based on a questionnaire to gather information and provide the end-user with valuable information. This tool allows generating a particular cloud road by providing a conceptual report for the decision-makers. Thus, this study achieved by an experimental questionnaire by ascertain the degree of knowledge on cloud computing and identify the most interesting business area. Finally, the results show the adoption tool supports the universities to decide on the possibility of cloud adoption or not. Table 1 summarizes the cloud platform that is used, goals, and drawbacks of surveyed studies.

As shown in Table 1, we can conclude that cloud computing is an essential field in the education sector. In addition, due to the dynamic characteristics of cloud technology, there are many challenges regarding the adoption process. These challenges lie to the misunderstanding of the role of cloud

computing in the education environment (education and management).

Table 1: Existing cloud platforms.

Ref. No.	Testing model/ vendor	Goal	Weakness
(Pardeshi, 2014)	Analytical/ None – theoretical study	Migration the traditional work to cloud environment.	An extensive theoretical analysis.
(Okai, 2014)	Scientific questionnaire/ Non	Road map for cloud adoption increase the income	Does not discussed the obtained results in details.
(Massadeh, 2013)	Analytical/ None – theoretical study	Considerable potential in improving the IT application and infrastructure at higher education institutions	Does not explain the real cloud vendor or achieved the result interpretation
(Attaran, 2017)	Roger Williams University/ Amazon Web Service and Navi cloud	Increase the adopting of IT in education filed and increase the income	Does not discuss the obtained results in details and compute the performance of cloud
(Guo, 2013)	Develop the university management system/ eclipse	High stability and scalability than traditional services technology	Weakness in interpretation and analysis
(Bildosola, 2015)	Academic questionnaire/ Openaula	Developed cloud computing adoption decision tool to computing the efficiency of cloud adopting in education sector	None

The advent of cloud computing technology accompanied by many significant challenges, primary of which are the additional overhead of remote access to data, infrastructure to guarantee data privacy, and user interface design for each cloud service. It is clear from the literature survey that the current studies do not satisfactorily use real cloud computing simulator.

3 CAMPUS CLOUD COMPUTING

HEIs are increasingly embracing the ability of cloud technology to reduce IT-cost operation, to restrain themselves more quickly to new opportunities and to become aware of the full potential of their data to inform strategic decisions about future technology trends (Ali, 2020). However, HEIs have a unique mission and vision that affect how decisions about cloud computing are made. Campus cloud computing (CCC) can be well-defined as a new style of computing in education which dynamically scalable and often virtualized education resources are delivered as services over the Internet or intranet (Mohammad, 2018). CCC has become an important technology and by which students use a variety of devices including PCs, laptops, smartphones, and PDAs to access shared software, storage, and application-development platforms over the Internet via services offered by cloud computing providers. Besides that, Unified commutation acts a holistic solution for higher education institutes and used for communication and real-time interaction. Also, it employed to unify the department's communication and improve administrative efficiency, boost security, and provide a strong learning environment. Figure 1 depicts the main component of CCC, which can be deployed to Iraqi universities.

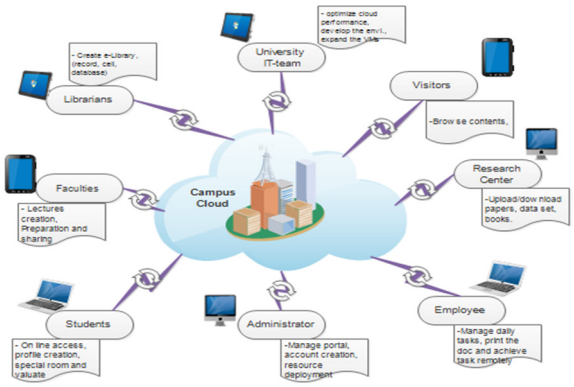

Figure 1: Campus Cloud computing Components.

Moreover, CCC Service Models consist of three layers, such as standard layers of cloud computing, like Campus-Infrastructure as a service (CIaaS), Campus-Platform as a service (CPaaS), and Campus-Software as a service (CSaaS). The first layer is CIaaS responsible for servers, hardware resources, and the IT department. The second layer is CPaaS responsible for the execution, database, and developer. While the third layer is CSaaS responsible for faculty, staff, students, administration department, and classes (Kogias, 2016).

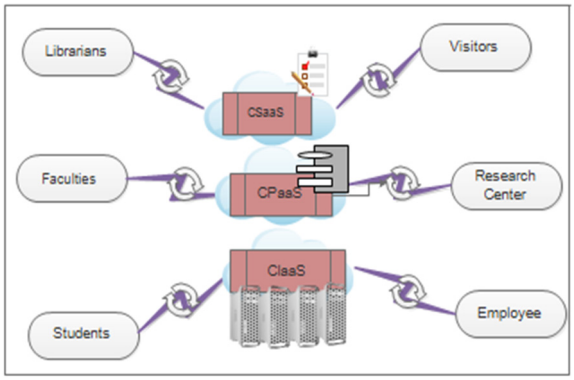

Figure 2: Campus Cloud Services.

As shown in figures 1 and 2, CCC consisted of three types of deployment methods Institutions of higher education can deploy their resources. The first one publicly presented as general and cloud providers are responsible for installation, management, provisioning, and maintenance (Dong, 2012). The second one is private clouds often data centers residing within the educational institution for the exclusive use and is responsible for the security of data and maintenance. Finally, a hybrid deployment module is an association of private and public clouds. In this case, the management responsibilities are often split between the education institute and the Public Cloud providers. This type is more effective due to combining high security and maintenance (Chakravarthi, 2018; Masiyev, 2012).

In the campus cloud-computing environment, low cost and free social interaction publishing (editing, and content creation) are two fundamentals features are associated with it. However, the successful implementing of cloud-computing in HEI needs time and accurate effort. Because of, many departments and organization units under the university will be affected, there are complex decisions to be made, and various stakeholders must be involved.

4 PROPOSED SOLUTION

This section explains, in detail, the main building of the CCC followed by an illustrative example of the interaction between the performed services embedded in the different modules of CCC. In order to build a real CCC environment, this section explains in details the roadmap for success in the cloud computing and adoption process. Figure 3 depicts that the cloud adoption strategic plan includes nine stages, assessment, planning, deployment and services selection, hosting and provider selection, Service level agreement (SLA) configurations, Migration, Integration and the federation, and optimization.

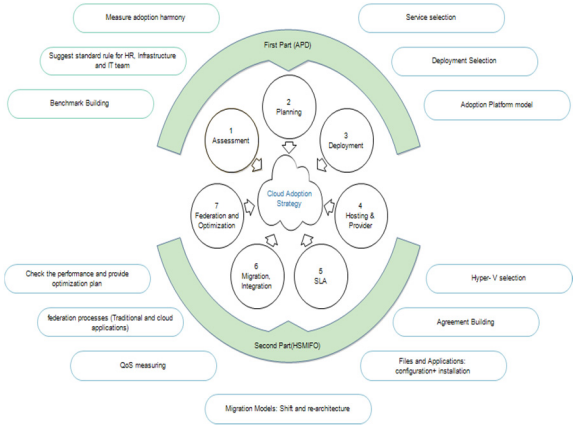

Figure 3: Campus Cloud adoption strategy.

4.1 Assessment

Iraqi universities and other HEI are enthusiastic to use last trend technologies in the education and management process methodologies. However, HEI suffers from a lack of IT-infrastructure and all universities need to extensively optimize the infrastructure and develop it. To solve these challenges, HEIs in Iraq are trying to increase their awareness in the direction of adopting cloud computing to get advantages in providing a better educational environment. Before the adoption process, HEI should assess the opportunities and challenges of employing cloud in the institute. This study achieves a deep assessment in Iraqi universities by sharing the questionnaire among university staff and lecturers. The questionnaire includes (23) questions with 4 answers for each one, after then, author check and analysis the answers. The questionnaire shows that almost all university staff want to use and adapt the technology in education management and learning. Accordingly, the questionnaire reveals almost all staff do not have any

experience with the cloud computing technology and associated services. In this assessment, 100 academic staff and students from 4 universities participated in the survey. All questions suggested regarding the needs of IT and cloud applications in HEI. Fig. 4 illustrates the result of the questionnaire.

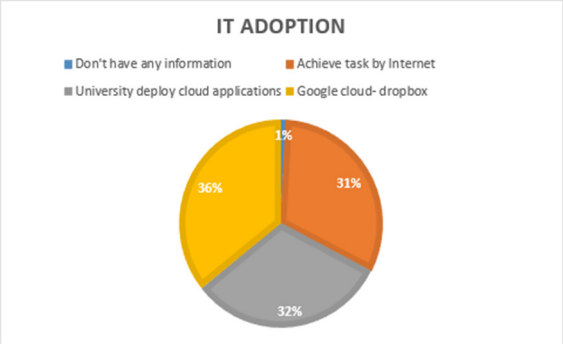

Figure 4: Obtained questionnaire results.

The questionnaire has analyzed regard to the implementation of technology techniques like electronic gates, internet service, portal applications, etc., toward the adoption of CCC in Iraqi universities with standard rules, protocol, services, and regulation.

As shown in figure 2, 1% of the universities (academic staff and student) does not have any experience and knowledge about the role of information technology in university. While, 68 % of universities (academic staff and students) are friendly use the cloud applications (desktop or cloudy) that are freely available by the university or by companies such as Google, Microsoft, Dropbox, etc. Finally, through the COVID-19 pandemic, 31% of university staff achieved all tasks by the internet. Accordingly, the results of the survey reveal that the adoption of cloud technology is applicable for Iraqi universities. Also, before installing cloud services, all universities need to determine where cloud services will add value, then a scalable deployment approach must be planned.

4.2 Planning

After brainstorming all cloud-adoption requirements in higher education, this step helps university leaders to determine the type of platforms and services that are suitable for institutions. Consequently, like specify the type of cloud deployment (hybrid, private or public). In this step, many requirements should be expected to be available like staff, experts, digital content, and network infrastructure.

Regard to employee, each university should have the IT-team (department), cloud experts, external cloud developer experts who will give the professional experts for university's IT-team. Also, share the right people in the right place in order to continuously update and develop the cloud work under in university. Moreover, IT-team should identify the practical cloud-system for the university with the best benchmark to provide an optimal environment for system migration to cloud data center with success.

Finally, benchmark help to a new policy standardization roles and identify the best way for software federation and integration in the new education cloud environment.

4.3 Deployment and Services Selection

It's an important phase in the cloud adoption process, the selection in process for cloud types in HEI. Moreover, many barriers associated with the selection process, like security, cost, and privacy. For example, in private style, a secure environment can be achieved however not sharing sufficient service among the university or college, and cannot achieve the term of elasticity, scalability, and flexibility with such type of deployment (Masiyev, 2012). Nevertheless, with the public cloud everything being to become optimal, however, the big concern can be summarized in security and privacy. Accordingly, the hybrid cloud is an optimal deployment for university and HEI as an optimal solution for cloud adoption. The hybrid cloud offers scalability without limitations; it is more profitable, gives the desired security, and provides great flexibility by charitable its users the occasion to discover unique operational opportunities (Ahmed, 2017; Baniyounes, 2019).

Regard to services layer, it is significant to identify which kind of service models is most appropriate to meet the needs and achieve the ideas of migrating to the cloud. Architecturally, Campus cloud uses Campus infrastructure as service (CIaaS), Campus platform as a service (CPaaS), and Campus software as a service (CaaS) Layers like cloud technology. CIaaS supplies everything: storage, servers, quota, and cloud-networking equipment's as a service. CPaaS provides the stage for IT-team to create and host their programs and applications; moreover, it is responsible for creating and hosting campus applications over the Internet. Services on this layer to eradicate the need to build and manage instances of virtual machines. CPaaS gives permission access to numerous platforms and developer languages, so, allowing programmers and students easy to achieve their tasks by connecting to the cloud.

Whereas CSaaS delivers complete software to the user via the internet, deploy the applications as a web-

based model, and serves several users. With CSaaS, not all university staffs are required to set up and install any applications on their laptop or anxiety about maintenance and upgrades or update. University applications like e-learning systems, admission process, admin, digital repository, email, account and financial processes, classroom management system, and other processes can be allowed on the CSaaS layer.

The choice of the delivery model is dependent on the type of need. As an optimal HEI setting, each of these three services going to be valuable as they all have their unique relevant-characteristic to the need of the university or college.

4.4 Hosting and Providers Selection

The significance of choosing the right hosting-vendor can be an over-important thing. The role of hosting-vendor is the core motivation of cloud adoption in HEI, due the success or failure of the cloud hosting its direct effect on the adoption process and strongly connect with the provider delivering the service. Therefore, it is critical to scrutinize the selected hosting-vendor before outsourcing data or files (Ahmed, 2017).

The most important purviews of hosting selection are (i) service provider dependable, (ii) the location of the outsourcing data stored, (iii) trust and security.

4.5 Making Service Level Agreement

The service level agreement (SLA) is a very vital criterion for the cloud adoption mainly in migration and integration phases. In nutshell, SLA acts binding agreement between the HEI and the cloud provider. SLA should convey and permitted upon by means of the HEI and selected hosting-provider before the deal is signed. Such negotiations must consist of the following points:

- Services interruptions: have to be scheduled (maintenance, updates and check bugs).
- Service transformation: have to be assured (no-postpone and no facts' loss).
- Service cost: any additional services have to be outlined and specify the cost.
- Service availability: an immediate statistics restoration plan need to be noted.

4.6 Migration

In this phase two steps should be implemented, migration planning to migrate the traditional applications and running applications in the cloud successfully. The migration plan is to make sure that the moving process walks in the right direction, while, the running application is to obtain the result in the cloud environment. Proactively, the creation of the baseline should be planned before the move to the cloud to track issues during the cloud adoption, demonstrate improvement and success afterward. A baseline process is a measurement of the current performance and availability of application then achieve a comparison after migration to validate a business case. In some cases, the baseline should be changed when the perform migration acceptance testing. Also, the baseline can be used as a comparison point during the migration to make sure that the methodology on the right track. The migration process takes two basic models, listed as follows (Baniyounes, 2019; Reza, 2017):

- Lift and Shift model: porting applications directly from the data center to the cloud data center.
- Re-architecting Model: it's completely focusing on re-architecting applications to take advantage of benefits available only in the cloud.

Two above models methodologically follow numerous steps to achieve a successful migration process. These steps are:

- Identify application dependencies and inventory: it is an important point to analyze on-premise architecture and identify the scope of migration. If the developer institute-team has a full understanding of applications, hosts, and architecture, it already reduces the possibility of missing dependencies during the migration process.
- Prioritize migration order: this step is to verify that the applications and their underlying server infrastructures are candidates for migration. Also, get end-to-end visibility and identify additional cloud migration risks or dependencies when every layer of an application's architecture is instrumented.

4.7 Integration and Federation

To create successful integration, all components should be realizing the complete potential of the whole cloud investment. Integration is often prepared using any of the three common traditional methods such as (Mohammad, 2015):

- On-demand integration tools that associate numerous clouds together.

- Executing complex on premise application platforms usually called conventional middleware solutions.
- Writing custom codes.

Likewise, another method can be achieved by using standard applications like Boomi Atmosphere by Dell, Web-Space cast iron by IBM (El-Gazzar, 2014). Generally, many gaps associated with integration and migration processes. The gaps are important aspects of organizational readiness. A gap is a skill or process that is essential for digital transformation. So, all companies take precautions to avoid the gap problem like Enumeration responsibilities with the digital transformation, Emphasizing new responsibilities, identifying the zone or zones that bring into line with each responsibility, Identifying the necessary skills to support each responsibility in resource availability and responsibility deadline, Identifying the roles that execute such skills (see figure 5).

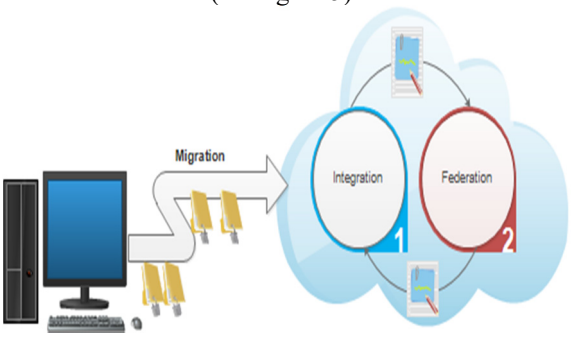

Figure 5: Integration and federation process.

Besides the integration process, the federation process is another important parameter in the cloud adoption plan. The importance of cloud federation comes from the role of it enables the cost-effective, dynamic sharing of idle cloud resources and services. In addition, it supports the cloud members to ensure QoS and availability by helping the members sign SLA. In this study, the federal rule going to be defined to guarantee cloud performance through the sharing resources and dynamic resource allocation. Therefore, federation stakeholders should deploy a preferably automated service selection mechanism that uses a predefined set of QoS criteria offered by providers and mentioned in SLA (Almazroi, 2019).

4.8 Optimization

While all the HEI needs to follow all previously mentioned stages for the cloud adoption plan. Yet, they will also need to streamline that stages-plan and investigate new rules with opted cloud services from anticipated statues. The process of optimization is important because new insights into cloud services are found when they are fully used. Such encounters will result in changes in the cloud adoption plan accordingly. During cloud adoption, avoiding common faults helps bring an edge over others (Baniyounes, 2019; Kim, 2018). Even after taking the first step towards cloud adoption, companies tend to worry about ways to handle, protect, and optimize the cloud but fail miserably. The best solution to cloud adoption problems is to begin with an optimal and appropriate cloud adoption plan.

5 CCC PLATFORM MODULES

CCC combines the traditional university management system and cloud model, aiming to deliver high quality and consistent services, reducing associated costs for HEI, and providing recommendations to HEI for successful and efficient migration of its traditional system to cloud environments. As shown in Figure. 6, CCC modules consist of student module, teacher module, staff module, auditor module, and cloud-system administrator's module.

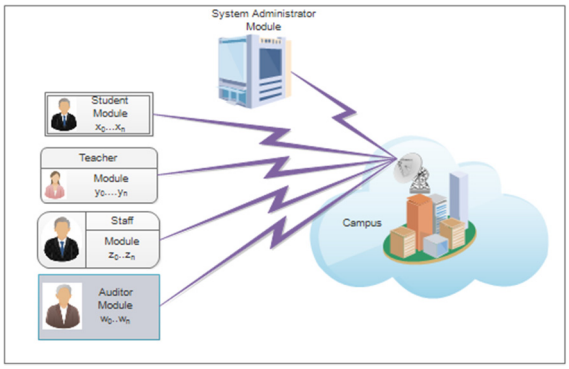

Figure 6: CCC main building module.

In the student module, the teaching resources are too important in fast downloads, efficient retrieval, and providing feedback to the practical needs of the student. While the teacher module is to meet the teacher's requirements for uploading and deleting the sharing-learning resources. The staff module is used by the cloud platform to achieve all management processes and achieve the post for university departments. The auditor module is mostly to ensure the system auditors audit and manage the entire learning resources. Finally, the cloud-system administrator module is mainly responsible for cloud maintenance and solves the gaps through the sharing resource on the platform, such as the user's management, resources, and systems, and so on.

The Merging between student, teacher, staff, auditor, and system administrator's modules have been explored new functional models like registering and landing, query, online editor, resource management, system management, personal information management, and GUI.

As an algorithmic work, CCC platform consists of three major parties:

- The cloud service provider (administrator)-(CSP): who manages and controls the deployment service and data for the ordinary VM, according to resource availability (R).
- Cloud Auditor (A), which holds the user credential and responsible to set up the required software such word, office programs for the assigned VM, and user-local machine.
- Beneficiaries (Students, Teachers, and Staff) (B), who probably use or share data at a CSaaS platform that is managed by CSP.

All the above parties connected through the cloud-system platform and work concurrently. Initially, in order to register a new one, cloud-Beneficiaries(B) request a secure connection form CSP, then, CSP checks the validity of the user (original or spammer attack) based on authentication function. CSP adds authenticated users to the user group in the system platform. Then, cloud users can get a secure credential for the login process.

Moreover, In order to understand the working mechanism, the following illustrative example explains in detail all operations under the cloud-system platform.

5.1 An Illustrative Example

This is a simple example that illustrates the working mechanism of CCC platform modules using an online connection and explains the obtained results and actions taken by the system. The system interactions are written in normal font, the user behaviors are in bold, and our explanation to some actions will be in CAPITAL letter.

THE SYSTEM ASKS THE USER TO LOG IN OR REGISTER IF IT IS HIS FIRST TIME.

Agents: Cloud-system administrator and B

B >> beginning send the query to the cloud-system based on client screen.

csp>> sign in or register as a new user,

B >> fill the required information and password

THE CLIENT_ID AND THE PASSWORD WILL BE SAVED.

System CSP >> check the identity for B machine; assign it to cloud-domain.

>> welcome B" - Nickname"; this is a new page for you.

B >> send the request to reserve VM from the system.

System CSP>> verify the resources (VMs availability), choose appropriate of them.

System CSP>> assign IP-VM and credential to end user via cloud- domain.

B >> enter the assigned user name and password via sharing login form.

System CSP>> return the successful connection; deploy required service according to module query.

B >> Invoke to build a task (learning, teaching, management).

IN THIS CASE, THE SYSTEM deploy an appropriate template.

System $_{CSP}$>> Running the required applications

$\mathcal{B}$ >> check the User-Management, information audit, resource availability.

System $_{csp}$>> prepare the quote for **B**.

$\mathcal{B}$ >> prepare file and work on machine.

$\mathcal{B}$ >> save the documents in the cloud-system.

System $_{csp}$ >> files have been saved successfully.

$\mathcal{B}$ >> sign out from the system.

User>> sign out from the system.

Second: - Download Data from the Campus-Cloud

$\mathcal{B}$ >> sign in

$\mathcal{B}$ >> customer_id

$\mathcal{B}$ >> *******

System> Verifying the "customer_id" and the password.

System >> welcome "customer_id".

THE SYSTEM PREPARES THE GENERAL INFORMATION FOR THE Beneficiaries SUCH AS (REMAINDER SPACE, NUMBERS OF FILES STORED IN HIS ACCOUNT, PREVIEW THIS FILE FOR DOWNLOADING)

System $_{\text{cloud provider}}$>> Reply the trusted VM-IP to the $\mathcal{B}$.

User>> turn-on client screen to start verifying with a cloud provider for authenticate process

User $_{\text{client screen}}$>> send query to retrieve the documents (d).

System $_{\text{cloud provider}}$ >> sending the unknown file (d') to authorized users.

User>> download the files and browse them.

System >> files have been sent successfully.

User>> sign out from the system.

AFTER THE SYSTEM FINISHES THE DOWNLOAD MECHANISM, IT WILL BE READY TO PERFORM ANY NEW OPERATION.

6 ANALYTICAL ANALYSIS

Despite the significant role of cloud technology in HEI, however, the implementation of cloud computing in HEI surrounds by many challenges. This study depicted many challenges like little of experience with the cloud technology field, security, and privacy. Open environment characteristics are a popular feature that is associated with cloud technology, so, security and privacy are big concerns in cloud technology. This section illustrates the analytical analysis for this paper by focusing on embracing the role of cloud in HEI through measuring the performance, agility usage, and cost.

- Performance: - the efficiency measurement of the cloud adoption in HEI is a core point for applicability or not. Accordingly, the performance is the responsibility of the end-users in the cloud environment and is largely based on university IT teams' ability to expect resources-availability that are need-based on user demands. The performance-measurement process is very important for the real-time calculation for user's requests. Thus, the real work of the university-IT team helps to sure and understand the size of instances, which in turn, assigning sufficient resources to each application.
- Agility usage: - generally, two types of agility have been released with campus cloud computing.
    i. Developer's agility offered to create business applications.
    ii. Infrastructure and IT team agility to empower developers, managing the use of resources, and continuously maintaining performance.

Agility does not come without a mindful way to deal with the picking cloud stage. The campus cloud makes the agility is conceivable, however, does not promise it. Significantly, without ensured performance agility is futile. Moreover, despite many benefits from implementing the campus cloud by providing useful infrastructure, tools, and platforms, the lack of integration with the home developed system. Which in turn, led to an increase the data redundancy and poor data management. Additionally, the experience and agility level of university staff need to develop and optimize by training and share the concept of campus cloud computing. Currently, Iraqi HEI the job of IT offices has been developing particularly inside bigger universities. As the utilization of cloud-based services expanded, central IT started to play the job as a specialist in cloud administrations to guarantee proper management, governance, and control.

- Cost: - campus cloud computing offers a lower cost per transaction or service. However, the costs can quickly rise contingent upon what number of VMs are being facilitated in the cloud. With campus-cloud, the well-known statement is "pay for what you think you will use." accordingly, the university-IT team needs to select some instances that should be running in the cloud data center and needed resources as demand. The performance benefits and the cost savings are considerable if instances are appropriately sized based on real-time application demand.

7 CONCLUSION AND FUTURE WORKS

Cloud computing is a new technology for developing a significant option in the education and management process. Higher education institutes (HEI) should allocate adequate cost to offer resources to deliver

education services with the newest technology. However, due to the economic crises experienced by the countries especially with COVID19 pandemic, the financial support for higher education institutions has decreased. Thus, education continues to keep pace with technology by available resources and exploit them with the rapid development of technology.

Accordingly, HEIs are quickly taking the adoption of cloud technology to reduce the service cost, to deliver more productivity in learning and management process, and to offer higher responsive for data retriever, to assist in decision-making. This paper proposed CCC system solution that is defined as the holistic adoption plan for cloud computing that includes nine stages. In addition, this paper built a questionnaire focused on the usage rate of using IT among the academic and university staff. The obtained result shows that more than 68% of university staff are precipitate to use internet family applications in their work. Nevertheless, they do not have enough knowledge about the term cloud computing.

Moreover, this study concludes that performance, agility usage, and cost are basic parameters that motivate the use of campus cloud technology in HEIs. Therefore, CCC helps to provide an abundance in cost, HR, time, and help the university staff to achieve their tasks at anytime, anywhere. Our attempt enjoys certain advantages when compared with the others, especially concerning the adoption of the strategic plan. It can be considered as the first campus cloud environment that defines in detail the working mechanism for each stage in the adoption plan.

Finally, this study opens the door for universities, authors, and students to obtain the developing plan. Also, authors going to develop a practical environment of CCC using Hyper-V and implementing it at the University of Fallujah.

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