



# Adoption of Cloud Computing in Higher Education Sector: An Overview

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**Abstract:** This research aims to highlight the main challenges and concerns of using Cloud Computing (CC), not only focusing on the benefits. The research presents a systematic review of CC concepts, models, services, and their positive effect and significant impact on higher education institutions. The result of the conducted analysis found many challenges and concerns that have to be overcome before deciding to adopt the CC in the Higher education environment. Transition to the CC model must be done according to a comprehensive plan that handles the different challenges. Concerns and challenges are classified, and each subcategory is discussed. The guidelines and recommendations offered by this research can help to overcome many challenges and clarify the roadmap of successful adoption of CC in high education institutions.

**Keywords:** CC, higher education, adoption of CC, cloud technology, service model

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## I. INTRODUCTION

In the modern world, technology is considered as the most influential element in all development aspects. CC now days considered a leading technology in the field of computing and the widespread solution for a core problem for different types of organizations.

CC has several definitions in literature that discussed the nature, architecture, use, and opportunities in the CC environment. The most common definition is given by NIST (National Institute of Standards and Technology), CC is on-demand access to a shared pool of computing resources [1, 2].

The nature of cloud enables any organization to store the data outside the workplace and perform the required update in the cloud [3]. The model of CC is based

on using the internet by the users to reach different computing resources according to their demands and paying amount of money for their consumption of resources [4].

The use of CC in higher education organizations offering new opportunities such as using virtual labs, software, hardware, and management instruments to monitor and manage their dedicated resources in the cloud. This concept is meet the higher education objectives to provide knowledge to the students either locally, in university, or from different sites or using both ways at the same time. On the opposite of using traditional local IT service providers, using in universities and other educational organizations could help to overcome the major problems from owncloud computing an infrastructure, platforms, software, and solving initiated maintenance problems and

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meet their quality of service, which formulated by SLA [5, 6].

The objective of higher education institutions except for knowledge transition is to be a research incubator for scientists, teachers and even students.

#### A. Research Motivation and Method

During the search that provided with existing researches about the adoption of CC in higher education institutions, most of the authors are focused on the benefits of adoption of CC and the framework of using this technology by institutions. Authors in this paper aim to explorer, highlight not only the benefits of CC in higher education institution, but focus on the concerns and challenges of adoption the CC in this environment. This research tries to give some recommendations and pieces of advice to overcome these challenges.

Authors follow a systematic literature review for collecting and assessing the content of researches and conducting valuable recommendations and advices.

## II. THE CONCEPT OF CLOUD COMPUTING TECHNOLOGY

#### A. Cloud Computing Service Models

The use of CC technology in educational institutions like other institutions is implemented through one of the CC models that provide the required services. The main basic services delivery models of CC. Based on [7], CC services are classified into three basic services as shown in Fig. 1.

1) *Infrastructure as a Service (IaaS)*: The IaaS provides users with the required resources from the cloud. These resources provided as services are networks, storage, processing and other resources that needed to run the software. It provides users with remote virtual hosting servers and ability to save any files types and accessing them from anywhere via internet connection. Users have to manage their operating systems, software, and applications. In such a model, users have to pay for the use duration of these resources [8].

2) *Software as a Service (SaaS)*: The SaaS provides users with access to the needed software, networking soft-

ware, and operating system are provided by the service. So, no need to install the software or application on the end machines. Also users not concern about managing software updates, security issues, and time-consuming maintenance.

3) *Platform as a Service (PaaS)*: An integrated platform for the development environment, deployment, and testing and supporting web applications provided to the users as a cloud service, while the client has to manage its required software and applications.

#### B. CC Deployment Models

1) *Public cloud*: This cloud model provides services for everyone (organization) who want to use any computing resources (Hardware, Software). Usually, these services are provided by an organization (provider) who sell the services according to the user needs and requirements. An example of such provider is: Amazon Elastic, Google App Engine, and Microsoft Azure.

2) *Private cloud*: The infrastructure of this model is designed for an organization. Installation is performed by the organization itself or by the third party assigned by the organization manager. This model provides more secure dedicated and separated cloud services for specific users. The implementation of such a model allows users with fast responsiveness to business needs and reduces the cost of services [9, 10].

3) *Hybrid cloud*: In the Hybrid model, two types of CC models are combined in one model. Public and private are used together at the same time. This choice is convenient when organization needs to scale up its IT infrastructure in a short time. Public cloud used for hosting public and insensitive data, while the private cloud used for hosting sensitive and critical data and services [11].

4) *Community cloud*: This type of CC provides services to a limited number of individuals or organizations, where these organizations are sharing the infrastructure and resources.

Services and resources use are restricted to the members of community. An example of community cloud is a group of universities that shared resources and data for research community, which managed internally or by the third party. Fig. 1 depicts the CC model.

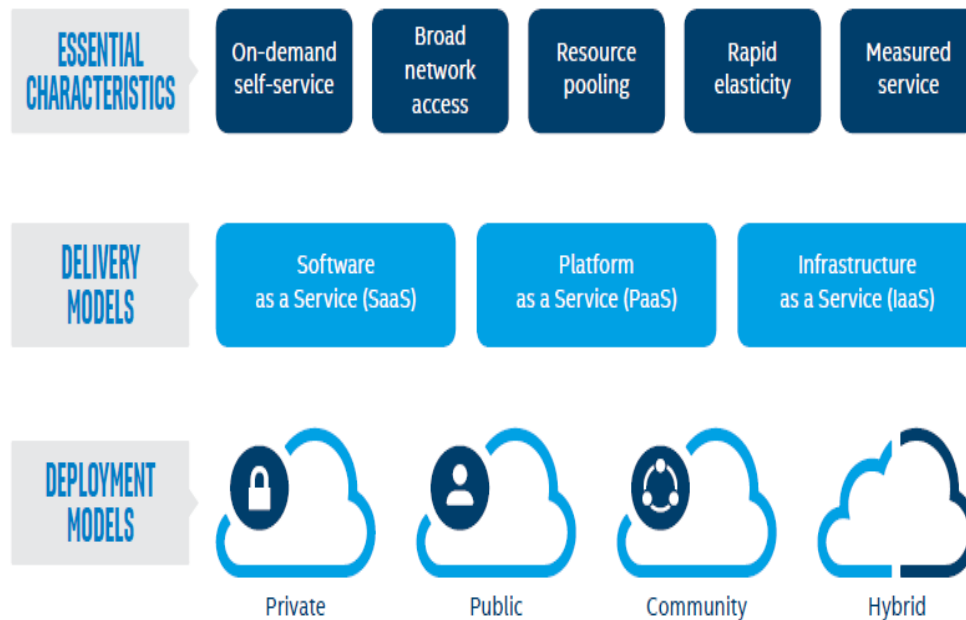


Fig. 1. The CC model [12]

### III. CC IMPLEMENTATION IN HIGHER EDUCATION SYSTEM

#### A. The Need for CC

In recent years, CC has initiated by many higher education institutions for the magnificent benefits achieved though its implementation [8]. Implementing cloud base education systems implicate the use and creation of knowledge as a critical factor for economic, social, and technological transformation. There were many reasons which enforced higher education institutes to adopt CC.

- The high cost of resources, such as storage, servers, software, and hardware, was one of the main reasons. After deploying cloud services, many institutions have reduced the cost of traditional deployment (hardware, software, maintenance, setup, etc., from 55-65% [13].
- Increase Availability of services and resources. Since the resources and services that are exploited by students, teachers, researchers, and IT managers are provided according to SLA. The enhancement of availability will reduce the downtime and make services (or) resources accessible for students and teachers all the necessary time.
- Virtualization: the use of such technology allows effectively support education specific topics as computer networks, programming, and many other topics [14]. This technology can reduce the high cost of hardware, servers, storage, and networks. Virtualization eliminates the downtime and enhances the efficiency of system, and any setup running

becomes easier, as mentioned in [15].

- Elasticity and Scalability. Cloud elasticity provides the needed amount of resources for each task. This feature is very useful for development operations, e-commerce tasks and software as a service. On the other hand, scalability includes the system's ability to grow workload sizes within pre-existing hardware, software and other related infrastructure in the absence of impacting performance [16].

#### B. The Benefits of CC for Higher Education System

The use of CC in higher education institutions is gaining many benefits from various aspects of their work. These benefits are achieved the use of cloud services by any of the educational system components, as depicted in Fig. 2.

The obvious benefits of CC in higher education institutes are:

- 1) *Ease of access:* Services and resources can be accessed from any place and at any time. This allows students, teachers, researchers, or any end-user to access the needed resources, publish or share any documents and webpages any time with minimum effort and time, where no need for downloading or installing any software, connect their devices with internet.
- 2) *Minimize the expenditure:* Having a strong infrastructure in higher education institutions requires large capital spending on this structure. The use of higher education institutions for CC contributes to the provision of large amounts of capital to spend on other needs of the

institution. On the other side, users of cloud infrastructure pay for the resources which will be needed and used, and this factor is dynamically is changed which in turn leads to optimal use of resources.

3) *Minimum maintenance*: The absence of needs for installing software and hardware setup, the malfunctions, and faults will be reduced to a minimum level, there will, therefore, be no need for technical support staff or maintenance problems.

4) *Powerful resources*: In the CC environment, the higher institution can use a powerful and developed software and hardware without any complexity, more storage capacity, and high-speed processing. Also, the institu-

tion can use virtual resources according to the students, researchers and teacher's needs.

5) *Competitive advantage*: Using CC in higher education institutions earns a competitive advantage. This feature is reflected in several aspects. The ability to create a competitive advantage through access and use of advanced software and application allow to analyze and process big data. Students, teachers, and researchers have the ability to access to the newest and most advanced methodologies in education and scientific research, while other institutions haven't the ability to achieve these results [17].

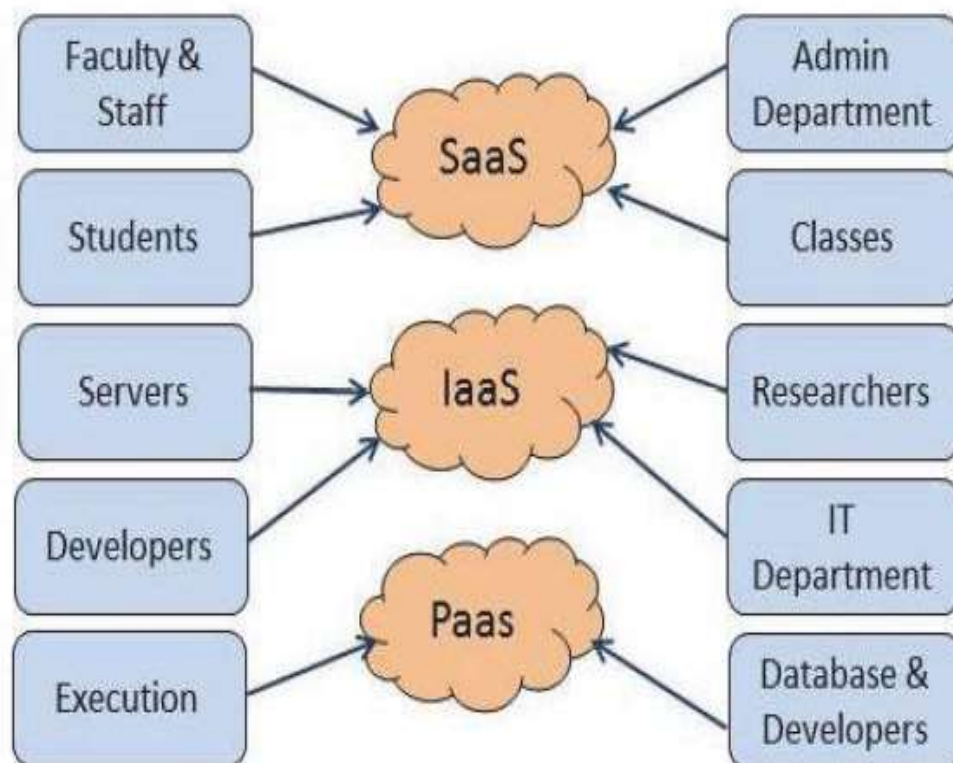


Fig. 2. Users of cloud services in higher education systems [18]

#### IV. ANALYZING CONCERNS OF ADOPTION CC IN HIGHER EDUCATION SYSTEMS

##### A. Technology and Performance Concern

There are important issues and challenges that may arise from the use of CC and related to the technological aspect and affect the performance of the educational system.

- **Security and Privacy**: It is considered as the most serious and popular concern of institutions and other different organizations. Existing a third party who takes responsibility for securing and protect-

ing the data and privacy poses a threat to the entire educational system.

- **Lock-in**: In some cases, the institute or organization finds all their data and services are tied to specific provider products, and their data is stored according to these products, which make the transition or migration to another provider so difficult [19]. Institutes may be claimed about the interoperability of the provider's products and data transferring from system to another with being according to their benefits.



- Integration and legacy systems. One of the major challenges that may appear when deciding to adopt CC services in the institution. That because the need to integrate the existing data structures and the entire system with the CC services. From other side, the huge number of different needed applications that may use in institutes must be compatible and associated with each other's [5].
- Reliability: CC services, like any service provided for customers or organization, is prone to stop or interrupt during the working time. Usually, the SLA guarantee the level of services provided by the cloud provider, although the customers worry about the reliability of provided services and must take these situations into consideration when deciding to adopt the CC-based services. It is important to take on consideration that many performed experiments showed that the reliability and performance of clouds are beneath the expectations [20].
- Availability: Availability of applications and resources should be 24h/day. The students or other users have to reach. Their applications anywhere and any time of course according to their privileges.
- Unsolicited advertising: is one of the threats which can appear when using cloud-based systems. It is a type of advertising or spamming that may be downloaded from application stores. This type of adware can penetrate the user's devices and show unsolicited advertisements. Such adware may collect much personal and specific information, then forwarding them to another place or website [21].

#### B. Economic and Financial Concerns

The adoption of higher education institutions for CC should not ignore the financial and economic aspects of the institution. The adoption of this technology requires spending in various aspects, including service fees paid to the service provider, some of the expenses of updating the equipment, training expenses, and rehabilitation required to deal with this technology. It is worth mentioning that suppliers often raise service fees after the institution has adopted this technology as a sustainable tool of education.

#### C. Management Support and Vendor Selection

The use of CC technology in higher education institutions depends to a large extent on the approval and support of senior management. Decision-making and support, of course, will be achieved only with the administration's conviction of the benefits that will be achieved

through this use of CC. Here is the role of specialists in technology in the educational institution to explain the needs and returns for the use of CC in the educational institution and the possibilities available to pay for it only. There are many vendors for cloud-based education systems, where the management of institution have to compare between them. This process must take into consideration the requirements of institute, the provider status, the reserved budget, and other considerations.

#### D. Operational Concerns

Institutions management must take into consider the probability of non-implementing the CC in their environments due to many reasons such as exceeding the expected expenditure, the benefits which achieved by cloud services may less than the cost of services, and any organization before implementing a new technology must be aware of the user acceptance of this technology. In many cases, cloud services couldn't be customized as the organization requirements, and if it could, the cost is improbable. Services also may face several challenges related to regulations requirements [22].

### V. CONCLUSION AND RECOMMENDATIONS

CC is a promising technology for higher education institutions. In this research, we discussed the effect of the adoption of the CC in education, models of services and deployments. By analyzing the previous researches, lot and very valuable benefits could get. CC offers access to applications, services, and resources at any time, anywhere with pay for use principle. In the study, several benefits and advantages are listed and analyzed. Despite the advantage of CC, which enhances the quality of knowledge transferring and facilitates the learning process during the offer of institutions have to be aware of several concerns and challenges before using such technology. Institute should study, analyze its requirements well, and then decide if it needs the cloud technology to avoid a non-implementing situation. Security challenges and privacy awareness will be reduced to minimum by adopting the hybrid model CC. Cost reduction and services sharing are difficult to be achieved by legacy systems and technology.

In the future work, authors intend to propose a new comprehensive framework for adoption CC in education institutions, which meets many requirements of administrative and executive managers in institutions.

#### Declaration of Conflicting Interests

There are no competing interests in this work.

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