



SWOT Analysis of Cloud Computing Problems in Higher Education

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Abstract— *the use of cloud computing technologies in the higher education system of developing countries is a real opportunity for these countries. This paper aims to identify the strengths and weaknesses, opportunities and threats of cloud technologies through SWOT analysis. It consists of identifying and studying the main challenges faced by higher education institutions in adopting cloud computing. Our paper sheds light on the challenges of adopting cloud technologies in higher education systems through SWOT analysis.*

Keywords— *Cloud computing, SWOT, strengths, weaknesses, opportunities, threats, E-Learning.*

I. INTRODUCTION

Today, technological advances are affecting all aspects of life, including access to information, processing speed, and communication quality. Cloud computing is one of the modern forms of development, efforts are being made to solve existing problems in various sectors of developed countries through innovative technological solutions of cloud services. "Cloud computing is not a new technology, but a new way of delivering computing resources (networks, services, servers, data storage and processing)" [1].

Despite the demand and flexibility of the cloud computing paradigm, the scale, and the high nature of the paradigm, Gartner estimates that there is a low level of cloud computing in higher education. Gartner noted that only 4 percent of cloud services are in education. Another study found that 88 percent of cloud computing services should be used in schools. However, moving to the cloud may not be an easy task overnight. Higher education system faces a number of challenges that deters the system from adopting cloud computing. [2].

II. THE FACTORS AFFECTING THE ADAPTATION OF CLOUD COMPUTING TECHNOLOGIES IN HIGHER EDUCATION

The IT department provides students, staff, academics, and developers with a variety of software and hardware. Cloud technologies, in turn, allow these tools to be virtualized. This allows to do educational, research and many other activities online. However, there are a number of barriers to the adoption of cloud technologies in higher education, such as:

A. Security issues

Security in cloud computing is a major problem faced not only in academic institutions, but in all areas when adopting

cloud computing. Cloud providers need to maintain privacy, integrity, and availability by setting security requirements to meet cloud computing systems in education. Some of these requirements are the availability of identification and authentication of accounts for students, faculty, researchers, and administrators to verify and clarify each person using a username and password. In addition, control permissions, priorities, and resource ownership (authorization) processes must be provided. Encryption methods should be used to protect important institution information, such as exam questions, grades, etc., from tampering or unauthorized access.

B. Privacy

Institutions of privacy should ensure that important information is protected from unauthorized and malicious access to the cloud. A high level of confidentiality must be ensured in the process of storing student records, researchers' intellectual property in the cloud.

C. Reliability

Reliability has also been a problem for cloud users. For example, in February 2008, Salesforce.com customers were without service for 6 hours, while Amazon's S3: normal storage service and EC2 experienced 3-hour interruptions in the same month and 8-hour interruptions a few days later. The main reason for this is shown as interruptions in cloud services. Disruption of services in higher education institutions may interfere with student learning and affect class schedules. Disruption of services in higher education institutions may interfere with student learning and affect class schedules. It should be noted that the risks in cloud computing may not be 100% [3].

D. Network bandwidth and speed

Internet bandwidth and speed are the cornerstones of Internet-based education services. The quality of the service depends on the speed of the connection, the implementation of which may require investment in the network infrastructure.

E. Management

There is a difference between traditional education management and cloud computing based education management. Thus, the implementation of cloud computing leads to management problems such as teaching and

implementation, content and courses, exams and student management.

F. Acceptance

It is not easy to convince decision-makers in higher education to move from one system to another. Cloud computing is a new IT Paradigm that will change the traditional system. Therefore, the perception and acceptance of users (academics and senior executives) influences the implementation of cloud computing within institutions. The process is shown in Fig. 1

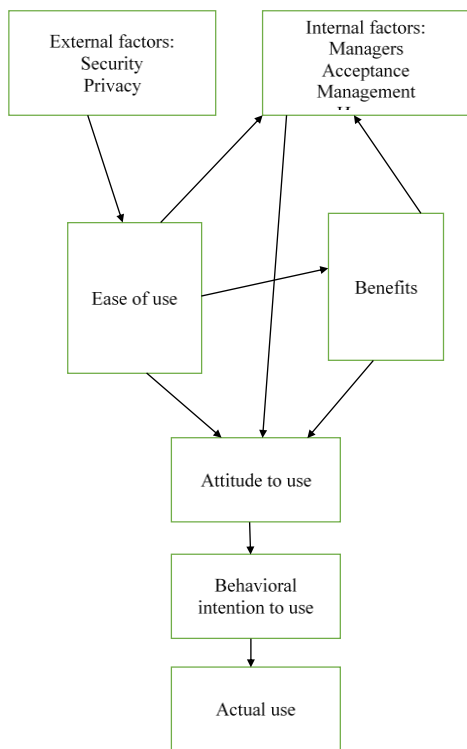


Fig. 1. An integrated model proposed for the adoption of cloud technologies in higher education.

III. ONLINE EDUCATION THROUGH CLOUD COMPUTING IN HIGHER EDUCATION SYSTEM

Cloud computing is about advancing a new era of knowledge by taking advantage of hosting. Following the hardware virtualization features, the e-learning program in the cloud reduces the cost of construction and maintenance of training resources.

The IaaS service of cloud technologies discusses some efforts to apply it in education, which focuses on booking a virtual machine for students over a period of time [6].

Cloud computing is used as the basis for creating and configuring VM images based on the IaaS service so that students can access MySQL, PHP, and Apache websites in a Java environment for their own experiences. Using this approach to the server, students can focus more on developing, deploying, and testing their programs in a server container [7].

Virtual machines offer a new model of services that increases the effectiveness of a personalized learning environment. The system is designed to subscribe to selected learning resources, as well as to create a personalized virtual

classroom, allowing content learning to register their programs on the server [8].

The Internet is constantly evolving from a place designed to read web pages to an environment that allows end users to run software applications. Interactivity and collaboration have become the key to new web content. The need for education is constantly growing and e-learning solutions need to be developed and improved.

Also, the e-learning platform needs to keep pace with technology, so use a new direction — cloud computing. There are several cloud computing service providers that support education systems. These include Google, Amazon, Yahoo, Microsoft and others. This paper focuses on the concepts of cloud computing, their uses, and the benefits of e-learning solutions. This research is important for the development of e-learning solutions based on cloud computing.

Typically, e-learning systems are developed as distributed applications, but this is not necessary. The architecture of a distributed e-learning system includes software components, such as a client application, application server, and database server (see Figure 2.), and the necessary hardware components (client computer, communication infrastructure, and servers).

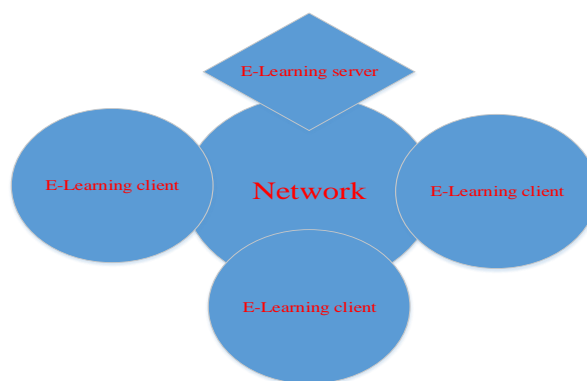


Fig. 2. Electronic learning system

The client device can be a desktop computer or a mobile device. The client application can be a simple web browser or a custom application. Even if current hardware and software are limited, mobile devices support multimedia applications. As the data processing is on the server side, the use of mobile devices for learning is growing rapidly. Still, mobile applications optimization is needed for electronic apps. The e-learning server uses a cloud computing system, so all the necessary resources are configured when needed [5].

The above model is useful for describing the stages of organizing e-learning in the higher education system through cloud technologies.

A. Infrastructure

Use of e-learning solutions on provider infrastructure.

B. Platform

Use and develop an e-learning solution based on the provider's development interface.

C. Services

Use the e-learning solution provided by the provider.

Although there is a major security issue due to the fact that both software and data are located on remote servers that can be damaged or hacked without warning, individuals and companies that use or develop cloud computing-defined e-learning solutions provides clear advantages [5]. These advantages can be summarized as follows.

D. Improved improbability

It is almost impossible for any curious (thief) to know where the machine that stores the desired information (tests, exam questions, results) is located or to know which physical component to steal to get it.

E. Virtualization

Virtualization allows quickly replace a broken cloud server without major costs and damage. Creating a clone of a virtual machine is very easy, so cloud crashes are expected to be significantly reduced;

F. Centralized data storage

Losing a cloud client is no longer a big deal, the bulk of applications and data are stored in the cloud, so a new client can be connected very quickly. Imagine what would happen today if a laptop that holds exam questions were stolen.

G. Monitoring data access

Monitoring data access is made easier, for example, because the only one location must be controlled instead of thousands of computers belonging to the university. In addition, security tasks can be easily tested and implemented because the cloud is the only access point for all customers.

H. Financial expenses

If e-learning services are used in a relatively short period of time (weeks, quarters, semesters), the cost savings will be huge.

IV. ILLUSTRATION OF CLOUD COMPUTING OPPORTUNITIES IN HIGHER EDUCATION SYSTEM THROUGH SWOT ANALYSIS

The acronym SWOT stands for strength, weakness, opportunity and threat. SWOT analysis is an effective tool used to determine the environmental conditions and internal capabilities of an organization involved in each project and is widely used in various decision-making processes. In this analysis, firstly, the purpose of the project, and secondly, its internal and external determinants are determined. This method can contribute to the study and evaluation of problems, based on all the key aspects of each issue, which can be comprehensively analyzed on the basis of the above factors [4].

As for this definition, strengths (S) and weaknesses (W) - internal factors, opportunities (O) and threats (T) - which are internal dimensions of control of the organization, are evaluated as external factors. SWOT analysis identifies what can help an organization achieve its goals and what challenges need to be overcome or minimized to achieve the expected results.

Table 1 shows the capabilities of cloud technologies through SWOT analysis. This SWOT analysis sheds light on the challenges of implementing or not implementing cloud technologies in our higher education system.

Strengths	Weaknesses
Cheap price. Learn at your convenience (anywhere, anytime and on any device). Backup and restore training materials. Simplicity of implementation. Storage capacity increases. Device diversity and location independence. Communication is easy.	Dependence on a high-level service provider. Technical difficulties and failures. Limited management and flexibility. Non-existent risk.
Opportunities	Threats
High level of interactive and collaborative learning. A smart environment with the ability to generate knowledge. The highest level of integration and knowledge sharing possible. Paperless and digital learning experience. High volume of data storage and availability of resources.	Data security. Management issues. Policy and control issues. Dependence on technology. Budget deficit

V. CONCLUSION

As mentioned above, there are many advantages of using cloud computing for e-learning systems in higher education. Higher education institutions, as stakeholders, must ensure that they offer quality education, research and public services to their students. As the number of students enrolled in public universities increases, the issue of quality is very important. The article discusses the advantages and disadvantages of using cloud technology in higher education through SWOT analysis, the method of organizing e-learning through cloud technology in higher education, how to better perform the learning process and prepare students for the necessary knowledge and skills is concluded.

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TABLE I. SWOT ANALYSIS