

## **Impact of Applying Cloud Computing On Universities Expenses**

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**Abstract:** *The recent world financial crisis has led to massive budget cuts for public education sector and diminishing private funds and endowments. Educational institutes, all over the world, struggling to maintain and update their IT infrastructures, crucial to daily works of students and faculty. Cloud computing is a new technology that can help colleges and universities balance their expenses while enjoying from high-standard IT services. This article investigates whether and how the adoption of cloud computing can help educational institutes tackle their budgets cuts. This article argues that cloud computing compared to alternative solutions brings countless benefits to the higher education system. Cloud computing technology is particularly advantageous for universities and colleges (e.g.FAU) that intend to make the access to the information easier, increase the speed of data transfer and at the same time decrease their costs.*

**Keywords:** *Cloud computing, innovation, cutting costs, higher education*

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### **I. Introduction**

Higher education is one of the most important pillars of social development. There is a strong partnership between the educational system and the industry. Researchers are able to contribute their knowledge and scientific breakthroughs to the industry which in returns leads to a stronger economy and a healthier society. It is very important for governments to invest in high quality universities and provide them the access to the most effective learning tools such as high standard IT infrastructure which can be used for educational software or easy data sharing within the classroom.

After the world financial crisis, many universities which suffered massive budget cuts, have had difficulty maintaining and increasing their computation capacity to match the ever growing need of computational resources for research purposes. As a result, these universities are trying to find alternative solution to cope with the ever growing conflict between financial strain and IT costs. Most of these universities started looking for new, secure and cheaper alternatives to existing IT solutions which would allow them to share information between university databases and students. Cloud computing has emerged as a modern and efficient way to share IT resources at a reasonable price. This paper argues the use of cloud computing platforms as an alternative solution for educational institutes which is likely to have a significant impact on the teaching and learning environment. Besides, this article consists of an overview and a discussion on the latest researches done on the application of cloud computing in colleges and universities.

Application of cloud computing in higher education institutes and for academic purposes creates numerous advantages for the colleges and universities. Firstly, it is cost-effective for them, considering the fact that they may be on a tight budget. Secondly, it has a positive impact on the educational experiences of the academicians who are involved in it. In addition, cloud computing increases the productivity of the IT staff.

Nowadays, the term “cloud computing” has become a significant idiom in the world of Information Technology (IT). Cloud computing at its core is a technology that uses the Internet and central remote storage and processing servers to support user applications and data. It allows users to access their data or their applications without installation, any local storage or RAM requirement. This is possible from any personal computer that is connected to the broadband Internet. Gmail or Yahoo email services are simple examples of cloud computing platforms. In other words, cloud computing allows individual users to own virtualized computing resources on a central physical data centre that is in fact shared among many other users around the world.

Universities take advantage of available cloud-based applications which allow their staff and students to perform their academic tasks. By providing the necessary IT infrastructure and other relevant educational services, cloud computing offers many benefits to educational institutes such as lower operation costs, personal and virtual computing resources and centralized storage for data access monitoring. (Pocatilu, 2009 )

The Purpose of this study is investigate and analyse whether or not cloud computing provides an appropriate platform for educational software and data sharing in educational institutes. The author will also try to illustrate how it can help the universities to reduce their excessive IT costs by adapting to cloud computing solutions.

## **II. Literature Review**

### **What is Cloud computing?**

Cloud computing refers to utilization of vast data centres distributed across the world for delivery of information and software maintenance as a service. It is a type of Internet-based computing, and it can be used in any market sector, including the educational sector, which requires IT resources. In cloud computing users do not need to have any background or knowledge on the internals of the services provided; they will transparently access the services through a broadband Internet connection anywhere in the world and need not worry about its maintenance or availability. Cloud computing services have become a significant player in Information Technology market share. CISCO white paper indicates that cloud computing market is a huge market which is expected to grow from \$40B in 2011 to \$240B in 2020. (CISCO, 2009 )

There are three different services which cloud computing providers offer:

#### **1 – IaaS (Infrastructure as a Service)**

Several years ago, if you wanted to control your company's website, you had to buy physical servers and other relevant hardware. However with IaaS, companies and other IT consumers can share and outsource their hardware requirements to the other companies, such as Google or Amazon, which have those resources readily available. IaaS providers supply customers with storage and other IT resources, such as disk storage, RAM, and IP addresses as they need them. This has particularly become easier with virtualization technology on common pool of physical data centre resources. IaaS is available through Amazon EC2 and IBM and is usually billed according to the amount of physical resources allocated and consumed.

#### **2 – PaaS (Platform as a Service)**

Many years ago, software developers had to manage their hardware, operating system, web server and databases locally. This was particularly very expensive for educational institutes with tight federal budget. With the introduction of cloud computing these software and hardware requirements can be provided remotely. Computer programmers can now run their software on cloud platforms without having to worry about managing and dealing with the complexity of underlying software and hardware requirements. This platform provides them with the operating systems and databases needed for development. PaaS also allows for the compute and storage resources to scale with the current application demand; this is extremely cost effective for educational institutes as they needed to purchase excessive software and hardware resources to be able to handle rare peak usages. PaaS is available through Google Application Engine or Windows Azure.

#### **3 –SaaS (Software as a Service)**

SaaS provides the consumer with the capability to rent processing, storage, networks, operating systems and other fundamental computing resources as well as their particular software application which is already developed and maintained by the provider. A Simple example of SaaS in an online email service such as Gmail which is hosted and maintained by Google.com SaaS providers install the application software in their pool of available datacentres and cloud users simply access the software through their clients such as Internet Explorer. Other types of SaaS hosting solutions are provided by Amazon Web services.

### **Different kind of cloud**

There are four types of cloud platforms in terms of sharing and security:

#### **1-Public cloud**

When the cloud is available as pay-as-you-go manner to the public, we call it a Public Cloud; e.g. amazon web services and Microsoft Azure.

#### **2-Private cloud**

Internal data centers of organization or enterprises which is not available to the public.

#### **3 – Community Cloud**

It means the cloud share by different companies. And most of the time it manage by third party or other organizations.

#### **4 – Hybrid Cloud**

This type of cloud is mix of several types for example (private and community or public and community) they are bound together by standardized technology.

(Michael Armbrust, Armando Fox, Rean Griffith, Anthony D. Joseph, Randy Katz, Andy Konwinski, Gunho Lee, David Patterson, Ariel Rabkin, Ion Stoica, and Matei Zaharia, 2009)

Also cloud computing it is not only a technology which is delivering many things. Many companies implement it in commercial issues. The famous example to this implementation is EC2 (AMAZON Elastic Computer Cloud) this cloud offers different kind of services in virtual computing environment.

We have different kind of clouds like smart market which is portal service to manage businesses. Smart desk, is a software package which users manage their applications by it.

Microsoft also use and invest on cloud computing. Microsoft cloud computing name is Azure.

Azure has three components:

- 1- Win- Azure
- 2- SQL Azure
- 3- Azure net services

Win Azure provides on demand compute for developer and manage the internet.

SQL Azure which help Microsoft SQL server to extend its capabilities into the cloud.

Azure net services which include Microsoft hosted and developer services that help to building blocks which needs for cloud based applications. (Sultan, 2010)

**Table1. Benefits of cloud computing**

Advantages	Description
Flexibility	Cloud computing offer more flexibility (often called elasticity) in matching IT resources to business functions than past computing methods.
Scalability	Organizations which use cloud computing not need scramble to secure additional higher-caliber hardware and software when user loads increase.
Decrease Cost	Organizations can reduce or eliminate IT capital expenditures (capEX) and decrease ongoing operating expenses.
Rearrangement of staff	By reducing or eliminating constant server updates and other computing problems and by cutting expenditures of time and money or application development.
Sustainability	The poor energy efficiency of most data centers, due to substandard design or inefficient asset usage, is now understood to be environmentally and economically unsustainable cloud service providers.
Easy implementation	Without the need to buying hardware, software licenses, or implementation services, an organization can deploy cloud computing rapidly.

### 2.1 Cloud computing costs

In this part I want to show is it economical to change or host to cloud or not?

According to (GRAY, J., AND PATTERSON, D. A conversation with Jim Gray., 2003) Using cloud computing in long term is economical and has a lot of benefits.

The capability to utilize the excess computing power is constructed on the supposition that applications can use all the cores on both sockets in the computer while costs of the computing have escalated to the maximum in 5 years,

The highest proportion of cost in IT devices is consumption of the electricity and cooling system which reduce the temperature of the hardware's. Cloud computing reduce all this costs in the system also because by using cloud we need less labors ( like engineers or technicians) therefore it leads to less expenditures in this area too (Sultan, 2010).

Also the best computing related-services which is economical and simple is cloud computing (Erdogmus, 2009).

### 2.2 Cloud computing in higher education

Efficiency of using cloud computing in higher education system had experienced by many universities. Also there is much previous work in field of cloud computing however majority of them are conceptual.

Many universities in United States, United Kingdom use cloud computing in their education system However there is some risks and challenges constrain higher education to adapt with cloud computing (Sultan, 2010) .Cloud system leads to more concentrate on research and teaching system rather than other IT software. (McCERA, 2010).

Also cloud computing offers a lot of benefits for e-learning systems by using virtualization and data centre storage for monitoring the data access. (Pocatilu, 2009 )

Also cloud computing is attractive subject for universities. In 2009 university of California (UC) at Berkeley, found cloud computing courses which were focused on developing and implementing SAAS application. (Fox, 2009).

IBM and Google are the main providers of cloud computing which promote it as useful tool for research and education. They publicized a cloud computing tool which designed for universities to improve knowledge of computer science students.

### 2.2.1. Risk and opportunities of using cloud in higher education

#### Opportunities

##### Dealing with peak demand

Some events such as enrollment in March can place an important IT infrastructure. Capacity of computing can be lent quickly and flexibly which is important advantage in this regard.

##### Cutting Costs

The most important factor in cloud computing is decreasing the costs. Therefore underlying principle is simply economies of scale. It means it should be costless for organization to prefer using it instead provides for itself.

##### Catering for specialized needs

Cloud computing can make services viable that are not economical on an institutional scale.

#### Risks

##### Security

In all kind of cloud computing in public and private organizations or universities, information transfer by Internet. This issue naturally increase the risk and concerning about the security in institutions and organizations. However there are some relies on degree of trust between institution and cloud computing owner.

##### Interoperability

Sometimes with special software, only one supplier can provide cloud computing communication. However these days' popular platforms like Google has independent platforms as services like Google application engine which is openness rather than lock-in.

##### Reliability

In fact, many cloud computing vendors should spend and invest more in cloud systems in colleges because of fail-proof system in more colleges. Strong Service Level Agreements (SLAs) can help manage, but not eliminate the issue.

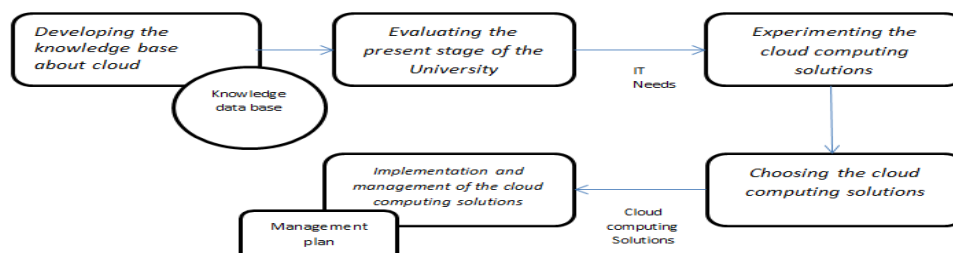
More, I try to explain different benefits and limitations on cloud computing in higher educations. Below table are shown benefits and limitations of cloud computing.

**Table 2 – Benefits and limitation of cloud computing**

Benefits	Limitations
From anywhere access to applications	All of applications cannot run in cloud
Supporting teaching and learning	There are risks for data protection security
Free software or pay per use software	Organizational support
Protecting environment by using green technologies	Maturity of solutions
Offline usage	Lack of internet speed can affect work methods
Increased openness of students to new Technologies	Lack of confidence

### 2.3 Cloud strategy in higher education

According to the (Mircea & Ioana, 2011) after world financial crisis which leads to more force to universities to cut their budgets and there is lack of budget to buy new IT devices. The best strategy is using cloud computing in colleges and universities.



**Figure 1: Cloud strategy in higher education**

The phases of using cloud computing in higher education:

1- Developing and expanding the knowledge about cloud computing. Participations in seminars, conferences and find suppliers. Consulting with experts. More information and more knowledge lead to better decisions. (Wyld, 2010)

2- Evaluating the current Stage of IT (Information Technology) of the university and understanding the university IT infrastructure. It means understanding the data, services and process.

Cloud computing will let diverse groups of users to access stored files, mails, database, and other applications from anywhere they wish. By using the cloud model, students will be able to communicate and share information in the educational environment.

Transition to cloud computing solutions takes time. It starts from testing pilot project and then externalizing the applications for cloud. Then development and storing some data inside the cloud. The next step will be consisting of daily processing of the internal operation. (Buzzelli, 2010)

3- Choosing the Cloud Computing solution. Identifies data, function and application and process in the university or college. It can be consist of three categories: teaching, research and administrative support for main activities.

Then in the next step we should evaluate the elements identify in the first step and the last step is choosing the model of cloud (public or private) for each functions and process.

### **III. Methodology**

I used secondary data in this article. (MICROSOFT, 2011)

This investigation is based on Florida Atlantic University which runs Linux based blackboard on hyper-V (kind of cloud computing)

This is a Microsoft case study which is implemented in Florida Atlantic University .in this article IT department changes their servers to virtual one and use hyper-v a kind of cloud in its IT sector.

Microsoft help the university ( IT department ) to implement this changes also they use Questionnaire and direct interview with IT department staff ( e.g. Assistant Director of Enterprise Computing Service , Systems Specialist, Enterprise Computing Services and etc. They implement and illustrate the case step by step.

### **IV. Analysis**

Florida Atlantic University (FAU) established in 1964 and it was the first public university in southern Florida. In 2009 it has more than 29,000 students in six different campuses.

The school are growing 5-7 % annually as the demand for IT services however because financial crisis Government cuts the budget therefore IT sector are not able buy new physical servers.

Based on interview with Basiratmand, Director of Enterprise Computing Services and Chief Technical Officer: they wanted to change the older servers also tries to increase the performance of the school's critical management system which used by FAU professor to communicate with students. However they do not have any budget therefore they should use their hardware efficiently.

After a while the IT department started to using VMware ESXi virtualization software (a kind of cloud) to use virtualize server. They created 12 VMARE that each one running the eight virtual machines.

However according to Assistant Director of Enterprise Computing Services: they do not have enough tools and staffs for manage the virtualize environment. So they decided to upgrade VMware product to manage the tools however the cost of licensing was very high and FAU IT department cannot buy them.

#### **Solution**

In 2010, they bought blackboard version 9.1 which designed for virtual environment and running the Linux operating system. Also it has Intel processor which has more flexibility, scalability and more option in virtualization. Also they try to find proper virtualization software.

Systems Specialist in Enterprise Computing Services of FAU stated that: IT department used Hyper-V virtualization technology in the Windows Server 2008 R2 operating system which provides high performance and control the Linux based virtual machines. They testing it about seven weeks and could not find any holes in Hyper-V.

(Hyper-V is Microsoft Private Server cloud. It is IAAS – infrastructure as a service)

In 2010 (MARCH) IT staff deployed windows server 2008 on 24 Hyper-V production hosts. They can create 149 virtual machines on these hosts. They have 4 or 5 virtual machines for their server.

The most significant advantage of virtualization with Hyper-V is that it can run with 2 different operations systems Linux and Microsoft server and also it can distribute many of our IT services for example remote campus location for higher performance.

### **Centralized, Automated Management**

Florida university using Microsoft system centre to manage its virtual and physical environment. Also staffs use this system to create virtual machines from templates which can manage both virtual machines and physical hosts. The program includes a feature called Performance and Resource Optimization (PRO) they use it to balance the server workloads automatically increase the performance of environment operating.

In addition, performing maintenance on physical servers is so easier in a Hyper-V environment. The IT staff can turn off physical servers, insert memory and the Hyper-V virtual machines are automatically paused.

Based on interview Basiratmand Director of Enterprise Computing Services and Chief Technical Officer of FAU believe: Microsoft is the best environment for cloud computing because of its low costs and high performances.

### **Benefits**

By using Hyper-V in data centre for virtualizing, FAU Decreases its IT costs at least \$ 600,000 and use new IT services without employment new staff. FAU run blackboard on Linux in the Hyper-V environment simplifying administration and increased the performance.

## **V. Discussion And Conclusions**

Based on Microsoft case the results indicate that using cloud computing in FAU has lot of benefits and advantages for their system.

FAU saving money on servers, with 149 virtual machines created so far, that's 149 servers they haven't had to buy at \$5,000 each, or more than a \$500,000. In addition it leads to decreased in server maintenance costs about \$ 100,000. In future they can save more money because they want to replace four Sun servers with Dell servers.

In addition, IT section increases its services and performances with no growth in staff,

Because virtual machines can be deployed to any campus location very fast from a central console rather than physical servers which send staff there to set them up. Also staffs have more free time and it leads to higher performances of them.

Also FAU has better performance with using Hyper-V because blackboard running faster

On Intel processor based servers. Better performance of key applications such as Blackboard means fewer user complaints and help-desk calls.

According to this case cloud computing has a lot of benefits for system of education. Is By using cloud computing universities are able to save a lot of money and also reallocate them in other important sections. In addition if they contract with reliable cloud computing provider like Microsoft they will have higher security too In addition it leads to higher performances of staffs.

In a nutshell, cloud computing is the new technology which can improve the quality and speed of transferring data with cost-effective price also it leads to decrease the consumption of energy because using virtualization rather than real servers and other IT devices . Therefore it can be useful for universities and other educational systems.

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