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ABSTRACT

Higher Educational Institutions worldwide have become highly dependent on information Systems for their IT provision and service delivery. Thus, the necessities for educational resources like hardware, software, study materials, teaching tools, teaching staff sets. Have been raised. The objective of this research is to find alternatives and replace the computing machines and other peripherals that are not optimally used, by adopting Cloud Computing. This research studies the current status of adopting Cloud Computing in Higher Educational Institutions in the Sultanate of Oman. It investigates the current state by distributing online questionnaire to Faculty in IT fields and employees who are working in ICT. Additionally, this research proposed a Higher Education Hybrid Cloud framework which will be delivered to all Higher Educational Institutions in Oman to provide flexible means for accessing educational resources anywhere and anytime on demand. It facilitates the innovative teaching pedagogies, enables more effective knowledge transfer and encourages lifelong learning. There search finding shows that adopting Cloud Computing in Higher Educational Institutions in the Sultanate of Oman is a better solution for learning progression and service delivery requirements. Accordingly, when the Proposed Higher Education Hybrid Cloud framework will be implemented, different academic institutions’ users will be able to access the services provided by cloud providers online which moves the user from being attached to a single machine to the Internet.

Keywords: cloud computing, higher education, Oman

1. INTRODUCTION

In recent days, Higher Educational Institutions are transforming their service delivery model by adopting cloud computing for solving problems of computing and storage.

Cloud Computing introduces many benefits for Educational Institutions like rapid decrease in hardware cost and increase in computing power and storage capacity. The Cloud Computing trend of replacing software traditionally installed on computers with applications delivered via the internet. Cloud Computing provides a set of tools to help students, faculty, researchers and developers to use applications without installing the mouthier computers and allows access to saved files from any computer with an Internet connection which makes learning tools accessible for a large number of students.

Higher Educational institutions, however, have a clear unique mission and a strategic purpose. Many educational institutions worldwide decided to move partially or completely their infrastructure to the cloud.

This trend didn’t seem to be followed in Higher Educational Institutions in the Sultanate of Oman.

Hereafter, this research paper intends to get answers for the following research questions: Are Omani Higher Educational Institutions (OHEIs) following this trend to move to the cloud? Is Cloud Computing currently ready to meet the needs and requirements of Omani Higher Educational Institutions? Is it really the right time to switch the IT infrastructure of these institutions to the cloud?

2. CLOUD COMPUTING IN HIGHER EDUCATION

2.1 Adoption of Cloud Computing in Higher Education

Higher education is the most substantial pillar for the country’s development. Through the partnerships between universities, government and industry, researchers and students have proven their contribution to the transformation of society and the entire world economy. In the field of education, Cloud Computing is very practical for a variety of reasons. Indeed, Cloud Computing will enable a certain educational institution to actually make use of the global internet resources for data analysis and data storage [Jain & Pandey, 2013]

Nowadays, many Educational Institutions intend to adopt Cloud Computing in order to solve computing problems and storage. There are three main benefits for Cloud Computing [Singh & Hemalatha, 2012] [Saidhbi, 2012]:

a. Rapid decrease in hardware cost and increase in computing power and storage capacity, and the advent of multi-core architecture and modern supercomputers consisting of hundreds of thousands of cores
b. The exponentially growing data size in scientific instrumentation/simulation and Internet publishing and archiving
c. The widespread adoption of Services Computing and Web 2.0 applications.
2.2 Challenges of Cloud Computing In Higher Education

Many challenges of Cloud Computing for Higher Education exist related to the relatively new and rapidly evolving marketplace for Cloud services.

For Higher Education, decisions to adopt Cloud Computing will be influenced by more than technical and cost considerations [Cisco, 2010] [Jain&Pandey,2013].

Information is the life blood of higher education, and decisions on how to manage that information can have far-reaching political, social, and economic considerations on the students, faculty and the society.

The adoption of Cloud Computing causes many risks and challenges such as deciding to use a more traditional outsourcing arrangement. The academic institutions need to weigh the costs and benefits but a major factor of these decisions will be their level of trust in both the cloud deployment model under consideration and the entity providing it [Jain&Pandey,2013] [He,Cernusca&Abdous,2011].

Rosalyn Metz [Metz, 2010] discussed why the traditional IT infrastructure is sometimes not good enough: when an institution develops or deploys a new application, they first must jump through a number of hoops. For example, if an institution decides they would like to install the learning management system Moodle, they might have to order a server, wait for the vendor to ship it, install the server in the data center, provision an IP address for the server, setup the DNS for the new IP address, install the operating system, etc. [Jain &Pandey, 2013] [Metz, 2010].

The Cloud Computing challenge shave a great impact on migration decisions, so it is possible to effectively handle these challenges and concerns, including training, contract negotiation, and vendor management through careful planning. As a matter of fact, many Academic institutions and organizations are turning to ward actual Cloud adoption and deployment and are “outsourcing” computing to the cloud. For example, the University of Alabama at Birmingham has moved its Blackboard system from on-site hosting to vendor hosting [He, Cernusca & Abdous, 2011]. In fact, the Cloud Computing market is projected to grow from $40.7 Bin 2011 to $240 Bin 2020 [Cisco,2010]. Consequently, it is important to note that the challenges of Cloud Computing can be greatly reduced or overcome through careful planning, through collaboration, and through sharing of best practices. In order to adopt Cloud Computing in Academic institutions successfully, the cooperation among administrators, practitioners, other campus personnel, cloud users (instructors and students), and cloud service providers is needed. [He, Cernusca & Abdous, 2011] [Jain & Pandey, 2013].

3. METHODOLOGY

The online questionnaire was distributed via Emails to around 25 Higher Educational Institutions in the Sultanate of Oman: a Government University, five Colleges of Technology, five Colleges of Applied Science, four Private Universities and ten Private Colleges. After a runtime of about three weeks, a total of 86 respondents had accomplished the online questionnaire: 75% of them are faculty who are working in IT fields and 25% are employees working in ICT management and data center. These participants represented 13% (Count: 11 of 86) a Government University, 20% (Count: 17 of 86) Colleges of Applied Science, 21% (Count: 18 of 86) Private Universities, 16% (Count: 14 of 86) Private Colleges and 30% (Count: 26 of 86) Colleges of Technology. The pie chart below shows the percentage of each Educational Institutions participants’ responses.

Figure 1: Responses of the educational institutions participants in the online questionnaire

The results of online questionnaire indicate that about 64% of Higher Educational Institutions respondents see the Cloud Computing as the future successful model of IT in Educational Institutions. Consequently, more than half of respondents indicate that the time to migrate the IT at the Higher Educational Institutions has arrived.

Figure 2: Migration of the IT at higher educational institutions in the sultanate of Oman to cloud computing
4. DESIGN AND IMPLEMENTATION

The proposed architectural framework namely Higher Education Hybrid Cloud (HEHC) consists of four layers: User Interface layer, Software as a Service layer (SaaS), Platform as a Service layer (PaaS) and Infrastructure as a Service layer (IaaS).

4.1 User Interface Layer

The user interface layer acts as an interface between the users and cloud contents. It connects users from different Higher Educational Institutions to the cloud contents. It contains an authentication server that works as a master load-balancer that verifies whether the user is valid or not or whether the user name and password provided by the user is correct or not.

4.1.1 Authentication Server

The authentication server associated with users from different Educational Institutions to submit their requeststothecloudviatheauthenticationserver.Itisresponsible for collecting therequestsfrom users and forward them after verification to the cloud contents.

Each user terminal communicates the authentication server for receiving services from cloud side. The procedure is depicted in figure 3.

The steps of procedures are summarized below:

a. First of all, user request is sent to the authentication server with necessary user identification information like username and password.

b. The authentication server contains information about users such as access modes, user account name, and password and user type which is responsible to verify whether the user is valid or not.

c. After verifying the user as a legitimate user, the authentication server sends the request to the cloud system.

![Figure 3: Steps of communication between end user and authentication server](image)

4.2 Software as a Service Layer (SAAS)

This layer is a software delivery model which provides the access by using thin client, normally using web browser over the internet to the hosted programs and applications on the cloud. The hosted programs and applications are licensed to the users for use as a service on demand which are disabled after use or after on-demand contract expire. Examples are ERP, Moodle, Eduwave and other application software.

4.3 Platform as a Service Layer (PAAS)

This layer provides the access to different platforms programming language, distributed systems, net-centric systems and similar platforms. It provides a flexible and configurable platform that supports multiple programming languages and gives the ability to develop and deploy the applications either on private or public Clouds. It facilitates the deployment of applications without the cost and complexity of buying and managing the underlying hardware and software. It provides all of the facilities required to support the complete life cycle of building and delivering web applications and services entirely available from the Internet. It offers many facilities for application design, application development, testing, deployment and hosting as well as application services such as team collaboration, web service integration, database integration, security, scalability, storage, persistence, state management, application versioning, application instrumentation and developer community facilitation [Ammar, Hamouda, Gamal, Abdelmoez&Moussa, 2012].

4.4 Infrastructure as a Service layer (IAAS)

This layer is the lowest layer which is responsible for building the servers and setup their configurations. It delivers computer infrastructure typically a platform virtualization environment as a service along with storage and networking. It provides the flexible way of dealing with the hardware layer (servers, storage systems, switches, routers, and other systems) through virtualization. Rather than purchasing servers, software, data-center space or network equipment, clients instead buy those resources as a fully outsourced service.

4.5 Implementation of Conceptual Architectural Framework

Our architectural framework, HEHC (Higher Education Hybrid Cloud) deploys on a hybrid cloud which combines a local infrastructure as private cloud with selected public cloud. The hybrid cloud deployment model allows mixing and matching services from different CSPs (Cloud Service Providers) and provides more security for the applications and data hosted in the private cloud since part of the infrastructure is controlled by the institution [Saidhbi, 2012]. In other words, hybrid cloud is a judicious mix of public and private clouds in order to gain the maximum advantage from the good aspects of each of these clouds. Hybrid cloud works out the most preferred infrastructure since it comprises of
public cloud which used for less sensitive tasks and private cloud that used for most vital processing tasks [Viswanathan, 2014].

In addition, it will give us the ability to secure the institution’s critical application and data by hosting them on the private cloud without having to expose them to a third party [Saidhbi, 2012].

Hybrid Cloud the cloud infrastructure is a composition of two or more clouds (private, Community or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds) [Mell & Grance, 2011]. The next figure shows the proposed Hybrid Cloud Computing implementation architecture for Higher Educational Institutions in the Sultanate of Oman namely Higher Education Hybrid Cloud (HEHC).

The following steps illustrate how the user can use resources from the cloud.

a. The user sends a request to HEHC Interface layer
b. The authentication server in the Interface layer contains information about users such as access modes, user account name, and password and user type. It is responsible to verify whether the user is valid or not
c. Once the user is authenticated as a legitimate user, the request will be forwarded to the appropriate layer. Otherwise, the request will be rejected
d. In SaaS layer, the request is directed to the applications hosted in this layer
e. In PaaS layer, the user is enabled to develop and deploy the applications and programs with the ability to access public clouds resources and platforms
f. In IaaS layer, the physical infrastructures will be virtualized, so the request will be directed to the appropriate location for either public or private clouds

4.6 Importance of Higher Education Hybrid Cloud (HEHC)

Higher Education Hybrid Cloud framework is designed to be implemented and managed by the Ministry of Higher Education. It is provided to all Higher Educational Institutions in Oman to get benefits from using Cloud Computing not only for education and gaining necessary skills, but it is beneficial for academic institutions and can save a lot of resources as well. It provides flexible means for accessing the file, storages, e-mails, databases, educational resources, research applications and tools anywhere and anytime for faculty, researchers, developers, administrative staff, students and other users in university, on demand. It allows an effective management of the technological needs of academic institutions such as software delivery, development platform provision, data storage, and computing.

The proposed HEHC framework facilitates innovative teaching pedagogies, enable more effective knowledge transfer and encourage lifelong learning. It facilitates e-learning, knowledge transfer from academics and affords more teaching learning methodologies like improvement in course contents and providing lecture notes, presentations and assignments in digital form via the Web.

Since the presented HEHC framework is used to serve different users from different academic institutions, the users can get benefit from HEHC. For example, students, administrative staff and faculty can access the services provided by cloud providers online. Further, the developers can use all the software needed for their development online and all the hardware for hosting their applications through a PaaS cloud provider. Additionally, the researchers whose projects and researches require a
great deal of processing power and/or additional server capacity can carry out their projects and researches through an IaaS cloud provider.

5. DISCUSSION

In this research, the current status of adopting Cloud Computing in Higher Educational Institutions in the Sultanate of Oman was studied to ensure whether HEIs in Oman currently adopting Cloud Computing or not and to highlight the perceived concerns of adopting Cloud Computing that engaged the Higher Educational Institutions as well as to determine how we could improve the quality and accessibility to education via cloud. After studying the current status of Cloud Computing adoption in HEIs, the research showed that Cloud Computing is a part of Higher Educational Institutions’ IT strategy.

Consequently, a high percentage of HEIs are currently adopting Cloud Computing or willing to adopt Cloud Computing in the future.

The main focal point of this research is presenting a Cloud Computing framework that can be used by Higher Educational Institutions in the Sultanate of Oman in order to enable service delivery much more efficient and effective than the current system.

A Hybrid Cloud Computing Model is chosen because this cloud deployment type enables HEIs to combines the local infrastructure as a private Cloud with selected public Clouds in order to serve students and other users from different universities to enhance the teaching-learning and service delivery. Wherefore, the proposed Hybrid Cloud Computing and its components have been discussed.

The presented framework is designed to be implemented and managed by the Ministry of Higher Education. It is provided to all HEIs in Oman to get benefits from using Cloud Computing such as reduce the hardware cost, solve the computing problems and storage and improve the quality and accessibility to education anytime and anywhere.

An Online questionnaire was distributed to around twenty five selective Higher Educational Institutions. Pilot study was done for the main questionnaire in order to get more suggestions for improvement. A high percentage of the questionnaire respondents indicated that Cloud Computing is the future successful model of IT at Higher Educational Institutions in Oman.

The main goal of the presented Cloud-based Framework is effective management of technological needs of universities such as delivery of software, providing of development platform, storage of data, and computing.

6. CONCLUSION

Cloud Computing is here to stay. Cloud Computing is an emerging computing paradigm which produces a solution for old problems and provides opportunities for delivering a variety of computing services in a way that has not been experienced before.

A few HEIs have already started using Cloud Computing technology for educational purposes. The main goal of suggesting the conceptual architecture is for effective management of technological needs of universities such as delivery of software, providing of development platform, storage of data, and computing.

This research demonstrated how the academic institutions are already taking advantage of the benefits of using Cloud Computing in teaching-learning environments to overcome the current learning and service delivery system limitations. It presented the advantages of Cloud Computing as a means of classrooms for faculty, administrative staff, students and others. The research showed that deploying hybrid Cloud Computing is a better choice for the academic institutions since it gives the combined benefit of private and public clouds. The proposed framework is just the pathway map for the implementation of a whole virtual cloud based teaching-learning and service delivery ecosystem.

To sum up, Cloud Computing offers a plethora of tools and choices that should be carefully evaluated to ensure that all educational institutions users obtain the maximum benefits from such technology.

REFERENCES


