Cloud Computing for Educational Institutions in Pakistan

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Abstract: Cloud Computing basically allows organizations to extend their existing IT capabilities by using the internet and allows multiple users at multiple locations to make use of the same service or software without having the organization to invest in it separately. They acquire IT resources through an IT service provider whom they pay only for the services as they use it. In this way organizations can transform their fixed cost to operational cost. Over the world, cloud computing is being considered by many organizations as their future strategy for computing services.

Cloud Computing is an IT solution for all type of organization but especially suitable for organization like SMEs, government and non-profit organization who operate under budgetary constraints. Academic institutions are also budget constrained organizations. As the education trends are changing, the computing needs for academic institutions are also increasing. This is why Cloud Computing is considered an appropriate solution for them, to meet their computing needs.

This research would study 'Cloud Computing' a solution to meet the computing need for academia. The paper firstly reviews foundations of Cloud Computing to establish the basis for the conceptual understanding of 'Cloud Computing'. With these theoretical bases, then a generalized framework has been proposed for implementing Cloud Computing as an IT solution for academia, to meet their computing needs. Finally, the implications of this framework are discussed with directions for further research

*Keywords: Cloud Computing, academia, information technology*

1. INTRODUCTION

Cloud Computing is an evolving paradigm, many researchers have attempted to define this technology. Various definitions exist for Cloud Computing but if one carefully analyzes these definitions, they more or less talk about similar concepts presented differently.
L. M. Vaquero et al. [3] have made a contribution towards analyzing various definitions of Cloud Computing and then summed up all the concepts by presenting a holistic definition of Cloud Computing. He states that:
"Clouds are a large pool of easily usable and accessible virtualized resources (such as hardware, development platforms and/or services). These resources can be dynamically reconfigured to adjust to a variable load (scale), allowing also for an optimum resource utilization. This pool of resources is typically exploited by a pay-per-use model in which guarantees are offered by the Infrastructure Provider by means of customized SLAs (Service Level Agreements)"

1.1 Cloud Architecture
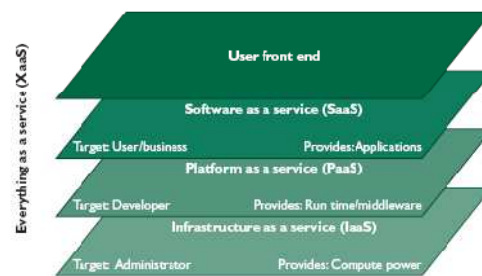
Figure 1. A general layered architecture of cloud infrastructures. Cloud computing uses IT infrastructure as a service. Its architecture defines three distinct layers from computing resources to end-user applications. [10]

The architecture of cloud computing has been presented by many scholars at various platforms. Literature shows that the approach of these scholars in elucidation of the architecture of Cloud Computing may be different but ultimately they mostly have discussed the similar concepts. Basically literature suggests that Cloud Computing model comprises of three abstract layers of services [10, 14]. These layers are stacked one above the other as shown in figure 1

- Infrastructure as a service layer; abbreviated known as IaaS – providing hardware as a service
- Platform as a Service layer; abbreviated as PaaS – proving development platform as a service
- Software as a Service layer; abbreviated as SaaS – providing applications as a service

1.2 Problem Statement
Cloud Computing is a contemporary trend in Information Technology. It is considered as a technology to manage Information resources. This technology can be utilized by academia not only to manage Information but also to keep abreast with their global counterparts and with the industry. In Pakistan, many academic institutions are operating under severe budget constraints due to which they are unable to invest much in Information Technology as a vital support activity. It is the need of the era that academia should have

access to high-tech and up to date Information Technology resources to efficiently manage their operations as an education provider and also as a hub of modern research. The author of this study would therefore like to study Cloud Computing as a technology solution for academia to manage their Data/Information efficiently through state of the art technology and provide better services in terms of education and research.

2. CLOUD MODEL AND IMPLEMENTATION FRAMEWORK

In Pakistan academic institutions generally operate under strict financial constraints, especially government institutions. For them it is not possible to invest heavily on support activities like, Information technology. For such cases 'Cloud Computing' is the best solution where academia can focus on innovative business models based on various aspects of cloud computing.

Focusing on the technology adoption problems faced by academia and the proposed Cloud Computing solution, a 'Cloud Computing Model' and an cloud implementation framework is proposed for the academia. This model / framework has been discussed with reference to higher education institution operating particularly in Pakistan but in its holistic view it can be mapped over other education institutions particularly higher education institution operating globally.

This model is based on various studies carried out in the past regarding implementation of Cloud Computing. The model is involves the role of Higher Education Commission (HEC) of Pakistan as well

2.1 Higher Education Institutions in Pakistan

In Pakistan there are total 133 universities/degree awarding institutions operating under the Higher Education Commission (HEC) of Pakistan. Out of these 73 universities are registered as Public sector universities and 60 are Private universities. Table 3-1 [17] presents the details about the number of public and private universities operating in each province of Pakistan.

Table 1. **Universities Registered Under HEC [17]**

Region	Universites	Public	Private
AJK	4	2	2
Balochistan	8	6	2
Federal Area	16	13	3
Gilgit-Baltistan	1	1	-
Khyber-Pakhtoonkhwa	24	15	9
Punjab	41	22	19
Sindh	39	14	25
Total	133	73	60

3. CLOUD MODEL FOR UNIVERSITIES

There are basic two of services that universities provide:

- Teaching/Learning; includes course material, projects, reports etc.
- Research: includes research

The data that universities maintain are categorized as:

- Intellectual Capital:
- This includes material like eBooks, Curriculum, Course outlines, Assignments, Projects/Term Reports, Outcome of R&D, etc. This type of data/information is an intellectual asset of any university but this can be shared with certain restrictions.
- Operational Data:
- This includes all data/information related to regular operational activities like daily transaction data. This type of data/information is purely related to universities internal matters and is not to be shared with other external entities.

Now based on these two type of data/information generated by universities, the author here suggest a Cloud Computing model which comprises of a partial Private and partial Public Cloud type. Thus a "Hybrid Cloud Model" is proposed for universities. Where the data/information that is purely related to universities internal matters, that is the Operational data, would be placed over a Private Cloud where as data/information related to Intellectual capital would be placed over the Public Cloud. Now in this model the Public Cloud would be owned by HEC, thus this would act as a Private Cloud for HEC. In this model this Cloud is termed as 'HEC Cloud' and the private clouds for each university would be termed as 'University Cloud'.

3.1 HEC CLOUD

Data/information placed over this HEC cloud would be the Intellectual Capital produced by universities. HEC would be the owner of that data/information where as the university that has produced that data/information would be the Contributor and the other universities who would be accessing that data/information would be Customers for that data/information.

The data/information placed over this cloud would be shared by all universities operating in Pakistan but strict policies would be applied to avoid plagiarism.
The benefit of would be that the

- Pakistani higher education system would have a pool of Intellectual Capital produced by Pakistan. This way HEC can maintain a record of the Intellectual Capital produced in Pakistan.
- This would motivate universities that are not much involved in R&D to get involved in R&D so that they

can also become a contributor for this pool of data/information.

- This would avoid duplication of efforts. Like in many cases, especially in case of students projects, there is no record of the projects carried out. Though many universities maintain this record internally, but this information is not available to other universities. If this information is shared through the centralized pool maintained by HEC then universities can avoid duplication of projects. Instead of doing the same project again in this case that project would be carried forward to a next level hence the quality of research would improve in universities.
- Students or faculty/researchers who can involve in collaborative research. Like if a researcher finds someone doing a research through some other university and that research is similar to his/her research idea, then instead of seperatly working on similar research they can share their resources and produce a better research output or they can even get involved in Collaborative Research.
- HEC can maintain a check on the work carried out by universities and if they find any deficiency they can help that university to improve.
- In short this would help improve the quality of teaching, learning and research At the same time universities don't have to invest huge amounts of money for the IT infrastructure to maintain this work and gain the benefit.
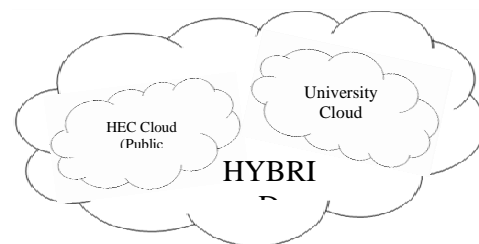
3.1.1 UNIVERSITY CLOUD

Data/information placed over this university cloud would be the Operational data/information produced by the universities. The individual universities would be the owner of that data/information. Only members of that particular university would have access to that data. No other university, HEC or any other organization would interfere with this data/information.

The data/information placed over this cloud would be accessed by members of that particular university only. Even they can apply polices for giving access to various type of users. For example the students would only access data/information related to their grades, courses they are taking, their fees related data etc. They would not have access to other operational data. Similarly, employees would be given access to data pertaining to them but would not be able to access data pertaining to other faculty members etc. etc.

This type of cloud would require strong security measures applied because this data/information would be placed over the internet through private cloud and it is not supposed to be views or accessed by outsiders. For example if someone from outside breaks the security of the system and manipulates the grades/results of students then this would have very strong repercussions.

The benefit of would be that the

- Universities don't have to invest heavily on IT as a support activity. Not even to buy computers, servers, etc etc nor even to but licensed software. They would not even require investing on maintenance of the IT infrastructure. They just need to pay a usage fee. Rest would be maintained by the Cloud service provider.
- By placing their operational data over the cloud, universities would only be paying for the cloud services they use hence, cut down on their IT budgets. In this way they can enjoy the benefits of growth in terms of automation and scalable technologies with low budgets.
- The university would be saved from hiring a pool of human resource to manage this IT infrastructure. This would not only save them from paying salaries but also help them save the cost used for training & development of these employees to keep them updated about the new trends & technologies in IT.
- The universities who can afford heavy investments in IT infrastructure they can even save money on this area and use that money on some other area to improve their services.
- University can provide better services by providing 24 hour access to data/information. This will give convenience to everyone working with the university. Convenience not only in terms of 24 hours access but also providing timely information. For example, students can get their results as soon as it is announced. They don't have to physically visit the university to register for courses or pay the fees. Everything will be handled through the online applications/system through the Cloud


Figure 3-2 <u>Proposed Cloud Model for Universities</u>
<u>(source: self)</u>

3.1.2 CLOUD BUSINESS MODEL SELECTION

Though all universities provide similar services but still the way they operate differs. The Cloud Business model that any university should select would differ according to the way they operate. There are many such models presented by various authors in published material. Thus it becomes difficult for an organization to decide which model to follow or which model would best suit their business operations.

There is no specific rule for selecting a Cloud Business model. The adoption of Cloud Business model would depend on:

- The size of the university, in terms of the type of programs offered, number of workforce, number of students, number of campuses etc.
- The level and amount of investment that the university can afford for Cloud
- The nature, type and amount of data they would place over the cloud
- They type of services that the university is acquiring from the service provider
- The amount of control that the university would like to have for the services that they are acquiring
- The level of risk that the university can afford to take, especially in terms of data security

Jericho[18] has presented a "Cloud Cube Model" in which he has categorized the cloud formations. Victor Chang et al. [19] have further elaborated these categories. These categorizes would help the university in selecting the Cloud Business Model. According to Jericho[18] there are four dimensions of this cloud cube model. The university implementing cloud will have to decide that in which dimension they fall and the accordingly they decide upon the Cloud Business Model, Figure 3-3 show the model given by Jericho[18] along with the four dimensions.
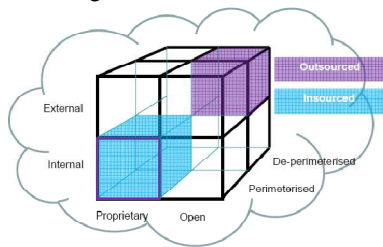
Figure 3-3 The Cloud Cube Model [17]

Based on Jericho's[18] dimensions of 'Cloud Cube Model' Victor Chang et al. [19] have further presented a combination of these dimensions and categorized Cloud Business Models into eight distinct types. These types are:
1. Service Provider and Service Orientation
2. Support and Services Contracts
3. In-House Private Clouds
4. All-In-One Enterprise Cloud
5. One-Stop Resources and Services
6. Government funding
7. Venture Capitals
8. Entertainment and Social Networking

Now based on these business models the university can easily select the Business Model that best fits it organization.

3.3 FRAMEWORK FOR IMPLEMENTING CLOUD IN UNIVERSWITIES
When a university decides to benefit from Cloud Computing, they should follow a stepwise gradual implementation framework for smooth transition and to gain maximum benefit from Cloud. The stages of the basic framework for implementation of cloud include:

- Evaluate Cloud Readiness
- Need Analysis
- Analysis of the current status
- Identification of type and level of services to acquire
- Selection of technology
- Identify Vendor
- Identify Payment Model to follow
- Decide implementation strategy

4. CONCLUSION AND RECOMMEENDATIONS

Information plays a key role in managing business in the modern globalized environment. Efficient management of information through modern information technology is considered as a key success factor for organizations sustainability. Cloud Computing is a technology that helps organization not only to manage information within the organization but also stay connected by sharing and managing information with the industry. With Cloud Computing even budget constrained organizations can enjoy the benefits of become global.

The aim of this Independent Study is to study is to study Cloud Computing as a technology for helping organizations to stay technologically advance and to propose the potential for implementing Cloud Computing in universities of Pakistan.

The education industry serves as a backbone for the growth of the country, whereas universities serve as the nerve centers for research & development. Managing Knowledge through learning is one of the critical activities that the universities have to execute. In order to accomplish this activity and to compete globally, universities need to invest in their IT infrastructure for managing their activities. This makes Information Technology a factor of strategic importance.

This study conducted on studying Cloud Computing as a technology for universities in Pakistan revealed very interesting results.

There is a general perception that managing a strong IT infrastructure requires heavy investments in terms of hardware and software resources and in terms of technology savvy workforce. Due to this reason many universities lack behind in terms if competing in managing their learning and knowledge management activities. This study has revealed that this problem for universities can be solved through Cloud Computing.

A wealth of literature is available that shows how organizations have benefitted from embracing Cloud

Computing. The advantage of getting better business services and low cost of Cloud Computing make it highly feasible for universities. Though Cloud Computing is a beneficial tool technology but as every technology has some benefits and drawbacks, so is the case with Cloud Computing. One of the major concerns by universities is the security of data. This issue can be overcome by proper management and by implementing appropriate rules/policies for data security.

As universities need to manage a strong and modern IT infrastructure for the business activities, a Cloud model for universities has been proposed. Universities are suggested to benefit from cloud technology not only to manage their internal processes but also to keep connected by sharing the intellectual capital in terms of research and academic curriculum. For this a hybrid cloud model has been proposed which will help link the universities through HEC in Pakistan. This will result in better output from universities, in terms of collaborative learning and knowledge sharing activities. But thinking, speculating and wishing is not the same as doing and quite different from doing it successfully.

In order to benefit from this proposed cloud model, universities need to be prepared for implementing this technology. The universities need to explore how this technology can be put to work for their organization. They also need to dig out the bottlenecks related to implementation of Cloud in the university; like, information overload, logistic complexity and many more. Through this study the author has also proposed a framework that the university can follow for brining the university to a Cloud readiness stage. Further to complement the cloud model an implementation framework for cloud has also been discussed.

In short, Cloud computing offers a significant solution for IT problems faced by budget constrained organizations like universities. Cloud helps organization to align IT with their business needs and help them transform into a dynamic organization.

AREAS FOR FURTHER RESEARCH

This study carried out on cloud computing has been observed to be very beneficial for universities and also has opened avenues for further research. This has led the author to present the following areas for further study.

- This study was carried out by getting input from universities randomly selected across Pakistan. Further research can be conducted by involving other universities across Pakistan. This will help to find out trends in various provinces.

- The research can be further elaborated by conducting similar study for various other organizations like; NGOs, SMEs (in general), schools and colleges etc.

- A study can also be conducted to find out how the major security issue can be handled and what measures can be carried out to manage strong security within a cloud.

- A study can be carried out to identify standards that can be incorporated when implementing cloud. Like, the standards to classify data, standards for managing trust within operating partners, standards for security. Standard protocols etc.

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