Cloud Computing for Higher Education Institutions:

A Feasibility Study of the adoption of IaaS in the Computing and Library Services of a UK university

Alexandros Chrysikos,

London Metropolitan University, United Kingdom

ABSTRACT

The following study is an investigation of Information Technology (I.T.) enablement for a Higher Education Institution (HEI), with focus on the feasibility of Infrastructure as a Service (IaaS) using Cloud Computing technology. A Feasibility Study was conducted on the potential IaaS risks and benefits for a HEI such as the Computing & Library Services of a UK university. A list of selection criteria and evaluation methods that could be regarded as the basis for a future IaaS Cloud decision model for HEIs is the proposed outcome. The findings of the current investigation contribute to the body of knowledge for both academics and I.T. managers.

Keywords: Infrastructure as a Service (IaaS), Cloud Computing, Higher Education Institutions, decision model, benefits, risks, IaaS in Business.

Introduction

In 2006, M. V. Charles, president emeritus of MIT, asserted: "We are seeing the early emergence of a meta-university—a transcendent, accessible, empowering, dynamic, communally constructed framework of open materials and platforms on which much of higher education worldwide can be constructed or enhanced" (Charles, 2006). Cloud Computing technology is being taken under consideration by many higher education I.T. leaders, but, in general, there is some hesitation in applying it due to variations in decision-making and implementation (Grajek, 2013). Each Higher Education Institution (HEI) has its own needs and requirements. Despite that, the current state of Cloud Computing in higher education is characterized as evolving. The agility, resiliency, flexibility, and economies of scale provided by Cloud Computing are rendering the construction and maintenance of on-premises data-centers obsolete. It is believed that over the next decade, the availability and advantage of new technology models will result in a substantial decrease in the use of on-premises data-centers. Higher education I.T. moves from a traditional data-centered model to a one-centered on the public Cloud and Cloud services (Educause, 2014).

Furthermore, there is great focus on how to make learning and teaching efficient for both academic staff and students (Zhou, 2012). The constant need for enhanced learning and teaching has led Higher Education Institutions (HEIs) to an increased use of technology. Consequently, this affects the educational experience, and providing up-to-date information systems, as well as maintaining them, can be very challenging for HEIs (Universities UK, 2013). Cloud Computing is a technology that offers attractive advantages to higher education through its network-based infrastructure, platform and software

on-demand services (Armbrust et al., 2010). The current study focuses on Infrastructure as a Service (IaaS) and its current application in HEIs, by conducting a Feasibility Study on the potential provision of IaaS services in the Computing and Library Services of a UK university. Before presenting the scenario, though, a brief review of the Cloud Computing trends in the UK higher education is provided.

Cloud Computing in the UK Higher Education

As the UK higher education sector review is continued, it is identified that, besides the UK government driven Cloud solutions, there are also Cloud services offered by the private sector. For instance, Google, Microsoft, IBM, and AWS, provide Cloud applications, services, and infrastructure (i.e. Office 365, Cloud Academy, data-storage, and e-mail) for educational purposes (Universities UK, 2013). The competition among Cloud services vendors has benefited HEIs through free of charge provision of off-campus-site e-mail services (Clark et al., 2011). For instance, the University of Westminster avoided an expense of £1 million by migrating to the Cloud, cutting expenditure on new hardware and software updates. Furthermore, an additional benefit was the reduced time spent on their user and system support, with a significantly lowered number of support calls to their Cloud provider (Universities UK, 2013). As Cloud Computing and IaaS develop within UK HEIs, their potential benefits and challenges must be clearly understood, especially if UK HEIs are to benefit fully from its implementation.

Case Study Scenario

Many UK based universities have also applied Cloud solutions but most of them have only implemented Cloud services through Microsoft's Office 365 Education and Azure (Jisc, 2013; 2018a; 2018b). All of them, though, consider expanding their Cloud Computing services because such services could offer cost effective solutions. If we also consider the current economic environment, such solutions could be proven to be beneficial for all HEIs.

At the university of the current case study, the only Cloud services provided are the student e-mail and the student personal drive services, which are hosted by Microsoft (Office 365 Education and Azure). However, the I.T. managers of the Computing & Library Services of this university have started considering the possibility of providing more Cloud services to their academic staff and students. For the time being, there are no in-house Cloud technologies used, so external cloud providers should offer the Cloud services again. The current study focuses only on the potential application of IaaS. The Feasibility Study recommendations are based on the current case study's UK university Computing & Library Services situation and on the currently available Cloud Computing technology and its solutions. It is likely that new solutions may appear in the near future as Cloud Computing is still an emerging area.

Evaluation Criteria of Cloud Provider Selection

To ensure that the Computing & Library Services of the university studied selects an appropriate IaaS Cloud provider, a complete list of evaluation criteria of Cloud provider selection and evaluation methods is developed. The list is presented in Table 4.

Table 4. Evaluation Criteria List of Cloud Provider Selection

Criteria	Description
Agility	Any new Cloud services offer portability, thus all data must be transferable to other future Cloud providers as well.
Convenience	The SLA should secure that the provider will offer a system that can be updated, maintained, and sustained without any extra costs.
Cost	The service cost must be accountable for the provider. In addition, the IaaS Cloud solution implementation and maintenance costs must be affordable.
Quality	The provider's offering quality must meet the institution's requirements.
Safety	The provider must guarantee the institution's information and data security.
Service	24/7/365 support provision. The Cloud provider must offer constant support to the institution.

IaaS Evaluation Methods

Considering the risks that may occur during the implementation of an IaaS Cloud solution, it would be safer for the institution to have some methods of evaluating its functionality. The following two methods are recommended to aid smooth transition.

Pilot Programs: The first method could be the launch of a Pilot Program. Those programs can also be combined with supplier, manager and user satisfaction surveys. By the time the Pilot Program are terminated, the feedback is of high value as it provides lessons and criticism for an effective and functional application of a potential IaaS Cloud solution. Moreover, with the Pilot Programs, many problems can be identified in early stages giving the opportunity to the organization to correct them (Rosen & Foody, 2005).

Cost Benefit Analysis (CBA): The second method could be the Cost Benefit Analysis (CBA). The CBA could be applied by the time the IaaS Cloud solution is fully implemented. The CBA is a practical way to measure the efficiency levels of the new IaaS Cloud solution applied. Furthermore, it could show whether the new solution was a worthy investment or it has to be altered or cancelled (John Reh, 2015). Conducting regular CBAs to monitor the institution's economic span after the final implementation of the IaaS Cloud solution is also recommended. For that purpose the use of the following equation is recommended (see Figure 1, page 4). The "cost associativity" equation, as it is known, expresses the opportunity for higher profit (Armbrust et al., 2010, p. 2).

$$\text{UserHours}_{\text{cloud}} \times (\text{revenue} - \text{Cost}_{\text{cloud}}) \geq \text{UsersHours}_{\text{datacenter}} \times \left(\text{revenue} - \frac{\text{Cost}_{\text{datacenter}}}{\text{Utilization}}\right)$$

Figure 1. Cost-associativity equation (Armbrust, et al., 2010, p.2)
Source: Armbrust et al., 2010, p.2

Implications

The implications of the current study are summarised in the following list. Specifically, a series of steps that could be used by any HEI (UK and non-UK) to select a Cloud provider in preparation for Cloud Computing adoption should:

- Diagnose all possible benefits and opportunities for migrating from existing computing solutions to Cloud services.
- Develop a Cloud selection-evaluation model that incorporates efficient cost/benefit and risk/evaluation methods, such as the one proposed in the current study. A model like this could support HEIs' decisions about where, when, and how they can adopt Cloud services.
- Ensure that a HEI's networking environment is ready for Cloud Computing.
- Diagnose and secure any in-house competencies that might be required to manage effective Cloud service adoption.
- Diagnose any technical challenges that must be identified when transferring any information, data or applications into a Cloud environment. The current study's recommended Pilot Programs could be proven useful to identify where problems may occur.

Conclusion and Recommendations for Further Research

The most significant benefits offered by an IaaS Cloud solution are high flexibility and scalability, mobile accessibility and automated services. Moreover, storage could be increased on demand and reduced costs will be achieved by the minimizing of the university's in-house I.T. services and maintenance (Lakshminarayanan et al., 2013).

On the other hand, the problems are many as Cloud Computing in Higher Education is still immature, the lack of standards, data security/privacy issues and the compatibility with the institutions' existing I.T. infrastructure are also significant concerns (Catteddu, 2010). However, there are organizations like the European Commission and the Cloud Consortium that try to give solutions on those problems (Schubert, 2010).

The solutions proposed are based on one single HEI. Therefore, further testing, of institutions of different sizes and in different countries with varying HEI context, is needed in order to examine IaaS application in HEIs. To enhance such a decision, further research regarding the long term effects on institutions that adopt Cloud service solutions is needed.

Towards that effort, a few questions for future research are proposed: (1) Could the proposed solutions be generalized in other Cloud service selections such as SaaS and PaaS? (2) What are the security risks for a HEI when an IaaS, as well as SaaS and PaaS, Cloud service is operated by a Cloud provider and what if the Cloud vendor is a global service organization? (3) Are the current Cloud SLAs sufficient to cover HEIs needs? (4) Focusing on the UK HEIs context, is the current Cloud solution offered by Jisc a

sufficient option that would help UK HEIs to keep their competitive advantages over other European and global institutions?

REFERENCES

Armbrust, M., Fox, A., Griffith, R., Joseph, A. D., Katz, R., Konwinski, A., & Zaharia, M. (2010). A view of cloud computing. *Communications of the ACM, 53*(4), 2.

Catteddu, D. (2010). Cloud Computing: benefits, risks and recommendations for information security (pp. 17-17). Springer Berlin Heidelberg.

Charles M. V., (2006). Open content and the emerging global meta-university. *EDUCAUSE Review, 41*(3), 30. Retrieved May 11, 2018, from https://er.educause.edu/articles/2006/1/open-content-and-the-emerging-global-metauniversity

Clark, M., Ferrell, G., & Hopkins, P. (2011). Study of early adopters of shared services and cloud computing within Higher and Further Education. *Context, 3*(2.1).

Educause, (2014). Cloud strategy for higher education: Building a common solution. *Research Bulletin*. Louisville, CO: ECAR. Retrieved December 30, 2014, from http://www.educause.edu/ecar

Grajek, S., (2013). IT issues panel. *EDUCAUSE Review, 48*(3) (May/June 2013). Retrieved December 30, 2018, from http://www.educause.edu/ero/article/top-ten-it-issues-2013-welcome-connected-age

Jisc, (2013). *Jisc Annula Review*. Retrieved May 08, 2018, from https://www.jisc.ac.uk/sites/default/files/jisc_annual_review_2012-13.pdf

Jisc, (2018a). Microsoft Office 365. Retrieved May 08, 2018, from https://www.jisc.ac.uk/microsoft-365

Jisc, (2018b). Microsoft Azure Express Route. Retrieved May 08, 2018, from https://www.jisc.ac.uk/microsoft-azure-expressroute

John Reh, F., (2015). *Cost Benefit Analysis. About.com*. Retrieved May 11, 2015, from http://management.about.com/cs/money/a/CostBenefit.htm

Rosen, A. & Foody, D., (2005). How to implement a successful SOA pilot program. *SOAWorldMagazine*. Retrieved January 10, 2018, from http://soa.sys-con.com/node/164533

Schubert, L., (2010). The future of cloud computing: Opportunities for European cloud computing beyond 2010. *European Commission*. p. 1-71.

Universities UK, (2013). Working for a smarter, stronger sector. *Efficiency and effectiveness in higher education progress report*. Publications and Documents, November 2013. Retrieved May 09, 2018, from http://www.universitiesuk.ac.uk/policy-and-analysis/reports/Pages/working-for-a-stronger-smarter-sector.aspx

Zhou, S. H. (2012). Building and practicing of interactive three-dimensional teaching network resources platform based on cloud technology. *International Journal of Advancements in Computing Technology, 4*(22), 444-451.