Moving Towards Cloud

Analyzing the Drivers and Barriers to the Adoption of Cloud Computing in HE (Higher Education) institution in UK: An Exploratory Study with Proposed Solution

Sohail Razi Khan and Luis Borges Gouveia
IT Department, University of Fernando Pessoa, Porto, Portugal
35525@ufp.edu.pt, lmbg@ufp.edu.pt

ABSTRACT

Cloud computing is a relatively new phenomenon and its implementation in various sectors is having far reaching impacts. The requirements to have dynamic education environment in higher education institutions across the world requires to adopt state-of-the-art practices to reduce infrastructural cost, improve operational efficiency, availability and provide on-demand resource allocation. Using cloud computing in (HE) higher education institutions can have enormous benefits where students can share their work easily, collaborate, and conduct research. However, despite the comprehensive literature, there is limited studies related to the benefits, drivers and barriers to the adoption of cloud computing technology in the HE institutions across U.K. This paper is an attempt to investigate initially the benefits and drivers to the implementation of cloud computing technology in the higher education institutions across 20 public universities across U.K. The paper also investigates the barriers in the implementation of cloud computing technology in higher education institutions and then concludes with solutions to these barriers that are hindering the adoption of cloud technology in the higher educational institutions across U.K.

KEYWORDS

Cloud Computing, Cloud Adoption, Higher Education Institution, Service Level Agreements, Drivers, Enabler factors, Barrier factors.

1 INTRODUCTION

Cloud computing has revolutionized the IT industry in last many years offering scalable computing resources. Due to cloud computing technology there is a minimization of in-house IT infrastructure resulted in cost saving, reduced administrative hurdles and provided an attractive outsourcing option. The theme of cloud computing is not new as it comprises off technologies such as centralized, distributed, utility computing and incorporate the concept of virtualization [1]. The cloud users don't have to own massive computing infrastructure and no upfront investment is required. The model allows various cloud users to share the network infrastructure provided by cloud provider and pay only for the service being used. This pay-per-use model enables convenient and on-demand network access to a shared pool of configurable computing resources such as servers, storage, applications, and services [2].

Cloud computing technology is being adopted in various business domains. According to Forrester report in November 2016, the cloud market will increase its market share in coming years because institution around the world are looking to adopt cloud technology because it

provides an alternative viable option to run core operations. The global cloud market will be worth $146 billion in 2017, up from $87 billion in 2015 showing an increase of 22% compound annual growth rate [3]. In today's competitive market, companies are trying to operate effectively and reduce costs. Cloud computing is a promising trend of computing that provides availability, scalability and flexibility and ensures operations at very low running cost [4]. The cloud computing technology is different from the traditional IT model as it is focused on services rather than technology. The technical details are hidden away from the consumers and they are charged based on the self-service and they are billed for what service they have used [5]. The technology provides computing as the utility to meet the everyday needs of business community. The cloud computing refers to the applications the hardware and software delivered as service over the Internet. The cloud computing is having a significant impact on operations and IT department functions across different business sectors.

Cloud computing as an elastic and scalable utility model that offers flexible, ubiquitous, on-demand network access to a shared pool of configurable computing resources (for example, servers, data centers, networks, applications and services) that can be rapidly provided and released with limited interaction of service provider or the management [6]. It provides shared infrastructure, self-service, dynamic and virtualized pay-per-use platforms which put it on high demand. Cloud computing implies a level of dynamic, flexible resource sharing and allocation of assets.

Similar to other sectors, education sector is heavily dependent on information technology in terms of content delivery, research, communication, and collaboration with the industry. With reduction in the public spending in HE institutions across the world and at the same time students are demanding for more technological services and support which is not possible with the traditional in-house IT infrastructure [7]. There is a rapid change which we have experienced due to information technology revolution and at the same time due to lack of funding from government has increased the financial burden on educational institutions. The major challenges faced by HE institutions is to provide world class education with lack of infrastructure, increasing cost to maintain the IT infrastructure and increasing staff expenses [8]. In this scenario cloud computing technology can help HE institutions by providing a solution at a reduced cost and provide a platform that can support collaboration, enhance communication, research and development. Cloud computing is transforming many HE institutions, by reducing the cost of infrastructure, providing scalability, agility and providing a viable alternative to the traditional in-house IT infrastructure. The next section of the paper will conduct a detailed literature review into the integration of cloud computing technology in the HE institutions and

provides a snapshot to the readers with various cloud service models that are being implemented. The next section of the literature review will discuss the impact of integration of cloud technology in HE institutions in U.K. The following section of the paper will detail the research methodology which will be used followed by the research questions which the researcher desires to find answer in the research. The next section will analyze and interpret the data collected from 20 public universities across U.K identifying the drivers and benefits in the adoption of cloud technology in HE institutions in U.K followed by the barriers in the adoption of cloud technology. The last section of the paper will represent data which will detail the solution to the barriers that are faced by HE institutions in U.K.

2 LITERATURE REVIEW

2.1 Cloud Computing in HE Institution

The HE institutions are familiar with the integration of new technology that will enhance teaching and research. As we speak majority of HE institution are highly dependent on the use of information technology to deliver courses, collaborate to do research and communicate with each other. In the traditional model, HE institutions will have a very large IT infrastructure cost, continuous maintenance issues, large workforce, update hardware and software licenses regularly so that they can provide a suitable environment for their students and staff [9]. In the last many years' cloud computing technology provided a suitable

platform for HE institution to offer educational services at very low cost with high availability, improved performance ensuring effective research collaboration and social interaction. The literature highlights various cloud based services such as Google Apps, Google Docs, Dropbox, YouTube being used in the education cloud[10]. The students and staff at the HE institutions are following the suit by accepting the web-based cloud services for everything from email to video contents.

After reviewing the literature, it was evident that Software as a Service (SaaS) delivery model was the most popular with a very high adoption rate [11]. It was evident from the literature that many HE institutions are using Google Apps for e-mails and to create documents and spreadsheet, bypassing the capital investment in the severs and software license cost. The integration of cloud technology in HE institutions have created new capabilities such as Infrastructure as a Service (IaaS), Platform as a Service (PaaS) which are being used by HE institution as shown from the figure 1.
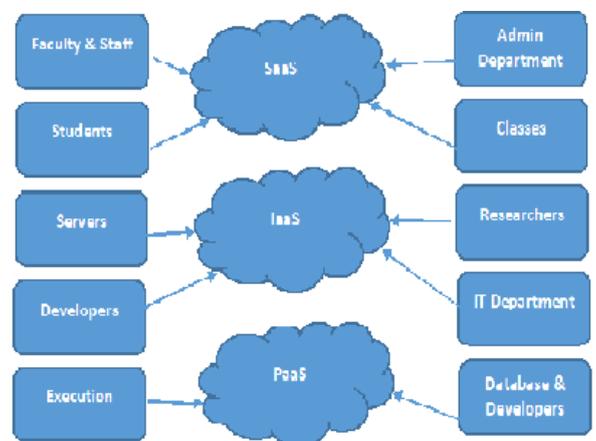
Figure 1: Cloud Computing Service Model in HE institutions

The cloud-based education system provides a platform to use and create knowledge in HE institutions which act as a decisive factor for social, economic, cultural and technological transformation [12]. Achieving this goal necessarily involves the use of technology, which would allow knowledge transmission and create new areas for education, research and development [13].

Cloud computing provides opportunity for the institutions to remain focus on research & development, front line services such as delivery of contents and collaboration with industry rather than waste their valuable time managing and maintaining the complex IT infrastructure [14]. The cloud computing applications related to education will form the basis of future IT infrastructure in education to ensure the development of hardware and software environment. By integrating the cloud technology, it will ensure high speed in-processing of the data thus replacing the pressure associated with the information explosion. The use of cloud technology in HE institutions will enhance the utilization of resources for educational purposes, reducing the infrastructure cost, ensure that the green energy demands are met and provides ease in the maintenance and operation of the system [15]. HE institutions across the world have recognized the ability of cloud computing to improve efficiency with high computing power associated can be used for extensive research. The cloud service have been adopted in HE institutions by having their

student email system being provided by third party cloud providers the most common one is Microsoft live@edu which is browser-based and provide students access to emails, office package as well as SkyDrive [16]. There are many other education-based cloud services such as Google App Education (GAE). Different features from Google includes Talk, Mail and Docs provides benefits to students to collaborate and share their learning experiences [17]. Cloud technology in HE institutions is providing a platform to support M-Learning by utilizing mobile devices to support online collaboration which will ensure sharing of information and environment that leads to quality research [18]. In the HE institutions cloud technology is used for hosting learning management systems (LMSs) e.g. Moodle and Blackboard within the cloud. Most institutions outsource the providers of the LMSs due to the high costs involved in the establishment and maintaining such systems [19]. In today's world e- learning has been adopted at different education levels including training for firms, lifelong learning, as well as in academic units; E-learning solutions range from commercial to open-source. There are two main entities of the e-learning system including trainers and students. The students get to access exams, courses, and can relay on their assignments online, whereas the trainers can introduce and share tests, manage courses and evaluate homework and assignments for the students. The entire process is only possible due to the use of cloud computing technology that ensures more communication and collaborations

between students and staff which provides an enrich learning environment [20]. The next section of the paper will detail the use of Cloud computing technology in U.K HE institutions and its overall impact.

2.2 Cloud Computing in U.K HE Institutions

The HE institutions in U.K are facing immense pressure to evolve and incorporate latest technological innovations. These new technological innovations will change the way the HE institutions deliver the education to their students. We are living in the technological oriented knowledge economy and there is a huge burden on these HE institutions to produce students with the quality of education that is equipped with advanced skills and technology to meet the challenges of the real world [21]. According to the detailed review of the literature, U.K HE institutions are facing a large reduction in the government spending and they have to reduce their budgets and meet the growing expectations of the students and communities at the same time. Various options are available such as providing distance education, online learning management systems and form collaboration with different research partners around the world using technology. HE institutions in U.K have adopted cloud technology which has brought lot of benefits such as cost reduction in the IT budget, scalability, elasticity and more social interaction and improved collaboration across U.K HE institutions to support research & development

[22]. The use of cloud computing technology in HE institution in U.K is becoming an integral part of delivering education and helping the institutions to meet their expectations [23].

The use of cloud technology in U.K HE institution will continue to increase as the technological innovation is having direct positive influence of technology on various teaching methodologies [24]. The HE institution are well familiar that offering technological mode of delivering of education will attract more students. A large portion of HE institutions across the country are using cloud computing technology to offer distance learning education to a wider audience. With the use of cloud computing technology various institutions in U.K are working in collaboration to do research while geographically dispersed across the globe [25]. The cloud computing technology is a preferred platform to manage online learning courses offered by various HE institution due to scalability and elasticity that is provided by cloud platforms. The use of cloud technology in HE institution in U.K is providing a great opportunity to learn for those who are not able to access these institutions and resources. The use of technology will promote corporate academic partnership which will be beneficial for educational institutions to have real world experience, promote research with the corporate world, and locate more funding for the HE institutions in U.K [26]. Due to use of cloud technology in U.K HE institutions there is a solid partnership between the corporate world and HE

institutions which leading to extensive development in the field of science and technology. The literature is full of examples where the use of cloud technology in U.K HE institutions has built ecosystem of innovation and research. But at the same time the adoption of cloud technology in U.K HE institution is having serious concerns regarding the security and privacy of data that will be stored on a third-party server [27]. Various examples have been quoted in the literature where service level agreement, operational and logistics challenges are considered as barrier to the adoption of the new approach. The other barrier in the adoption of cloud technology in U.K HE institutions requires a lot of training and support for faculty to use technology and overall need of change in the organizational practices is required so that new technologies can be adopted [28]. The next section of the paper will detail the questions which are being investigated in this research.

3.0 RESEARCH QUESTIONS

To investigate the research further following are three questions that are formalized to be investigated further which are as follows: -
RQ1: What is the level of adoption of cloud computing technology by HE institutions in U.K?
RQ2: What are the benefits and barriers to the adoption of cloud computing technology by U.K HE institutions?

RQ3: What should be done to remove the barriers to the adoption of cloud computing technology in the U.K HE institution?

3.1 Data Source and Presentation

The study is to investigate the level of adoption, benefits, barrier, and solution to the adoption barriers of cloud computing technology in U.K HE institutions. The method for data collection was detailed questionnaire containing various sections. The first part of the questionnaire requires the respondents to enter their personal information such as job title, name and name of the HE institutions and years of experiences whereas in the second part of the questionnaire relates to the benefits and drivers to the adoption of cloud computing technology in U.K HE institutions. The third part of the questionnaire relate to barrier to the adoption of cloud technology in the HE institution. The fourth part of the questionnaire require the solution to the adoption barriers to implementation of cloud technology in U.K HE institutions. Before the questionnaire was distributed it was validated and tested for its reliability using the Pearson Product Moment Correlation. The outcome of Cronbach alpha reliability coefficient (@) of 0.81 which was indication that the instrument is reliable for data collection. After the detailed validation process 3000 copies of the questionnaire were distributed to 20 public universities across U.K and 2580 responses were received with response rate of 86.00%. The questionnaire were distributed to IT Staff (50), academic staff (50), senior management (20),

and students (80) in each university. Data was captured in Microsoft Excel and obtained from completed questionnaire from various respondents. This approach was an attempt to evaluate the opinion of a sample in the targeted population which will lead to better understanding of the situation.

3.2 Result Collection & Interpretation

The results of this research will highlight the benefits of cloud adoption to U.K HE institution but at the same time the research will identify the barriers to the adoption of cloud technology. The research will also identify the cloud services they are adopted by U.K HE institutions. The last part of the research will focus on the resolution to the adoption barriers of cloud technology in the HE institutions so that transition towards cloud technology becomes smoother in the future for other HE institutions that are planning to adopt cloud computing technology.

## 3.3 Adoption Trends of Cloud Computing in U.K HE Institutions

The results gathered from the research question 1 was based on 2580 respondents that completed the questionnaire from 20 public universities that are involved in this research process. The response gathered from the respondents in this research clearly identifies that all (20) universities involved in the research have adopted cloud technology which represents 100% adoption rate as shown from Figure 2. The research findings collaborate with the report by

[29] that HE institutions are adopting cloud computing model as it supports their research and delivering of higher education in an effective manner.
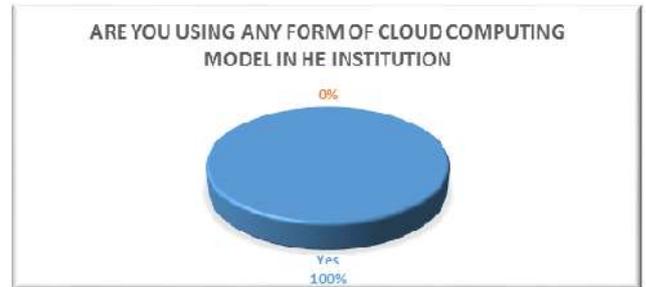
**Figure 2: Adoption rate of Cloud Computing in HE institutions in U.K**

In order to find which cloud services were adopted by HE institutions it was evident that overwhelming majority of HE institutions 76% are using SaaS. Applications such as Google Docs, Moodle, Google Mail, Yahoo Mail and NetSuite offered by SaaS in HE are universal, free and in high demand whereas 10% HE institutions are using PaaS service model that includes services such as online databases, Google Sites and Microsoft Dynamics CRM. 14% of HE institutions are using IaaS to support virtual computing laboratories, data storage, and backup as shown from Figure 3.
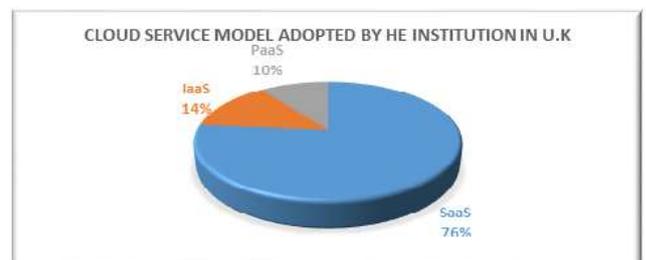
Figure 3: Cloud Service Model adopted by HE institution in U.K

In the third questions it was clear that 22% HE institution in U.K are using more than one Cloud service model to support their operations. This

shows growing confidence to move towards the cloud computing technology.
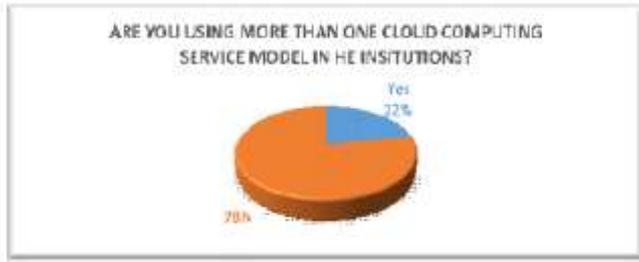
Figure 4: Multiple Cloud service model in HE institution

In the next question the focus is to investigate the benefits of the using cloud technology for HE institutions in U.K. Majority of respondents 27% came to the conclusion that with the use of cloud technology in the HE institution can make major cost savings which is considered as the most important factor to the adoption of cloud technology in U.K HE institutions. As shown from the following figure 5, the next major benefit due to the adoption of cloud technology in U.K HE institutions according to the data collected is improved availability of services where 20% of respondents agreed that cloud computing technology in integrated in the HE institution due to exceptional high uptime for network services (5 9s 99.999% uptime guaranteed by cloud providers). The next driver to the implementation of cloud computing technology in HE institution across U.K was due to high scalability (13%) & then mobility (11%) that can support on-demand services according to specific requirements of the HE institutions regardless of the location of the cloud user. HE institutions across U.K are trying to adopt cloud technology which is considered as

environmentally friendly according to 11% of the respondent and have low carbon emission. The next major benefit for the adoption of cloud technology in HE institution in U.K was due to reduced IT complexities (9%) easy to maintain IT system (9%) which will allow HE institutions to focus on research & development and course delivery rather than maintaining complex IT systems.
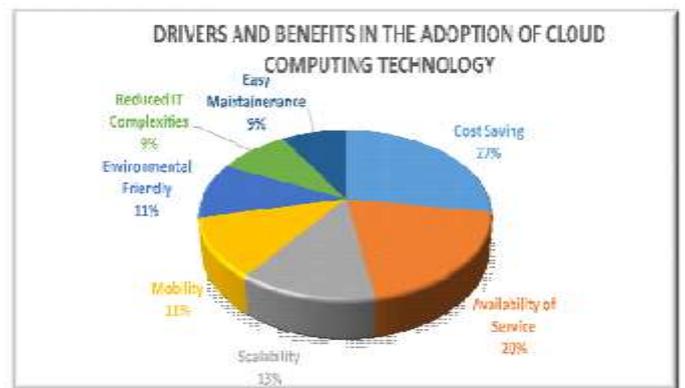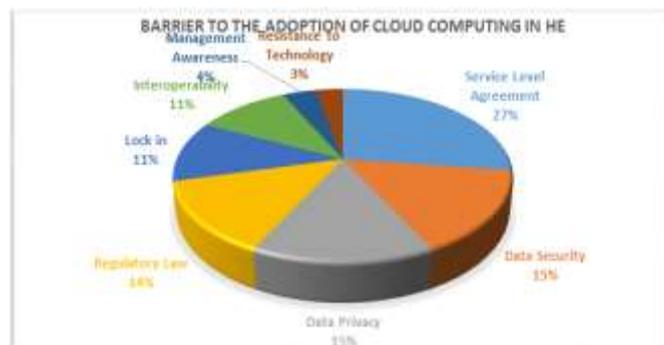

Figure 5: Benefits for adoption of Cloud Computing in HE institutions

The next questions tries to investigate the number of barriers to the adoption of cloud technology that are faced by HE institution in U.K. The most critical barrier to the adoption of cloud computing technology in HE institutions across U.K according to 27% of respondents was lack of uniform Service Level Agreement or a framework which can act as a benchmark to the QoS (Quality of Service) provided by the cloud industry as mentioned by Figure 6. Majority of respondents considered lack of SLA uniform framework as a barrier to the adoption and due to this factor they can't compare the Quality of service offered by each provider which leads to lack of accountability, variable level of service offered and confusion in understanding the legal

jargon in the Service Level contracts. The next major barrier to the adoption of cloud technology in HE institutions in U.K according to the respondents was due to data security (15%) & data privacy (15%) challenges which is a major source of concern for all stakeholders as the cloud provider can be hosting data from a remote location outside U.K or EU. The result gathered from this questions is supported by the detailed work carried out by [30], according to their work 75% of Chief Information Officers and IT specialist consider data security & privacy as a major barrier to the adoption of cloud technology. The next barrier to adoption of cloud technology in HE institutions is the regulatory framework (14%) such as Data Protection Act U.K and the implication of new laws as GDPR (General Data Protection Regulations) which stipulates stern actions and penalties in case of any data breaches by cloud providers and users. The HE institutions are concerned about the theft to the intellectual property which can have serious repercussions for HE institution across U.K. The next barrier to the adoption of cloud technology to HE institution is the Lock-in (11%) concern by the cloud user that they will be bound to use the cloud provider services without any option to leave or more their data to another provider if they desire to do so. The next barrier to the adoption of cloud technology in the HE institution is the issues of interoperability (11%) as many systems used by HE institutions are using legacy systems that will not be adaptable to new cloud computing technology. The next barrier to the adoption of cloud technology to

HE institution is lack of management awareness (4%) and resistance to new technology (3%) which requires change in institutional culture and extensive training to overcome these barriers to the adoption of cloud technology as shown from the following figure 6.

Figure 6: Barriers to Adoption of Cloud Computing in HE institutions

The next question was trying to find a solution to the barriers for the adoption of cloud technology in HE institutions in U.K. The respondents were asked to provide solution to these barrier and overwhelming majority of respondents (40%) replied by proposing a uniform SLA framework that all cloud providers have to follow to improve the overall QoS (Quality of Services). This framework can be used to compare the level of service offered by each provider across the industry and provider can be held accountable for their services. The framework will address most of the barriers in the adoption of the cloud computing technology in HE institution across U.K. 16% of the respondents' also recommended end-to-end encryption to remove concerns related to data security & privacy and prevent any data breach when data is stored or on transit over the public network.

In order to remove the barriers to the adoption of cloud technology in the HE institutions in U.K the respondents have also recommended Third Party Auditor (15%) to check the cloud provider facilities and whether it meets the set requirements. The respondents also recommended management awareness (15%) and improve training (14%) to improve the overall understanding of cloud technology and cultural change effort to reduce resistance to new technology. In order to address these barriers the cloud industry requires a uniform SLA framework that can address all the concerns in the adoption of technology in the HE institutions. This SLA framework will act as a minimum benchmark to all cloud providers to offer services according to the set requirements and held accountable if they can't meet the terms and conditions as shown from the figure 7.
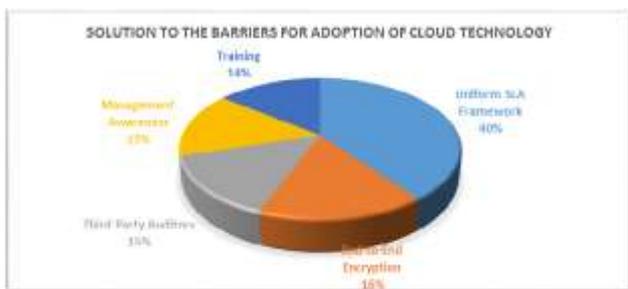

Figure 7: Solution to the barriers in adoption of Cloud Technology

3.4 Study Result: Drivers, Barriers, and Solution to Cloud Computing Adoption in Higher Education U.K

In this section of the paper we will conclude with detailed findings of the study as shown from the following Figure 8. It was evident from the data collected from various respondents, all HE institutions in U.K that have participated in this research are using cloud computing technology.

The research was able to identify the key drivers or enabler in the adoption of cloud technology in the HE institution.
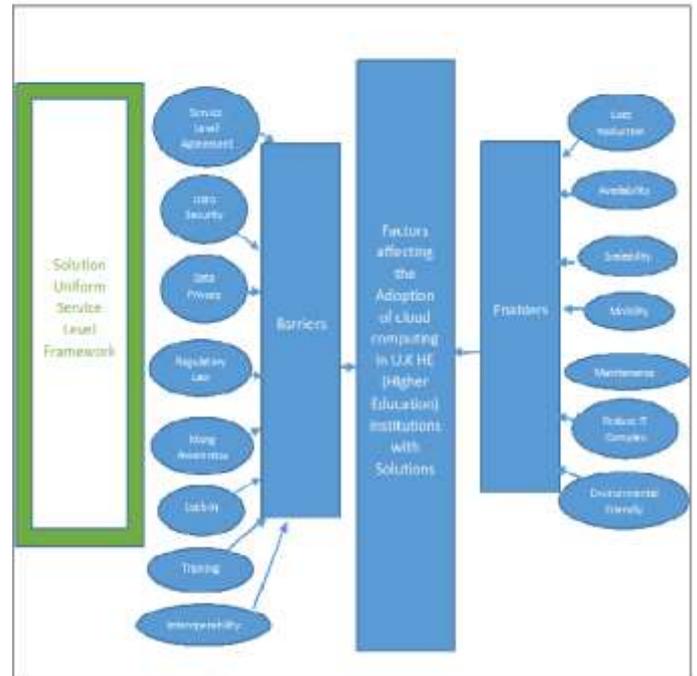
Figure 8: SLA Framework solution to adoption barrier in Cloud Computing

Majority of respondents agreed that they have adopted the technology as it offers cost reduction as compared to the traditional in-house IT infrastructure. The research was able to highlight further drivers to the adoption of cloud technology in the HE institution such as availability of service with 99.999% uptime, offers scalability to the end-users, environmental friendly technology with low carbon emissions, easy maintenance with reduced IT complexities so that HE institutions can focus on research and content delivery. The research was able to identify the barriers in the adoption of cloud technology in the HE institutions in U.K. It was evident from respondents due to lack of uniform service level framework there is variable level of

services offered by cloud provider and they can't be held accountable for poor services offered. Barriers such as concerns related to data security, privacy, regulatory law, lock-in, interoperability issues and lack of management awareness is considered as a challenge to the adoption of cloud computing technology in the HE institutions in U.K. The research also attempted to find solution to the adoption barrier to the cloud computing technology in the HE institution. Overwhelming majority of respondent recommended to have a uniform Service Level Fraework that stipulates a minimum standards agreeable to all cloud providers across the cloud industry. The framework will address all barrier to the adoption, such as data security & privacy concerns, ensure accountability if the service don't meet the expectations, increase adoption rate and allow more users to use cloud technology in the HE institution in U.K. The framework should address the regulatory framework requirements in-terms of Data Protection act and upcoming regulations such as General Data Protection Regulations so to avoid any data breaches. The uniform SLA framework should be agreed by all stakeholders, standards should be set and everyone should follow it regardless of their locations. Future research work can investigate they key entities in the proposed uniform SLA framework that can address all the barriers in the adoption of cloud computing technology in the HE institutions across U.K. By agreeing on a uniform SLA framework for HE institutions more educational institutions across the country will adopt the service which will allow to offer quality education to students and provide better service to the communities they are serving.

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