A MODEL FOR ADOPTION OF CLOUD COMPUTING FOR E-LEARNING: A CONCEPTUAL VIEW

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Abstract

The cost of higher education (HE) is constantly increasing with less public funding and yet the demand is increasing causing institutions to search for ways of reducing costs while improving delivery as well as competitiveness in the global market. Cloud Computing (CC) is a potential solution because it has the capability for end users to seamlessly access data and applications from multiple devices and platforms. However, research findings indicate that the rate of adoption and subsequent deployment within higher educational institutions (HEIs) compared to other sectors is low. This study is therefore investigating the responsible factors and their dynamics. As universities readjust to demands due to globalization and internationalization, it is expected that the findings of this research will aid HEIs to make informed strategic decisions about adoption of CC technology.

Keywords: Cloud computing, cloud adoption, e-learning, higher education.

1 INTRODUCTION

Though e-learning presents some challenges, it provides, among others, flexibility of access to learning materials, just-in-time delivery (JIT) and perceived cost effectiveness [1,2]. The shift from the traditional learning methods is mostly accounted to by the use of the internet thereby resulting in changes in the learning content, delivery and modes [3].

Cloud computing (CC) leverages the power of the internet to provide computing resources (software, platform, infrastructure etc.) to the end users on demand. There are four main deployment cloud models: private cloud, community cloud, public cloud and hybrid cloud [4]. Private cloud is provisioned for one organization but may comprise of multiple users. Community cloud is provisioned for exclusive use of a particular community of consumers with shared values and concerns e.g. security, policy compliance confidentiality. Public cloud infrastructure is provisioned for open use by the general public. This cloud model is usually favored by the academic institutions. Hybrid cloud infrastructure comprising two or more clouds (private, community or public). In hybrid cloud the uniqueness of each of the entities are maintained but with a standardization in technology to enable data application portability [4].

CC can be seen as a new direction that significantly enhances e-learning [5] with new functionalities [6]. These functionalities include storage and collaboration tools which are essential for research, peer-review, critique and publication of materials [7]. However, despite these functionalities, only about 4% of cloud technology use is in the academia with 96% comprising of industrial sectors and services [8]. In order to address the low rate of CC adoption [9] a sound theoretical framework and research model is needed to identify factors and their relationships affecting the adoption of cloud computing (CC) for e-learning in higher education institutions (HEIs). It will also be interesting to ascertain from the study if and how the deployment models may affect adoption by HEIs. Considering that IT is being delivered as a service, this research will aid the development of a model of adoption of such innovative IT services like CC that is driven by sound economics and high speed digital networks.

The rest of this paper presents method, CC adoption for e-learning, model development and hypotheses, conclusion and future studies.

2 METHODOLOGY

The main research methods are quantitative, qualitative and mixed methods. This research will employ the quantitative method following the positivist paradigm that has been used successfully in Information Systems (IS) research [10]. Primary data will be collected using survey conducted electronically and systematically analyzed using statistical package for the social sciences (SPSS) to identify results and patterns as well as evaluate the research predictive model [11].
This study is limited to a particular area of higher education (HE): universities in Scotland. All the 15 universities were selected so as to cover all geographical locations. The sampling population will be limited to technical staff (Information and Communications Technology ICT), academic staff (computing/IT, teaching/research) and other IT staff as they are at a better position to give opinion on the subject matter.

3 CLOUD COMPUTING ADOPTION FOR E-LEARNING

Attitude, intention, acceptance, adoption and diffusion have all been used as an indicator to measure adoption in various contexts by different authors. Most of these studies did not define the terms acceptance, adoption and diffusion but describes adoption as covering both intention and actual use [12]. Adoption is defined as the decision to make full use of an innovation as the best course of action available whereas diffusion refers to the accumulated level of users of an innovation in a market [13]. Adoption has also been described in phases that includes investigation, research consideration and decision making in order to introduce new innovation in the organization [14], whereas diffusion is the decision to implement the technology after adoption.

From the foregoing, we describe adoption as the decision of the higher education institutions (HEIs) to accept, deploy and make use of innovative technology like CC to facilitate and improve e-learning. This means that the HEIs we study may not use CC but they must at least make a decision to accept, adopt and deploy it. CC leverages an e-learning ecosystem with reliable, flexible, cost-efficient, self-regulated and quality of service (QoS) guaranteed infrastructures [15]. Consequently, HEIs' adoption of CC technology will enable them to access new techniques, methodologies, processes and applications while also meeting their dynamic needs and demands [16].

Models and theories used in IT/IS adoption include but are not limited to Technology Acceptance Model (TAM), Technology-Organization-Environment (TOE), Diffusion of Innovation Theory (DOI) and Computer Self-Efficacy (CSE). However, it is hoped that the four theories used in this research are adequate for providing variables that would give insight into the factors that have hindered adoption with the aim of facilitating adoption of CC for e-learning. The next section describes in detail how the model was derived.

4 MODEL DEVELOPMENT

Literature on IT adoption suggests that most researchers conduct studies by integrating theories used in information system with frameworks that cover the contextual antecedents. Hence, a theoretical model for adoption of IT in institutions may consist of a combination of innovation adoption theories and contextual framework of IT adoption [17]. Furthermore, a search through the literatures shows that no single theory or model can be used to explain attitude, behavior and various determinants in the context of IT adoption. Hence, by combining theories and models, it is hoped that these antecedents will be synthesized and developed into a model that may be used to enhance adoption of cloud computing for e-learning.

In this research, four underpinning theories and models were combined to develop the proposed conceptual model of CC adoption for e-learning. This was done by using constructs from existing models that are relevant to the study. The combined theories and models used are TAM: Perceived Ease of Use (PEOU) and Perceived Usefulness (PU), TOE: Relative Advantage, Complexity, Compatibility, Top Management Support, Technology Readiness, Institution Size, Competitive Pressure, Trading Partner Pressure, DOI: Triability, and Observability; and Computer Self-Efficacy (CSE). These theories and how they are combined will be explained in subsequent sections.

On one hand, it may be argued that TAM deals with individual's adoption of technology. However, PU and PEOU are of relevance for individuals' intention to accept and use technology within institutions [18]. These two determinants according to TAM are fundamentally important for attitude towards using a particular system and also determine intention to use and the actual usage behavior. On the other hand, the decision to integrate any technology within an institution lies with the management. However, successful implementation is exemplified by individual adoption pattern [19]. Thus, it is important to understand what influences individuals' adoption pattern thus, the integration of PEOU and PU from TAM construct in building the research model. It may also be difficult to assess certain parameters for e.g. relative advantage. Therefore, respondents would be assessed based on their perception of such parameters e.g. perceived relative advantage.
4.1 Technology acceptance model (TAM)

TAM appears to be the most widely used theory of IT adoption. In addition, TAM has also undergone extensive validations, applications and replications over the years to predict the use of information systems [20] and has proven to be very popular in IT/IS adoption. TAM was first introduced [18] after being adapted from the Theory of Reasoned Action (TRA) [21].

It is pertinent to note that PEOU and PU of TAM were considered relevant to this study as they explain individuals’ intention to accept and use technology in organizations [18]. PEOU is the extent to which a person believes how effortless using a system would be. Similarly, PU is the degree to which a user believes that using the technology will improve his or her work performance [22]. We therefore believe that if CC technology is perceived as easy to use and less complex, HEIs should be willing to adopt it for e-learning. From the foregoing, we can hypothesize that:

H1a: There is a positive relationship between PEOU and the intention to adopt CC for e-learning.
H1b: There is a positive relationship between PU and the intention to adopt CC for e-learning.

4.2 Technology-organisation-environment (TOE)

The three features of TOE framework are technological, organizational and environmental contexts [23]. Technological context describes existing and new technologies relevant to the HEIs. Organizational context describes the characteristics of the HEIs such as scope, size, complexity and management structure. Environmental context in relation to HEIs describe the challenges, competition and government regulations.

In technological context, CC is perceived to have advantages over non cloud based systems. For example they are scalable and flexible i.e. services provided to end users can be scalable based on their computing capabilities and individual demands. Computing resources can also be accessed remotely (virtualization) irrespective of place and time. They also offer services that include but not limited to software, platform, infrastructure and data. These perceived advantages also include instantaneous allocation of resources based on demand, and without the need for human interaction, can be accessed via multiple platforms, dynamic facility based on demands as well as capability to be measured and metered [4]. From the foregoing, we can hypothesize that:

H1c: There is a positive relationship between perceived relative advantage and CC adoption for e-learning.

On one hand, easy to use, less complex and compatible systems will facilitate its adoption. Therefore, CC technology should fit into existing systems. On the other hand, innovations that are incompatible with existing ones are slow to integrate within new systems [24]. From the foregoing, we can hypothesize that:

H1d: There is a negative relationship between perceived complexity and CC adoption for e-learning.
H1c: There is a positive relationship between compatibility and CC adoption for e-learning.

Security is the absence of unauthorized access to, or handling of the system state [25]. For the purpose of this research, we defined security as the ability of the institution to safeguard against unauthorized access to cloud computing services including availability, integrity, confidentiality and privacy of data. Global IT security spending has increased by 7.9% reaching $81.6 Billion in 2016 [26] and data security has been one of the main areas of concern in cloud computing [27,28,29]. Security drives as well as inhibits adoption of cloud due to resources being devoted by the cloud service providers [28]. There appear to be lack of standardization concerning security in the cloud. Different authors and researchers have proposed different models [28]. Despite the lack of consensus [30], more is being done to address the situation [29,31].

From the foregoing, it is evident that if adopting institutions are confident that their data are secure, available when needed, their privacy and confidentiality are protected; and access are granted only to the authorized personnel, then they are more likely to adopt cloud computing. We can therefore hypothesize that:

H1d: Security is significantly and positively related to CC adoption for e-learning.

PEOU is the degree to which an individual believes that using a particular systems would be free of physical and mental effort [18]. In the case of CC, cloud vendors provide the infrastructure and the platforms for the end users. The end users do not have to worry about physical machines, intricacies and interconnectivity and maintenance. It can therefore be argued that since all the internal workings have been dealt with by cloud providers, CC maybe perceived to be non-complex and easier for the end users to use them. Thus, we hypothesize that:

H1g: There is a correlation between complexity and PEOU.

PU is the degree to which an individual believes that using a particular system would enhance his or her job performance [18]. If the use of CC would enhance user’s performance (in the form of perceived relative advantages over non CC systems), then it could be argued that a relationship exist between PU and perceived relative advantage. In essence if a systems is perceived to be useful then it may have perceived relative advantages over other systems as that system is seen or perceived to improve user’s performance. Thus, we hypothesize that:

H1h: There is a correlation between perceived relative advantage and PU.

We refer to HEIs’ technology readiness as the existence of ICT infrastructure. Similarly, technology readiness also includes human resources [32,33,34,35]. It is expected that CC technology will seamlessly be integrated into these already existing ICT infrastructures.

H2a: There is a positive relationship between institutions’ technology readiness and CC adoption for e-learning.

Management support in HEIs comes in different forms, from financial [36] to creation of enabling environment [37,38]. However, integrating resources and reengineering processes involved in the implementation makes management support increasingly important in adoption [9]. Therefore, we hypothesize that:

H2b: There is a positive relationship between HEIs top management support and CC adoption for e-learning.

The impact of size on adoption is still being argued [39]. In this research, we describe size to include number of students, employees and revenue streams of the HEIs [40]. Thus, we believe that HEIs with more students will generate more internal revenues in addition to the external revenues therefore, have greater chances of adopting CC. Thus, we hypothesize that:

H2c: HEI’s size is significantly and positively related to institution’s ability to adopt CC for e-learning.

The availability of funds to HEIs may impact on their decision to adopt CC technology [40] thus; we extended TOE to include cost. In this research, we describe cost as the expenditure made by HEIs to acquire innovative technologies like CC. it is expected that adoption expenditure and implementation is proportionate to the expected benefits of such technologies [32] thus, CC technology for e-learning should be affordable in comparison to already existing systems. Therefore, we hypothesize that:

H2d: There is a positive relationship between cost and CC adoption for e-learning.
Environmental factors impact on innovation adoption and organizational performance [23]. Similarly, it also impacts on the availability of such innovations and the extent to which they are accepted [41].

We describe competitive pressure as the pressure being exerted by other HEIs or educational and technical partners (IT equipment) like Microsoft, Oracle and Cisco, or from students who require high level of service and support [33]. It is in a constant flux and in order to be competitive, HEIs must continue to adopt the latest technological innovations as well as reinvent themselves. Thus, we hypothesize that:

\[ H_{3a}: \text{There is a positive relationship between competitive pressure and CC adoption for e-learning.} \]

Trading partners (customers, suppliers and network) can also influence organizations to adopt innovations [41]. For HEIs, trading partners may include software and hardware suppliers and technical partners. A complex IT innovation requires facilitating technology portfolio, organizational structure and emphasis on environmental strategy [42]; organizations however, may depend on their trading partners for their IT design and application tasks [34]. Therefore, pressure from these partners is expected to have some form of impact on the decision to adopt the technology. Hence, we hypothesize that:

\[ H_{3b}: \text{There is a positive relationship between trading partner pressure and CC adoption for e-learning.} \]

### 4.3 Diffusion of innovation theory (DOI)

Innovation involves new ideas, practices or artefacts with characteristics (relative advantage, complexity, compatibility, trialability and observability) that can influence its adoption [13]. This section focuses on trialability and observability since relative advantage, compatibility and complexity have already been discussed under TOE framework.

Trialability is the opportunity to test an innovation before deciding to adopt it [13]. Trialability therefore can be said to be directly related to actual system use or ease of use and in effect to adoption of CC. The ability to try out, test or experiment should facilitate the adoption of an innovation.

Observability occurs when an innovation is visible and available and everyone has it, then individuals are more likely to adopt the innovation. At a point when it becomes pervasive, those who would not normally adopt such innovation may consider adopting it. CC technology can be accessed from multiple devices and platforms; and is available over a broad range of networks [4]. Roger’s theory shows a positive correlation between observability and adoption. It is believed that when potential adapters observe the new technology being introduced, they are likely to adopt that technology.

Some researchers on one hand argued that the model could still be improved with additional internal organizational characteristics and external factors as it appears limited [43]. On the other hand, some are of the opinion that the model already has both external and internal dimensions [44]. The external dimension can be quantified and measured while in the internal dimension, the perception is relative to the individual. Therefore, factors including economic and technological and perhaps the perception of the end users (staff and students) seem to be consistent with the external dimension of Rogers’ attributes. Thus, DOI could be used to explain the acceptance of CC for e-learning.

Though DOI was formed on the basis for adoption and diffusion theory [13], subsequent theories of diffusion that have been used in various studies also identified characteristics that are consistent with that of Rogers about perception, attitude and adoption of CC and IT/Information System IS technologies [45,46] and it is hoped that these consistencies will be further validated in this research. The foregoing discussion leads to the two hypotheses below:

\[ H_{4a}: \text{There is a positive relationship between trying out a technology and adoption of that technology.} \]

\[ H_{4b}: \text{Observability and the pervasive nature of a technology are positively related to the adoption of that technology.} \]

Furthermore, if end users have the opportunity to test or experiment with CC before adoption, they can explore its characteristics including how easy it may be to use it if they eventually adopt it.

In effect, we hypothesize that:

\[ H_{4c}: \text{There is a correlation between trialability and PEOU.} \]
4.4 Computer self-efficacy (CSE)

Although this research is focused on HEIs adoption of CC for e-learning, CSE has also been used to show uses of new technology [47,48,49,50] and behavioral factors which in essence may impact on CC adoption. CSE refers to individuals’ belief in their capabilities to use computer in diverse situations [51]. However, it is individuals who make up organizations including HEIs. Self-efficacy has been found to have a major role to play in the adoption of various technological innovations like CC [49].

Individual’s capability to adopt new technology is a major factor in the willingness to accept new technology [48]. As stated earlier (section 4), the decision to integrate any technology within an institution lies with the management. However, successful implementation is exemplified by individual adoption pattern [19] thus, it is important to understand what influences individuals’ adoption pattern.

Fear of computers, confidence and ability, perceived difficulty of use, not understanding the importance of technology and lack of motivation affect the acceptance and use of computers [48]. It could therefore be argued that the aforementioned factors may affect HEI managerial decisions in institutions, as those unlikely to use them are also unlikely to recommend them for adoption by their institutions. Hence, we can hypothesize that:

\[ H_5: \text{There is a positive relationship between individuals’ belief in their capabilities to use technology and CC adoption for e-learning.} \]

The hypotheses presented and discussed in the foregoing pages result in the high level research model at figure 2.

![Figure 2: High level model](image-url)
Figure 3: Detailed research model and hypotheses
CONCLUSION AND FUTURE STUDY

The research so far is at conceptual level. To investigate the adoption of CC in e-learning of higher institutions, the study has used as underpinning theories TAM, TOE, DOI and CSE. Variables from these theories have been selected to develop a theoretical model which will be operationalized into a survey questionnaire to empirically test the model. The 15 universities in Scotland will be used for the study. It is hoped that when collected data are analyzed, it will reveal the reasons for the low adoption rate of CC among the HEIs thus, helping them to strategically realign and compete in the current competitive HE market.

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