J. Appl. Environ. Biol. Sci., 7(6S)27-34, 2017

ISSN: 2090-4274
Journal of Applied Environmental and Biological Sciences
www.textroad.com

Role of Trust Factors in Cloud-Based E-Learning for Higher Education

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Received: May 19, 2017
Accepted: July 18,2017

ABSTRACT

Nowadays, cloud computing is considered as the 5th utility in the world because of ubiquitous computing needs. For education institutions, cloud computing is a promising technology for leveraging teaching and learning process through electronic learning or e-learning. However, trusting public infrastructure in storing important and confidential data is a major obstacle towards adopting cloud computing in the education institution e-learning environment. Thus, this paper focuses on identifying trust factors from the user perspective in existing works. Afterwards, the factors are compared with the outcome of the survey that has been conducted at some local higher education institutions. As a complement to previous studies, this paper discusses the role of trust factors which influences the adoption of cloud-based learning in the education institution.

KEYWORDS: E-Learning, Trust, Cloud-Based, Higher Education Second.

INTRODUCTION

Cloud computing as a rapidly developing information technology has brought new changes and opportunities for IT industry especially in education field[1]. With the promising benefits to education sector such as on-demand self-service, broad network access, resource pooling, rapid elasticity and measured service, the public infrastructure became the key in expanding the angles of e-learning. E-learning brings a new scenery and variation in network-based learning mode. By utilizing cloud computing technology, education quality can meet the 21st century generation of education.

It is well-known among researchers that the most vital challenge of cloud computing is the trust issue as it is related to security concerns [2-3]. This pay-as-use infrastructure opens up many opportunities for security threats and risk because of its Internet-based nature, which results in evading the adoption of cloud computing by many institutions and organizations in their e-learning systems [4-8]

Hence, this paper aims to highlight the trust role in adopting cloud computing in higher education institutions. The related works in cloud computing and e-learning field is discussed in the next section, which investigates the issues of cloud adoption in educational institution. In addition, the features and benefits of cloud computing for e-learning are discussed in details. Section 3 identify the concept of trust in general and explores the related issue regarding trust in online services. Section 4 discusses the case study that have been conducted to seek user trust in adopting cloud computing in the local higher institution. Finally, s6tection 5 concludes this work with a discussion and future trends.

RELATED WORK

Literature Review

Nowadays, the number of education institution started to look up for adopting cloud computing in their e-learning system is increasing. For instance, several universities in United Kingdom have adopted Google Apps due to cost and unreliable in-house email systems. In addition, some universities and schools in underprivileged countries in Africa are using cloud computing supported by Google and Microsoft[10]. For Asia, cloud computing in the education sector is still in infancy stage.

Based on the statistical prediction introduced by Docebo, Asia's region has the highest growth of e-learning from 2011 until 2016 which is 17.3% [11].This figure might influence Asia's higher education institutions to consider cloud computing as an alternative for supporting e-learning in the future. Since cloud computing depends on the internet as the backbone for its services, there is high potential to adopt cloud computing in an e-learning system. Further discussion of cloud computing and e-learning will be continued in the following sub-topic.

Cloud Computing

Cloud is a terminology with old history in telephony, where it has been adopted as a metaphor for Internet-based services, with a common depiction in network diagrams as a cloud outline. The underlying concept dates back to 1960's when John McCarthy declared that computation may someday be provided as a public utility[12-

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13] The term cloud had already came into commercial use in the early 1990s referring to large Asynchronous Transfer Mode (ATM) networks [14].

In general, cloud computing services consist of three main types: (i) Infrastructure as a Service (IaaS): offers remote delivery (through the Internet) of a full computer infrastructure (e.g., virtual computers, servers, storage devices, etc.); (ii) Platform as a Service (PaaS): under this layer, the provided services are almost the same as the traditional computing model; and (iii) Software as a Service (Saas): under this layer, applications are delivered through the medium of the Internet as a service. Instead of installing and maintaining software, user can simply access it via the Internet, without the need for complex software and hardware management [15].

Besides the services, cloud computing provides the deployment model as well. It consists of four components as depicted in

Figure 1 namely public, private, community and hybrid cloud. Each of them represents a specific type of cloud environment, primarily distinguished by ownership, size and access. Cloud computing promises numerous benefit that attract user to choose this service as a platform for their organization or institution such as: (i) supporting the multi-platform, (ii) providing elasticity storage with easy access, (iii) it has economic cost model, (iv) on demand computing support, and (v) freeing users from managing and maintaining resources.

Thus, e-learning can inherit such benefits by efficiently adopting cloud computing technology. Majority of the previous studies found out that despite of cloud computing disadvantages, educational institutions are still working towards adopting cloud computing in their e-learning system [16-17]. However, the adoption process is not as simple as choosing a framework and trying to merge it with the current environment. Complete guidelines and other requirements are needed to be thoroughly considered.

E-Learning

Electronic learning or e-learning is a learning method that uses web as a medium of transferring knowledge to learners. E-learning systems are widely used in various sectors of teaching which include universities, companies, medical organizations, and even in training schools at a lower level.

The main stakeholders involved in e-learning systems are the educators and students. Students can derive major benefits from an e-learning environment in terms of efficient media delivery time, timely feedback and communication with teachers. Students can also communicate interactively with tutors and other students anywhere at any time. Hence, e-learning providers can gain more benefits by using the cloud computing infrastructure since this ready-made platform supports all their requirements.

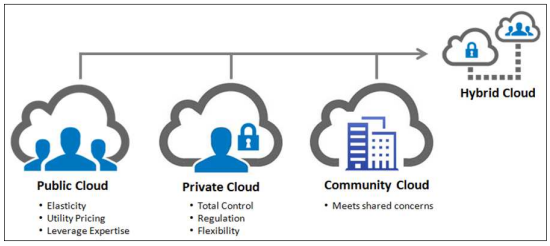

Figure 1: Deployment model of cloud computing [18]

According to[19], there are eight components in e-learning framework. Numerous factors help to improve the quality of learning environment, and many of these factors are systemically interrelated and interdependent. A systemic understanding of these factors can help designers create efficient distributed learning environments. Each of the dimensions describes specific role in e-learning framework:

i. Institutional-it contains all the features covering administration, academic and student issues.
ii. Pedagogical-mostly looks into the teaching and learning dimension which involves analysis of the content and purposes, environment modality, organization and pedagogical methods and strategies.
iii. Technological-this dimension focuses more on infrastructure, hardware and software related development.
iv. Evaluation-it caters all the evaluation processes including the content development, e-learning environment, level of course and institution as well as the student.
v. Resource support-to support the resources which consist of online and offline resources.
vi. Management-completely responsible of managing the e-learning including the model of users, process and product.
vii. Ethical-this dimension consists of 8 branches; political and social context, cultural diversity, geographical diversity, students diversity, digital divide, netiquette and legal problems.
viii. Interface design-this dimension covers the development of pages and website, content, navigation, accessibility and usage test.

However, there are some challenges in implementing e-learning, especially with the nature of internet as the main backbone. In fact, the internet has become a popular venue for illegal activities. This situation results in exposing e-learning to threats and attacks, as it opens up opportunities for the third party to intrude systems illegally [6,18].

The adoption of cloud computing in e-learning 28 ıe application to be publicly shared, which causes the vulnerability of cloud computing. Therefore, usı ally educators and students have doubts on cloud computing security concern. According to[20-21], the main obstacle to adopt cloud computing is trust. In order to adopt cloud computing in the e-learning environment, users need to trust the system as depicts in

Figure 2.

Trust in cloud-based can be measured in several approaches. This study focuses more on user trust, because in e-learning environment, the party which is most concerned in adopting and using the system is the user. As it is used to indicate the trustworthiness, user trust value is the vital part to be improved. However, there are problems in determining the trust factors in cloud-based e-learning system. Different studies derived numerous number of trust factors, which results in different and unstandardized trust values [22-23]. This situation opens up the opportunity for this study to propose the most significant trust factor as further discussed in the next section.

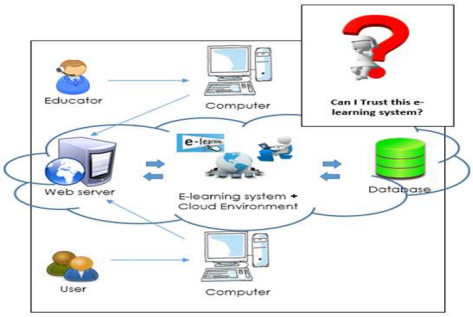

Figure 2:Cloud-based e-learning system

TRUST CONCEPT

Trust is social phenomenon that has been widely discussed in many schools of thoughts. Trust reflect into broadspectrum, such as philosophy, sociology, psychology, and other social sciences [24]. This word usually refers to the concept of believing in other people, which makes us trust them. As it is built in many kinds of human interactions, trust is an integral component which allow people to act under uncertainty and with the risk of negatives and consequences [22]. For example, in a daily communication, if someone asked "Can I trust you?" Then, how to convince him/her that I can be trusted? What are the criteria that one must have to gain the trust? To answer this curiosity, this study addresses the question by identifying several factors that affect trust in cloud computing environment.

According to [24], in computing technology, trust can be formalized into computational concept. This computational concept is used in distributed artificial intelligent (DAI) methods to simulate the result into some values. For instance, Equation (1) shows the calculation of estimated situational trust for agent where notation 'x trusts y in situation α' is: $T_x(y, \alpha)$ and also takes a value in the interval [−1, +1).

$$\mathbf{T_x(y, \alpha) = U_x(\alpha) \times I_x(\alpha) \times \widehat{T_x(y)}} \quad (1)$$

From a general computational trust, researchers move on to applied trust in different domain. In tandem with global issues of communication technologies, trust has been integrated into online services through web trust [25-26]. According to both authors, trust consists of uncertain characteristics which are considered as subjective.

Trust Conceptual Model

As depicted in Table 1, there are previous studies regarding the trust model in several domains such as e-commerce, health and education. These studies proposed trust factors in the domain of performance and security. From the reviewed work, some authors discussed one trust factor only, while others have listed as many as eight trust factors, but without trust evaluations. In addition, the calculation and evaluation methods are

different according to their domain of study and scope. These are other constraints that this study can identified from previous works.

In cloud-based e-learning, very few studies look into proposing the significant user trust factors as well as calculating the trust value [20-21, 27-28]. This study aims to identify the significant user trust factors by comparing previous study works. Moreover, a survey is conducted to study the user trust factors of the local environment in cloud-based e-learning systems. Further details about the survey are discussed in the next section.

Case Study

The main role of trust in cloud-based e-learnir ake user belief that the system can be trusted and used in the same way as the legacy system. In most ional institutions, the adoption of cloud computing is preferred because of its cost effective model, in e and support of multi-tenant users [29-30]. This survey is conducted to investigate the significant of previous studies trust factor for the local environment. The expected results out of this survey are to complement the existing user trust factors in previous studies and to highlight the significant user trust factors for cloud-based e-learning system.

METHODOLOGY

This study has been conducted to identify the user trust factors in cloud-based e-learning system. Malaysian Polytechnics have been selected as the higher education institution because they newly moved from the legacy e-learning system to web-based system. For the legacy system, the users might not have problems with the trust as it is locally managed. However, by moving this system to a centralized server in the cloud-based environment, the concerns of safety and security arise regarding saved data (teaching material and assessment) and personal information.

Table 1:Studies and the proposed trust factors

Author(s)	Trust Factors														
	Performance								Security						
	Execution Time	Reliability	Scalability	Accuracy	Throughput	Usability	Availability	Flexibility	Non-Repudiation	Authentication	Privacy	Data Integrity	Safety	Confidentiality	Authorization
[16]	√						√		√	√		√	√	√	√
[27]		√													
[28]	√						√								
[31]			√				√	√			√	√			
[21]	√				√		√					√		√	
[32]	√			√	√										
[33]	√						√					√			
[34]	√	√			√		√					√			
[35]							√			√	√	√	√		√
[36]	√	√					√								
[37]	√	√			√		√								
[38]	√					√									

This survey results represent the users' feedback after experiencing using both legacy e-learning and cloud-based systems. The questionnaire form was distributed online and consists of two parts. Part A encompasses of user personal details and the usage background.

Part B considers the main objectives which tackle the user trust factor in two parts namely performance (execution time, reliability, availability and usability) and security (data integrity, authentication, authorization and safety). The demography involved students from Malaysian Polytechnics as depicted in Table 2.

There are 272 respondents whereby female population comprises of 51.8% and the rest are male. The considered institutes are 29 out of 33 Malaysian Polytechnics. The respondents randomly participated through the online survey which represents different polytechnics as depicted in Table 3.

Table 2:Demography of respondents

Gender	Frequency	Percentage
Male	131	48.2
Female	141	51.8
Total	272	100.0

Table 3:The institutions that participate in the survey

#	Institution and No. of Respondents	#	Institution and No. of Respondents
1	PoliteknikUngku Omar (38)	16	Politeknik Metro, Kuantan Pahang (1)
2	PoliteknikSeberangPerai (3)	17	Politeknik Sultan Abdul Halim Mu`Adzam Shah (65)
3	Politeknik Melaka (4)	18	Politeknik Metro, Johor Bahru (1)
4	Politeknik Kuala Terengganu (1)	19	PoliteknikTun Syed Nasir Syed Ismail (5)
5	Politeknik Sultan MizanZainalAbidin (41)	20	Politeknik Kota Bharu (1)
6	PoliteknikMerlimau (5)	21	Politeknik Kuching (11)
7	Politeknik Sultan Azlan Shah (8)	22	Politeknik Port Dickson (9)
8	PoliteknikTuankuSultanahBahiyah (2)	23	Politeknik Kota Kinabalu (9)
9	Politeknik Sultan Idris Shah (4)	24	Politeknik Sultan Salahuddin Abdul Aziz Shah (5)
10	PoliteknikTuanku Syed Sirajuddin (6)	25	Politeknik Ibrahim Sultan (3)
11	PoliteknikMuadzam Shah (6)	26	PoliteknikNilai (7)
12	Politeknik Sultan Haji Ahmad Shah (5)	27	PoliteknikBanting (1)
13	PoliteknikMukah (22)	28	PoliteknikMersing (1)
14	PoliteknikBalikPulau (3)	29	Politeknik Sandakan (3)
15	PoliteknikJeli (2)		

The following

Figure **3** depicts the respondents departments. More than 40% of the respondents are from IT department and the rest respondents come from various departments. **Error! Reference source not found.**Table 4shows the Cronbach's Alpha result diagram of the questionnaire. The result 0.969 shows that the questionnaire which consists of 30 items is reliable to be answered by the respondents.

Table 4: Reliability of questionnaires value

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.969	0.970	30

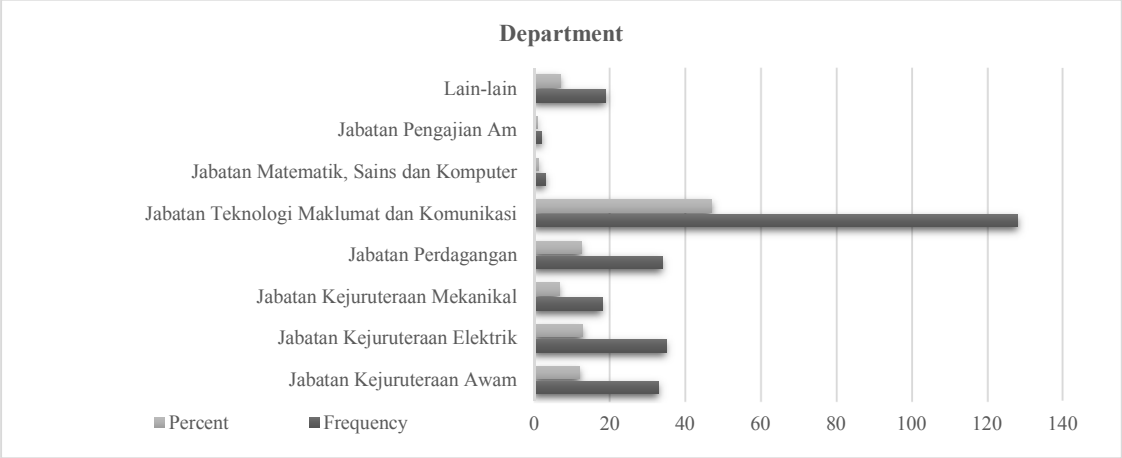

Figure 3:Departments in the Polytechnics

RESULTS AND DISCUSSION

This study analyzed the data using AMOS, one of the statistical software and an added SPSS module. AMOS is a visual program for structural equation modeling (SEM) and specially used for path analysis and confirmatory factor analysis. The data in this study has been analyzed based on six hypotheses as listed below:

H1: Execution Time and Reliability have a positive influence towards trust in e-learning system.
H2: Execution Time and Usability have a positive influence towards trust in e-learning system.
H3: Reliability and Usability have a positive influence towards trust in e-learning system.
H4: Execution Time and Security have a positive influence towards trust in e-learning system.
H5: Reliability and Security has a positive influence towards trust in e-learning system.
H6: Usability and Security have a positive influence towards trust in e-learning system.

From the measurement model inFigure 4, there are four main factors affected trust among student in cloud-based e-learning system. These four main factors namely execution time, reliability, usability and security correlate positively to increase trust among students. The correlations between these factors are shown inFigure 4. It is obvious that the highest correlation among factors is between reliability and usability, while lowest correlation is between security and execution time and between usability and security which represent 0.948 and 0.712 respectively.

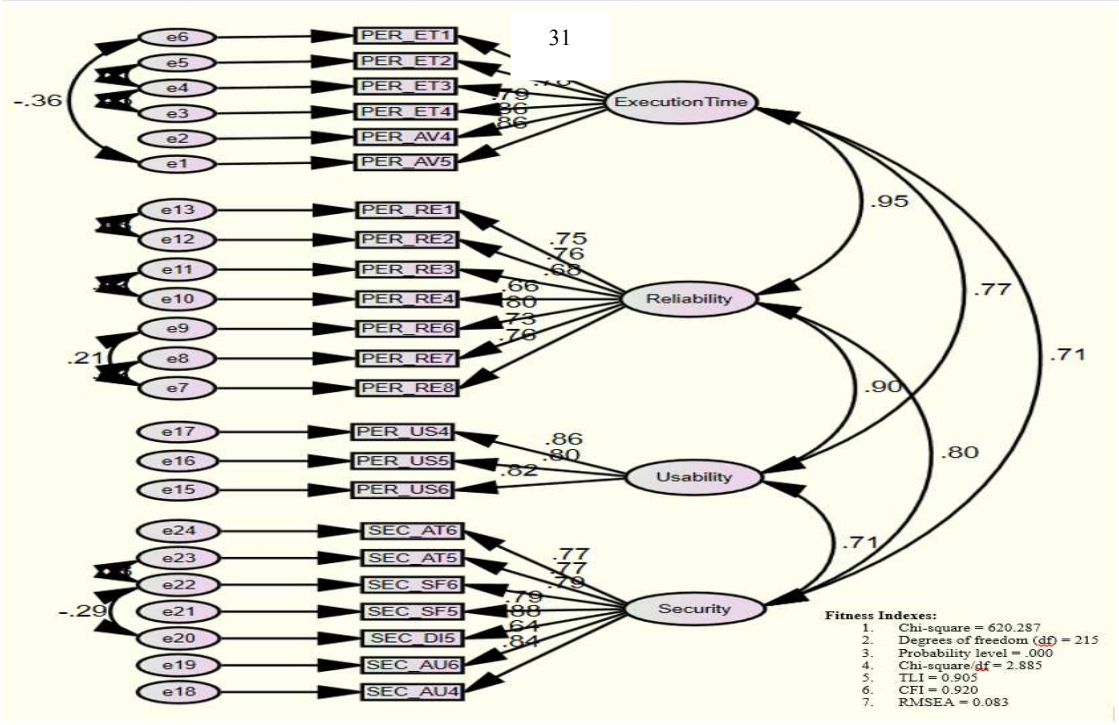

Figure 4: Measurement model

However, all of these trust factors correlate in high estimation value which reflects their strong influence among each other. As compared to previous work, all these trust factors were also considered. Hence, this case study confirms the significance of user trust factors in cloud-based e-learning system.

Cloud computing supports the multi-platform, elasticity storage with easy access, an economic cost model, on demand computing and freeing users from tedious administrative tasks. Such features became attractive points for educational institutions to adopt cloud in their e-learning services. However, educational institution must be aware of the risky side of cloud-based technology. Risking personal data, assessment and learning material in the public cloud, however, forces theinstitutions to take second opinion from the administrators.

Thus, education needs different kind of trust as compared to other domains as concluded from this study. From the survey, this study managed to point out the strong correlation among factors which reflects the significant trust factors for cloud-based e-learning system. The trust factors are namely execution time, availability, reliability, usability, authentication, safety, data integrity and authorization which match with trust factors from the previous work.

Furthermore, this identified that significant trust factors are essential to improve trust evaluation through the calculation of accurate trust value. For future work, this study aims to propose a comprehensive calculation of user trust value via service level agreement (SLA), while considering risk in cloud-based e-learning and improvise the existing algorithm on user trust calculation, in order to suit higher education institution needs.

ACKNOWLEDGEMENT

Highly gratitude to University Teknologi Malaysia in providing facilities for this study. Also for Prof.MadyaMazleenaSalleh, Dr.AnazidaZainal and Dr. Ab. RazakCheHusin for their guidance and assistance in getting this paper published.

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