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Cloud Computing Adoption Factors for University Administration

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Graphical abstract
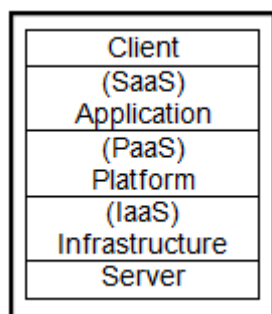
Abstract

With the current financial crisis and challenging growing needs, many universities are facing problems in providing necessary information technology (IT) support for administrative, educational, and research activities. Cloud Computing (CC) has been developed to meet these demands, and is accepted by numerous organizations as a good alternative to manage their IT provisions. However, it is rarely used at universities. This paper intends to find out the major reasons that have caused many universitiesare non usage of CC. A systematic review was conducted based on recently published works on CC to identify the staff positions as well as their required services. Secondly, a correspondence to these was initiated to find out the models/services/applications that are available in the marketplace. Furthermore, an explorative case study was used to find out the factors that have caused the negligence of CC applications at universities. A semi-structured interview was also conducted with administrators, IT staffers, technicians and clerks at four public and private universities in Malaysia. The collected data were analyzed using an open coding methodology. To support the finding of interview a survey is done and a questionnaire distributed. For analysing the result of questionnaire correlation and regression is done by using SPSS.

Keywords: Cloud computing adoption; cloud-based services; cloud-based solution; repudiation factors

Abstrak

Dengan krisis kewangan dan keperluan semasa yang mencabar dan semakin meningkat, banyak universiti menghadapi masalah dalam menyediakan teknologi maklumat (IT) bagi menyokong pentadbiran, pendidikan, dan aktiviti penyelidikan. Pengkomputeran Awan telah dibangunkan untuk memenuhi permintaan ini, dan diterima oleh pelbagai organisasi sebagai alternatif yang baik untuk menguruskan peruntukan IT mereka. Walau bagaimanapun, didapati ianya jarang digunakan di universiti-universiti. Artikel ini bertujuan untuk mengetahui sebab-sebab utama yang menyebabkan kebanyakan universiti tidak menggunakan pengkomputeran awan. Kajian literatur bersistematik telah dilaksanakan untuk mengkaji kerja-kerja penyelidikan terkini dalam bidang pengkomputeran awan dan bertujuan untuk mengenal pasti kedudukan kakitangan serta jenis perkhidmatan mereka perlukan. Kedua, hubung kait kepada faktor ini diselidik untuk mengetahui model/perkhidmatan/aplikasi yang terdapat di pasaran. Kajian kes penerokaan telah digunakan untuk mengetahui lebih lanjut faktor-faktor yang telah menyebabkan kurangnya permohonan CC di universiti-universiti. Temu bual separa berstruktur turut dijalankan dengan pentadbir, kakitangan IT, juruteknik dan kerani di empat buah universiti terbesar termasuk responden dari kalangan orang awam dan swasta di Malaysia. Bagi menyokong hasil dapatan dari temubual, kaji selidik akan dilaksanakan dengan mengedar soalan kaji selidik. Data yang dikumpul akan dianalisis menggunakan kaedah korelasi dan regresi menggunakan SPSS

Kata kunci: Penggunaan pengkomputeran awan; servis berasaskan pengkomputeran awan; penyelesaian berasaskan pengkomputeran awan; faktor penolakan

■1.0 INTRODUCTION

Like any organizations, universities and higher education institutes need to use Information Technology (IT) services such as email, sharing space, web base services, and the Internet. Academic institutions often have many requirements that have special characteristics, and these must be considered carefully to fit the needs of different kinds of students. A technology can easily become outdated with limited IT resources and heavy workloads for administrative, teaching and learning activities. In regard to this, cloud computing (CC) is one of the newest paradigms which can meet all the requirements.

Cloud computing (CC) has recently reshaped the IT industry as a service-oriented computing and its definition varies according to different authors; however, a comprehensive definition has been described by the National Institute of Standards and Technology (NIST) which explains CC simply as a model.[1,2] More precisely, NIST defines CC as 'a model for enabling

convenient and on-demand network access that can be rapidly provisioned and released with minimal management effort or service provider interaction'. CC promotes availability and is constructed with five important characteristics, three service models, and four deployment models.[3]

In a business and academic environment, the usage of cloud computing has been discussed for several reasons. CC is believed to reduce costs of implementation and maintenance, enhance the mobility of a global workforce, and can be used without being installed on individual computers. Moreover, it is consisted of flexible and scalable infrastructures, provides quicker access to the market, and allows IT department transformation where the focus can be shifted to innovation rather than maintenance and implementation only.[4]

However, the beneficial characteristic of cloud computing is neglected by some organizations, including universities, because most IT personnel believe that they can secure the environment better than a service provider.[5] In order to know the reasons behind their preference on other software packages, some interviews have been conducted and the factors had been classified into policy, security, and applicability.

■2.0 LITERATURE REVIEW

2.1 What Is Cloud Computing

Cloud computing is a manner of computing that is dynamically scalable and can be often virtualized as a service provided over the Internet.[6] The NIST defines the five fundamental characteristics of CC as: a) on-demand self-service (customers can manage their requirement without referring to a cloud provider;[3,7] b) broad network access (provides access to services over the internet or private network;[3,7] c) resource pooling (allows users to access their resource through a pool of computer resource which is usually remote;[1,3,7] d) rapid elasticity (refers to capabilities that can be elastically provisioned and released;[1,3,7] and e) measured service (service used by customers are measured before the customers pay accordingly.[1,3,7] Cloud computing is a kind of IT application and infrastructure that works out of the boundaries of an organization's local data center. In the context of a university, CC can be used as an out-of-campus or on-campus computing system.[7] Most organizations have employed this system because it can significantly reduce their costs.[8-10]

2.2 Cloud Computing Service Model

Commercially available operating systems can be divided into three categories according to the level the system interfaces with the software platform (see Figure 1).[1,3,11-13]

a) Software as a Service (SaaS): SaaS provides the whole stack of services and the client need not perform any administrative tasks, but only pays for his or her usage. Cloud consumers release their applications to the hosting environment that is accessible through networks from various clients (e.g. web browser, PDA, and etc.) by the application's users. However, the cloud consumers cannot control the cloud infrastructure that often employs multi-tenancy system architecture. Different cloud consumers' applications are organized in a single logical environment on the SaaS cloud to achieve economies of scale and optimization in terms of speed, security, availability, disaster recovery, and maintenance. Examples of SaaS include SalesForce.com, Google Mail, Google Docs, and so forth.[1,3,11-13]

b) Infrastructure as a Service (IaaS): The service provider provides basic infrastructure, typically just empty virtual machines. A client has to install his own operating system and applications before he or she can rent the processing, storage, networking, and other basic computing resources for all purposes. IaaS is also called Hardware-as-a-Service (HaaS).[1,3,11-13]

c) Platform as a Service (PaaS): The service platform provides a platform where clients' applications can be developed and executed. The client does not need to worry about the administration of the underlying hardware and operating system; he or she only has to provide applications. PaaS is a development platform supporting the full "Software Lifecycle" which allows cloud consumers to develop cloud services and applications (e.g., SaaS) directly on the PaaS cloud.[1,5,11,12]
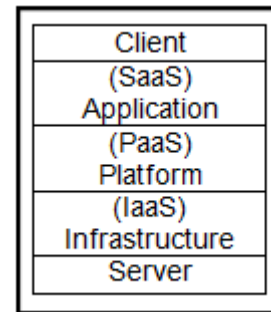

Figure 1 Cloud service model

2.3 Popular Cloud Computing Application

a) Google Apps: This is a popular cloud platform provided by Google and is a collection of web-based messages and collaboration tools. These include messaging tools like Gmail, Google Talk, and Google Calendar and collaboration tool like Google Doc. In Google Doc, text files, spreadsheets, presentations, and other applications like the Microsoft world are cloud-based; the data can be reachable anywhere and the only software you need to access it is an Internet browser.

b) Amazon Web Services: These are a collection of remote computing services that make up a complete cloud computing platform which is offered over the Internet by Amazon.com. Amazon Web Services provide online services for other web sites or client-side applications[14]. Although most of these services are not exposed directly to end users, their functionality is accessible by other developers. It utilizes a hosted framework running on the web-scale infrastructure of Amazon Elastic Compute Cloud.

c) Amazon EC2) and Amazon Simple Storage Service (Amazon S3). EC2 is a service that allows the creation of virtual machines to run on one of Amazon's data centers. Amazon S3 is a storage system for the Internet which is designed to make web-scale computing easier for developers. Moreover, it provides a simple web services interface that can be used to store and retrieve any amount of data at any time and place convenient to the user.[15].

d) Dropbox: This is the biggest web-based storage service designed to avoid unnecessary traffic and storage with several millions of users and uncountable number of files.[16]

2.4 Computing Services for University

Universities, like other organizations, require services such as email, storage, financial transaction which need cloud computing applications, models, and services to meet their requirements. In fact, many university staffers have already used cloud technologies in their personal life.[16,17]

By using a cloud model and applications based on a cloud, they can work and communicate in their educational environment at their own convenience.

With CC, the system's administrators can obtain general processing, storage, database management, and other resources and applications through the network. The rest of the administrative staff will benefit from these services and infrastructure 24/7 from all places at low costs.[16]

The activities of a university can be generally classified into three main categories, i.e., research, teaching, and administration.[16,18,19] Research and teaching are two fundamental activities of universities. The main personnel in a university are the students, academic staffers (which comprises of tutors, instructors, lecturers and professors), administrators, and non-academic staff. Examples of non-academic staffers include IT staff, technicians, and clerks.[16,20,21] The focus of this study is on the administrators and non-academic staff. The generally required services by the administrators and non-academic staffers are summarized in (Table 1).

Based on (Table 1) and related works on cloud solutions for universities, the appropriate cloud base application is found and as proposed in (Table 2).

Table 1 Division of staff required Services based on their position in organization

Service / Staff Position	Administrator	IT staff	Technician	clerk	year	reference
Email	✓	✓	✓	✓	2010	(18)
Business Intelligence	✓				2012	16, 22
E-learning					2012	16
Microsoft Office	✓	✓	✓	✓	2011	4, 6, 20-22
Online document viewing and editing	✓	✓		✓	2012	17, 21, 23
Student lifecycle	✓				2012,2011	16, 24
sharing space	✓	✓	✓	✓	2011	24
storage	✓	✓	✓	✓	2008,2010,2011	25-27
scheduling meetings	✓				2011,2012	23, 28
virtualization	✓	✓	✓	✓	2012	22, 29
security	✓	✓	✓	✓	2010,2009	26, 29, 30
Acquisition	✓				2012	16
Accounting-financial	✓			✓	2011,2012	16, 22, 24
Case management	✓				2012,2008,2010	16, 31, 32
Building administration	✓				2012,2008,2010	16, 31, 32
Digital Library				✓	2012,2008,2010	16, 31, 32
Educational_ ERP	✓				2012	16, 22

Table 2 Cloud-based solutions for staff requirement

Service \ Solution	Microsoft Office 365	Google App	Drop box	Doodle	Amazon Web Services	Cloud-Based Firewall Service	Microsoft Dynamics CRM Online	Educational ERP	Campus Management	Cloud paper product
Email	✓									
Business Intelligence									✓	
E-learning		✓							✓	
Microsoft Office 365	✓									
Online document viewing and editing	✓	✓								
Student Lifecycle									✓	
Sharing space	✓	✓	✓							
Storage		✓	✓							
Scheduling meetings and other appointments				✓						
Virtualization					✓					
Security						✓				
Admission							✓		✓	
Human Resource							✓			
Acquisition										✓
Accounting-financial									✓	
Case management		✓							✓	
Building administration									✓	
Digital Library								✓		

Despite the abilities of cloud computing to cover all required services of the administrators and non-academic staffers, most universities remain doubtful towards the usability of CC.[33,34]

■3.0 METHOD

In this research, mixed method research technique was used to answer the research questions. According to definition, mixed methods research involves collection and analyzing of quantitative and qualitative data which allows the researcher to draw more substantive conclusions.[35]

3.1 Qualitative Part

The qualitative part of this research involves using case study to answer the research question. In this research, the possible applications of cloud computing in educational institutions include drop box, Google App, Microsoft Live, Amazon Web Services (AWS), Doodle, Microsoft Office 365, and the Cloud-Based Firewall Service. Four famous universities among the public and private universities of the Malaysian has been chosen as the focus of this case study since these universities are amongst high rank and big universities in Malaysia and has established Center for Information and Communication Technology (CICT) that is responsible for the study and adoption of new IT technology. A case study methodology enables the researcher to closely examine the data within a specific context.[36] The staffs at this ICT centers are, generally, the administrators, IT staffers, technicians, and clerks who are decision maker for adoption of new technology. Some them also are academic staff who has executive position in IT center. The required services of each category of staff have been previously recognized in (Table 1), and the cloud-based applications have been assigned for each position appropriately in (Table 2). The samples were purposefully selected at random from the sampling frame to participate in this study.[37] Twenty eight persons were chosen and interviewed, containing ten directors and deputy directors from the cloud project member, two technicians, two clerks, nine IT staff, and three programmers.

3.2 Quantitative Part

A questionnaire-based survey was used to collect data among IT managers and IT decision makers. The questionnaire use 5 points likert scale. To test the hypothesis a correlation and logistic regression analysis has been used. Samples are chosen among IT managers and IT staffs and some lecturers who have positions in ICT centers of chosen universities. From hundred twenty distributed questionnaires about 96 questionnaire have been returned. In this study, 34 survey items for constructs drive from interview and previous study used in the questionnaire. The questionnaire had two parts. Part one is a demographic data and part two consists on the questions for evaluating the predictors.

3.3 Hypothesis

Hypothesis 1: Inapplicability will be correlated with the adoption of cloud computing.
Hypothesis 2: Security will be correlated with the adoption of cloud computing.
Hypothesis 3: Policy will be correlated with the adoption of cloud computing.
Hypothesis 4: Accessibility will be correlated with the adoption of cloud computing.

■4.0 RESULTS AND DISCUSSION

4.1 Qualitative Data Analysis

Qualitative data analysis entails the usage of open coding[38] as a process of identifying, naming, categorizing, and describing the data.[39,40] This open coding provides a list of intellectual bins or seed categories.[41] In this study, four categories have been coded as the reasons that have caused a lack of interest in using cloud computing at chosen university. The categories include security, accessibility, policy for acceptance of cloud computing, and applicability.

a) Policy

In chosen universities, cloud computing has been refused due to internal organization policy of cloud-based application. One of the respondents said that, "we should use the facilities provided by chosen university (work place)". Another respondent said that, "we use the application provided by chosen universities, chosen universities email and, Web Services". The third respondent said that, "we use the facility provided by chosen university to store and share our data". Most respondents gave the same response. During the future research, they said "if they want to move their data in cloud based data center they prefer just to move their insensitive data; because they do not need to do maintenance and employs new staff they just pay and use the services which causes to low managerial activities". Also they said" if they want to use cloud data center for their private data they prefer to use private cloud not public cloud"; which, this result is in line with results published for the role of CC in organizations. [44-46]

b) Security

Security was one of the important concerns of the respondents, especially when the data goes out of their local networks. This is in the same view with the results published by Rajkumar Buyya,[42] Tharam Dillon 1, Krešimir Popović,[43]Yi Wei,[44] and Takabi.[45] They all agreed that security issue is the topmost issue that governs the acceptance of cloud computing in an organization. The path to secure CC is surely a long one, and it will require the participation of many stakeholders on a global basis. Nevertheless, new cloud security solutions continue to be published around traditional issues such as data and resource access control, encryption, and incident detection. Also Clients could carefully examine and negotiate the Service Level Agreements with their cloud service provider to determine and minimize their risk exposure before agreeing to use any cloud computing service. In addition to, by employment of security arrangements such as wiping a virtual machine's memory space securely after shutdown and frequent monitoring using Private Virtual Infrastructure (PVI) which shares the responsibility of security in cloud computing between the service provider and

client, the risk exposure will be decreeing.[46-48]

c) Inapplicability

Some respondents of chosen university believe that cloud-based services are not applicable for their work due to the duties assigned to their positions. One of the respondents expressed that, "we are technicians and work on hardware, so the existing cloud-based services are not applicable for us". The findings of the research have been contravening results of previous study regarding inapplicability.[49-51]

d) Accessibility

A few number of respondent said the accessibility to cloud computing services is not easy they said" cloud based application is not accessible and it cost huge money to access to them", mean while cheap and easy access to cloud based services is one of the major advantage of cloud computing which highlight by many of researcher. Plenty number of researcher mentioned that, the "cloud" term have been driven from the idea of businesses and users being able to access applications from anywhere in the world on demand.[1,52,53]

4.2 Quantitative Data Analysis

This analysis includes likert -based information that has been collected using a 5 point likert scale questionnaire. Statistically analyzed scores are collected using SPSS's statistical functionality consisting of Correlation bivariate and linear regressions computations. The statistical functions were performed based on one dependent variable, the universities leaders' and decision maker intent to adopting cloud computing data centre, and 4 independent variables that resulted from interview representing the perceived innovation attributes: inapplicability, security, policy, and accessibility. In the first step of the analysis, all of the control variables were entered into the model as predictors of intention to adopt. The results of entire linier regression analysis are provided in (Table 3).

Table 3 Regression result

Predictor	Un-standardized Coefficients		Standardized Coefficients	Sig.
	B	Std. Error	Beta	
Inapplicability	1.000	.000	.241	.000
Security	1.000	.000	.357	.000
Policy	1.000	.000	.535	.000
Accessibility	1.000	.000	.117	.003

[a.] Dependent Variable: interest

The regression in (Table 3) supports all study hypothesis. Result show that all predictor has strong, positive and statistically significant ($p<0.05$) relation with interest of IT management and decision maker regarding adopting of Cloud Computing Data Centre (CCDC) in universities. However as shown in (Table 3) policy can predict 52% of the dependent variable it means that by good policy the interest of IT manager for adoption of CCDC will increase. Mean while there is a few study which said the policy has significant relationship with CCD adoption but the result of this study support this hypothesis.[33] In addition, the study showed that the security also has significant positive relationship with adoption of cloud and can predict 43% of interest of leader for adoption of cloud. Also, this study show that the inapplicability of cloud computing data centre also has significant relation with interest of leaders for

adoption of it but it just predict small percent of interest of decision maker for adoption of cloud(3%), and finally the accessibility who takes up the minimal percentage of prediction(2%). However, inapplicability is the weakest predictor for predicting interest of IT leaders for adoption of cloud in the context of chosen university in Malaysia.

■5.0 CONCLUSIONS

This study was carried out to find the reasons for the ignorance of cloud computing usage at chosen universities. The preliminary results revealed that the staff resists the usage of cloud-based applications, although most of them are familiar with a certain number of applications. During the qualitative research four main reason for avoidance of organization found which were security, policy, accessibility, and inapplicability. Although, most of the respondents felt that the security issue play an important role in encouraging the usage of cloud-based applications; the result showed that policy is most important in compare to security issue, and lack of proper policy has further hindered its usage. In addition, also accessibility and inapplicability has statistically significant relationship with adoption of CC but, this relationship was very week in compare to policy and security issue of cloud. Future researches still need to include more universities in Malaysia to cover the reaction of many universities towards CCDC adoption.

Acknowledgement

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