Cloud Computing Adoption by Higher Education Institutions in Saudi Arabia

Analysis Based on TOE

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***Abstract*— (1) Background, Motivation and Objective: Academic study of Cloud Computing within Saudi Arabia is an emerging research field. Saudi Arabia represents the largest economy in the Arabian Gulf region. This positions it as a potential market of cloud computing technologies. Adoption of new innovations should be preceded by analysis of the added value, challenges and adequacy from technological, organizational and environmental perspectives. (2) Statement of Contribution/Method: This cross-sectional exploratory empirical research is based on Technology, Organization and Environment model targeting higher education institutions. In this study, the factors that influence the adoption by higher education institutions were analyzed and tested using Partial Least Square. (3) Results, Discussion and Conclusions: Three factors were found significant in this context. Relative Advantage, Data Privacy and Complexity are the most significant factors. The model explained 43% of the total adoption measure variation. Significant differences in the areas of cloud computing compatibility, complexity, vendor lock-in and peer pressure between large and small institutions were revealed. Items for future cloud computing research were explored through open-ended questions. Adoption of cloud services by higher education institutions has been started. It was found that the adoption rate among large universities is higher than small higher education institutions. Improving the network and Internet Infrastructure in Saudi Arabia at an affordable cost is a pre-requisite for cloud computing adoption. Cloud service provider should address the privacy and complexity concerns raised by non-adopters. Future information systems that are potential for hosting in cloud were prioritized.**

***Index Terms*—Cloud Computing, Higher Education, TOE, Saudi, Adoption, University, College.**

I. Introduction

There are potential benefits of adopting Cloud Computing model. It offers a shift from computing as a product that is owned, to computing as a service that is delivered to consumers over the network from large-scale data centers or clouds (Abdollahzadehgan et al., 2013).

Risk factors associated with such adoption decision should be taken into consideration before adopting this model. In practice, investors try to reduce the degree of risk and minimize uncertainty by either being risk averse while losing the potential benefits of this investment or doing a careful assessment especially in mission critical system and business processes. Understanding innovation adoption factors helps institutions analyze it in a structured approach.

Assessment of technical factors is not enough at institutional level. Innovation should fit within the context of the institution and external environment. Cloud computing leads to IT commoditizing (Sultan, 2010). Due to this argument, resistance is anticipated by Information technology departments within institutions. Public Cloud Computing enables data to be stored outside of the institution. Service provider can be in a different country or even a different continent. This should raise different types of risks related to data privacy and legal aspects.

Saudi Arabia is a developing country. Cloud computing allows accessing advanced technology and sophisticated infrastructure without the need for large investment. Adopting cloud computing represents an opportunity for institutions in Saudi Arabia to access high-end technologies with minimal expertise and investment. It is anticipated that cloud computing will supersede traditional computing represented by building data center and managing the infrastructure internally. Relative advantage is associated with cost reduction and responsiveness to business requirements (Sultan, 2010).

Several definitions of cloud computing were proposed in the literature. The commonly acceptable technical definition is the one provided by the National Institute of Standards and Technology (NIST) (Alshwaier et

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al, 2012; Haag & Eckhardt, 2014; Alabbadi, 2011). The definition is:

> "Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model is composed of five essential characteristics, three service models, and four deployment models." (Mell & Grance 2011)

Limited research papers about cloud computing in Saudi Arabia were published. AlHarbi found high level of users' acceptance of cloud computing in Saudi Arabia. The research was based on the Technology Acceptance Model (Alharbi, 2012). However, this paper did not specify the position of users surveyed in the enterprises and whether their judgment was based on personal cloud applications or enterprise cloud applications.

Understanding the position of Institutions with respect to Cloud Computing adoption is essential research area. In this paper, the focus is on Higher Education community in Saudi Arabia.

A. Research objectives/questions

The research objective is to find and analyze the Technological, Institutional and Environmental factors that directly affect the adoption of Cloud Computing by Higher education institutions in Saudi Arabia. The focus of this study is Cloud Computing solutions that are hosted outside of the premises of the college or university. Cloud computing solutions being addressed by this study is institutional level solutions such as library systems, ERP, learning management systems and research solutions.

In this paper, we aim to answer the following questions:

1. What is the level of Cloud Computing Adoption by Saudi higher education colleges and universities?

2. What are the significant institutional, technological and environmental factors relevant to Cloud computing adoption decision by higher education institutions?

3. What additional factors that should be considered in future studies? (Using unstructured questions)

4.What are the main barriers toward cloud computing adoption?

B. Research Motivation and Importance

Cloud Computing is considered in 3 out of 10 top strategic technology trends for 2014 year according to Gartner (Cearley, 2014). It is considered one of the new areas of research under Management Information System discipline.

To the best of our knowledge and based on literature review, this work is one of the first papers that addresses institutional, technological and environmental factors within the cloud computing context in Saudi Arabia.

II. Literature Review

In this study, it was decided to adopt National Institute of Standards and Technology cloud computing definition. This definition was published on September 2011 to serve as a baseline and standardize cloud computing (Mell & Grance 2011). Since the publication of this standard, several academic studies included this definition as part of the literature review process (Alshwaier et al., 2012; Abdollahzadehgan et al., 2013; Borgman, 2013; Haag & Eckhardt, 2014; Klug, 2014).

Cloud Computing model was evolved from several technologies. The model is an evolution of virtualization, Grid Computing, Utility Computing, Web services and Internet. High speed wireless network, low cost broadband and Low storage and HW cost had contributed to the development of cloud computing (Alabbadi, 2011).

Cloud Computing is more than an outsourcing. According to the definition, there are five essential characteristics that distinguish cloud computing from an outsourcing (Alabbadi, 2011; Karla et al., 2010).

Several commercial SaaS cloud services are available in the market today. This includes email services, CRM Salesforce, GoogleApps and ERP systems (Kalpeyeva & Mustafina, 2013; Taweel, 2012). Cloud computing

vendors are also targeting the higher education segment (Mircea & Andreescu, 2011).

A. Cloud Computing in Higher Education

Several cloud computing companies target educational institutions. Our objective is not to cover all services available in the market in this context. However, the objective is to have an overview about the offering in the market that can be used by higher education institutions.

Some companies offer programs for educational institutions. Example of these programs is Microsoft Live@edu (Alshwaier et al., 2012). This service has been transformed to Microsoft Office 365 recently. It includes Word, Excel, PowerPoint, Outlook, OneNote, Publisher, and Access. The offer includes shared collaboration storage in the cloud to allow sharing documents among students in their projects (Microsoft, 2014).

Google also provides a program for education through its Google Apps for Education Suite. This suite includes productivity applications such as Google Docs. The suite includes email service, classroom management system, shared storage represented by Google Drive, website creation and hosting, and collaboration tools (Google, 2014). A case study in the university of Westminster indicated the benefits and saving attained by using Google Apps services by the university. The primary purpose of this service is to use email, collaboration and storage services of Google Apps for non-sensitive information. An estimated saving of £1,000,000 was recognized. (Sultan, 2010)

IBM Cloud Academy is a community cloud computing program. It provides best practices and consultation services in addition to the cloud solutions offered to higher education institutions. These solutions include collaboration solutions, infrastructure computing, integration solutions, virtual desktops solutions …etc. (Sultan, 2010; IBM, 2014).

Efficiency factor was recognized by specific higher education institutions that adopted cloud computing. Efficiency was achieved by Washington State University by adopting a virtualization environment which is considered an enabler for cloud computing. Saving was recognized by using Google Apps email services. Cloud computing was also used by a number of higher education institutions in poor African countries such as Nairobi, Ethiopia and Rwanda (Sultan, 2010).

B. Technology Organization Environment Framework

TOE serves as a taxonomy for factors that facilitate or inhibit the adoption of innovations (Haag & Eckhardt, 2014). TOE has advantage over Diffusion of Innovation model due to the consideration of the environment factors (Oliveira & Martins, 2010; Alshamaila et al., 2013; Tam, 1997). Institutional theory addresses the interrelationship between institutions. Adoption theory was used in the context of institutions. It addresses only the technical factors (Ross, 2010). The theoretical framework of TOE was proposed by Tornatzky and Fleischer in 1990 on studying the adoption of technology innovations (Tam, 1997; Haag & Eckhardt, 2014).

TOE was used in the context of cloud computing (Haag & Eckhardt, 2014). Before that, it was used in similar research areas such as open system, e-business and Internet use. Several factors were explored and validated.

TOE is an institutional level theory in contrast to Technology Acceptance Model. At institutional level, analysis should not be focused on technical factors only. The institutional and environmental contexts of running the technology should be integrated and analyzed (Tam, 1997; Alshamaila et al., 2013).

Higher Education Cloud Computing was tested under TOE framework in developed countries. A study that was conducted in USA revealed that compatibility, top management support, and relative advantage had the most significant contributions to the variance in IT managers' interest in adopting cloud computing. Institution size was not found a significant determinant of the adoption (Taweel, 2012).

Alharbi proposed an updated UTAUT that include the trust construct in the original model (Alharbi, 2014). The critic for this paper is that UTAUT is appropriate for individual level. However, he suggested this model for institutions. In addition, trust based on his definition can be covered by the security and privacy variable under TOE.

In the context of cloud computing, generally, different factors were associated with each of TOE taxonomies in different studies (Klug, 2014; Hsu et al, 2014; Lian et al, 2014; Oliveira et al, 2014). Based on Shiau et al, “Although comparing the results from one study to another may be difficult, the fact that studies use different factors does not prevent a researcher from evaluating the proper application of the TOE framework”. (2012)

III. Research Model and Hypotheses

The approach of the research is based on Technology, Organization and Environment framework. Assessment will cover the adoption factors at the institutional level rather than the personal level (Tam, 1997; Low et al, 2011; Taweel, 2012; Alshamaila et al, 2013; Borgman, 2013).

A. Research Model

The following table represents the constructs used in the TOE model. Support from literature is included with the definition.

Table 1. Factors Definitions

Construct	Definition
Relative advantage +	The ''degree to which an innovation is perceived as being better than the idea it supersedes'' (Rogers, 2003).
Compatibility +	''The degree to which the innovation fits with the potential adopter's existing values, previous practices, and current needs.'' (Rogers, 2003)
Privacy Concerns -	A security breach is "an incident in which a company or a government agency loses information, personal records, or other sensitive data" (Oliveira et al, 2014).
Complexity -	Complexity is the perceived difficulty by a firm to understand and use an innovation (Klug, 2014).
Vendor lock-in -	Vendor lock-in refers to the possibility of customer being in a situation where he cannot migrate to another vendor due to cost or technical barriers. (Taweel, 2012; Alshwaier et al, 2012)
Top management support +	Refers to: the attitude of top management toward the relevant technology and the level of support devoted for the adoption.
Regulatory policies -	Refers to: the policies imposed by the government to regulate cloud computing market.
Government Pressure +	Government efforts and incentives to facilitate the adoption of cloud computing by higher education community.
Peer Pressure +	The influence of the ecosystem in which the organization operates. Partnership between universities and colleges can be established in the area of education and research. (Oliveira & Martins, 2010; Low et al., 2011)
Cloud Computing Adoption	Refers to the degree of which an organization plans to adopt cloud computing.
Organization size (moderator variable)	Size can be measured in terms of employees' number or revenue amount. In higher education context, size may be measured in terms of number of students. (Klug, 2014)

The following diagram represents the research model and the proposed constructs. The variables in each of the three areas were driven from previous studies (Tam, 1997; Sultan, 2010; Oliveira & Martins, 2010; Low et al, 2011; Taweel, 2012; Nkhoma et al., 2013; Abdollahzadehgan et al, 2013; Borgman, 2013; Alshamaila et al., 2013; Lian et al, 2014; HSU et al., 2014; Oliveira et al, 2014; Klug, 2014).

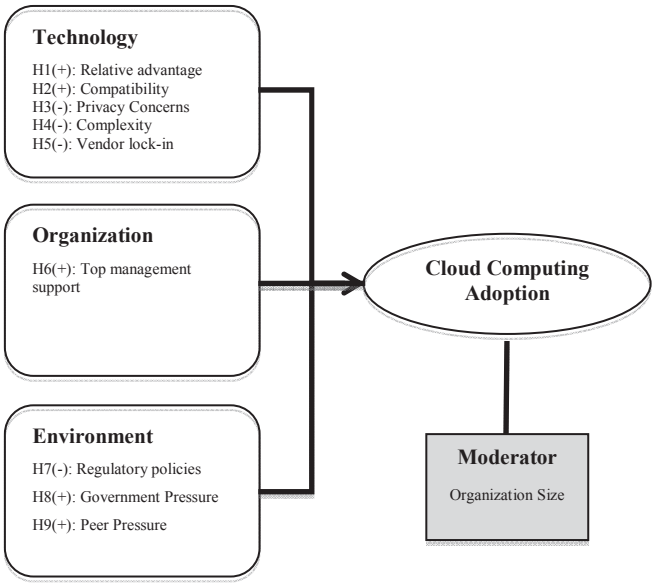

Figure 1. Research Model

IV. Research Methodology

The research is an exploratory quantitative cross sectional based study. Structured survey instrument was used to collect the primary data and test the hypotheses. Additional open-ended questions were included to capture qualitative data.

A. Target Population

The population of the study is Saudi; non-military or security; Colleges and universities that offer at least 4 years undergraduate program or advanced degrees.

Total number of institutions based on the target population restriction is 55. For that reason, full enumeration is feasible. No sampling is required under this scope.

V. Data Collection

Sampling units are higher education institutions in Saudi Arabia. In addition, the institution is considered a consumer or potential consumer of cloud services rather than a cloud computing vendor. (Ross, 2010)

The instrument to collect the data was a survey. The survey was sent by email to the key informant person who is responsible for the decision-making regarding

information technology or his delegate within the institution (Tam, 1997; Suo, 2013).

A total of 33 responses were received which represent a response rate of 60%. Two responses were eliminated since they were answered by non-key informant persons within the institution based on the demographic questions and further verification by contacting the respondents. The analysis was based on the remaining valid 31 responses.

VI. Data Analysis

Analysis of the data consists of four parts. First part is descriptive statistics to understand the nature of the respondents and analyze frequencies. The second part is related to the model analysis. Third part is an analysis of the moderator variable. Forth part is an analysis of open-ended questions.

VII. Discussion

Government pressure was negatively correlated, with less degree of significance, with the adoption level. This is opposite to the hypothesis statement. Respondents expressed disagreement with any role played by the government toward the adoption process. E-government program did not cover higher education organizations in the area of cloud computing. Based on this, there is no effective government pressure toward the adoption of cloud computing.

A non-significant variation of management support toward cloud adoption was found. Based on the mean distribution of both adopters and non-adopters, management provided a degree of support toward the adoption of cloud computing. Management support construct incorporated understanding the benefit, providing the required resources and supporting the implementation.

Based on Partial Least Square analysis, the following hypotheses were accepted:

• H1: Relative advantage will positively influence cloud-computing adoption.

• H3: Privacy concerns will negatively influence the intention to adopt cloud computing.

• H4: Complexity will negatively influence cloud-computing adoption.

Relative advantage construct was reduced to "personnel reduction dimension", "cost saving dimension" and "agility dimension" before the hypotheses testing to increase the level of composite reliability. Relative advantage was the most significant factor. Relative Advantage was more apparent to cloud computing adopters relative to non-adopters. This gives an important practical implication about the future of cloud computing.

With respect to data privacy, a significant negative association between cloud computing adoption and the degree of concern was revealed. Adopters expressed less degree of concern regarding the privacy than non-adopters. This can be attributed to risk mitigation measures taken by adopters, taking into consideration the data privacy aspects in the Service Level Agreement or realizing that cloud computing is more secure than what it was perceived before the adoption.

Negative association between complexity and cloud computing adoption was confirmed. Adopters perceived cloud computing as less complex than non-adopters. Based on complexity measurements, cloud computing is generally not complex with a mean distribution between Disagree that cloud computing is complex and neutral. Based on the discriminant analysis, cloud computing is perceived more complex by smaller institutions; who are generally non-adopters as well. This could be attributed to the lack of information technology skills and resources to evaluate this technology.

With respect to regulatory policies, Saudi law did not provide sufficient protection regarding the use of cloud computing. This result is consistent between adopters and non-adopters. An explanation for this is that adopters may trust the compliance of service providers to the Service Level Agreement.

Based on the discriminant analysis and ANOVA test, large organizations are ahead of smaller ones in terms of cloud computing adoption. Further tests revealed that smaller institutions perceived cloud computing as more complex and less compatible with their institutions than larger institutions. Smaller institutions also had more concerns about vendor lock-in issue. Finally, peer pressure was more apparent for larger institutions. The latter

ANOVA test results gave insightful explanation why smaller institutions were behind.

Cloud computing Adoption level and future adoption level by higher education institutions in Saudi Arabia were expected to be high based on respondents' feedback.

VIII. Research Contribution

This research is considered one of the first exploratory studies in the field of cloud computing in Saudi Arabia.

A. Practical Implication

Results may give cloud computing vendors an insight about the critical factors that affect the adoption of cloud computing. Relative advantage could be deteriorated due to the unreliable performance of Internet connectivity. It was explained by specific decision makers that the Network and Internet infrastructure in Saudi Arabia is under development, the bandwidth is limited and cost is high compared with USA and Europe. One respondent stated that "…getting a high speed data rate (bandwidth) connection is considered to be costly compared to other countries in Europe and North America." Another one commented out that "The issue is not with cloud computing but rather with the communication means. Cloud computing assumes a very fast, reliable and highly available connection means at an effective cost." Based on that, Internet Service Provider should improve Internet Infrastructure and provide high availability for the network service at an efficient cost before promoting for cloud computing services.

Differences were also found between large and small institutions. Small institutions adoption level was lower than large universities. This could be attributed to the maturity level of larger institution in terms of information technology knowledge and practical experience compared with small colleges that do not have enough resources and experience to evaluate such emerging solutions.

Non-adopters expressed more concern with respect to privacy and complexity of the technology. For that reason, marketing efforts should be concentrated on these two aspects to increase the adoption level. Benchmark data should be valuable in this regard. Since the adoption has been started, one of the successful adopters case can be used as a model for non-adopters.

Cloud Computing for smaller institutions is more complex and less compatible. This finding could be attributed to the lack of resources to explore and test new technologies by these smaller institutions. Vendor lock-in concern was found a significant discriminator factor between large and small institutions. Smaller institutions do not have enough power against the vendor lock-in issue compared with large universities. Small institutions are generally private colleges or universities while all large universities are public ones. Larger universities are government institutions and hence have more power against commercial vendors. In addition, the finding of ANOVA test indicated the significance and importance of peer pressure to large educational institutions.

Gradual adoption of cloud services is also recommended by starting with the most adequate system for cloud computing. Email, E-Learning Systems, Learning Management Systems are good start point for cloud adoption.

Cloud service providers who are targeting higher education segment should invest on the systems prioritized in this study. The priority list represents the most candidate system to migrate to cloud computing. Learning related systems, files backup and storage, and universities or colleges websites are the next systems to be migrated to cloud computing.

Legal concerns were highlighted in open-ended responses about hosting government institutions' data outside of Saudi Arabia. This highlight the importance of investing in cloud computing data centers within Saudi Arabia.

Finally, the research can help decision makers in the target institutions. The study serves as a benchmark data for IT decision makers in colleges and universities.

B. Scientific Implication

This paper represents a cross sectional exploratory study. Cloud computing adoption factors were analyzed based on technology organization and environment framework and three factors were found significant.

The study was done in the context of Saudi Arabia. Based on our current knowledge, no published paper has addressed this theory for the target population before.

Additional measurement items were captured through the open-ended questions. These cloud computing relevant items can be used in future studies.

IX. Limitation and Future Work

The size of the population was small. Degree of freedom for the statistical analysis was relatively low. Further clustering analysis to further understand the moderator effect (organization size) was not possible due to this limitation.

It is recommended to perform a study about risk mitigation measures taken by cloud computing adopters to mitigate privacy of data concerns. This is to further understand the source of negative association between Privacy concern and Cloud Computing adoption. As discussed, this can be attributed to risk mitigation measures taken by adopters, taking into consideration the data privacy aspects in the Service Level Agreement or realizing that cloud computing is more secure than what it was perceived before the adoption.

Study can be repeated in the future to understand the shift in the adoption overtime for the target population and the shift in the determinant factors. This study can be repeated in other countries to compare the significant factors.

It is also recommended to include a construct about the reliability of the technology. Many of the respondents indicated the issue of network connectivity to the cloud service provider.

X. Conclusion

The study target was the full population of higher education institutions in Saudi Arabia. Response rate of this study was relatively high. The external validity of the study is high due to these facts.

Higher education institutions should invest on future technologies that help them focus on the core business. There is a high potential of success for cloud computing in the near future. Curriculums related to Information Systems' disciplines should be updated to cover cloud computing and prepare future workforces for the new trend. Conferences and workshops should be hosted by higher education institutions to direct the future of this technology and maximize the return on investment. Unbiased research papers publish by academic institutions are valuable references for decision makers.

Non-adopters highlighted a degree of privacy concern about cloud computing adoption. There is a trust issue with respect to storing intellectual property assets and students records on the cloud. The level of concern was of less degree by adopters. Banking system can serve as an analogy for the trust concern. People in Saudi Arabia, more than thirty years ago, did not trust depositing their financial assets in banks. However, recently, the situation has been changed dramatically. This is the expected future for cloud computing. Cloud service providers should play a major role in establishing the trust on these services and provide high degree of security and service quality.

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