Towards an Integrated Conceptual Model for Cloud Adoption in Saudi Arabia

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Abstract: There are several advantages of utilising cloud computing in organisations such as cost saving and flexibility in acquiring resources. The use of cloud computing in developing countries, such as Saudi Arabia, is still in its early stages and has not been as widely adopted there as in developed countries. In fact, moving a current system to the cloud depends on many factors that may affect a Saudi Arabian organisation's decision to adopt the cloud. In order to encourage the adoption of cloud technology it is essential to understand why some enterprises are more prepared than others to move to the cloud. Hence, the aim of this research is to examine factors that might impact on a Saudi Arabian organisation's intention to adopt cloud computing. In this paper, we propose a conceptual model which integrates aspects of the Technology Organisation Environment (TOE) framework. The proposed model identifies the key factors that might influence organisations to employ cloud services. Our findings show that all the proposed factors in the cloud adoption model, except for competitive pressure and trading partner pressure, are statically significant.

1 INTRODUCTION

Cloud computing is the emerging paradigm of delivering IT services to end users as a utility service over the Internet. A number of technologies are used to make cloud computing happen, including virtualisation and Web 2.0, and their presence makes cloud computing more efficient and usable (Jeffery and Neidecker-Lutz, 2010). The concept of cloud computing started in the 1960s, but the expression "cloud computing" became widely popular only in 2007 (Chen et al., 2010). A number of different proposals, such as grid computing, have been developed but none of them has achieved cloud computing's level of success in offering services to the general public.

Cloud computing can bring several advantages to organisations. The cloud can reduce capital expenditure for both large and small organisations and enable them to pay only for the services they consume rather than setting up in-house IT infrastructure (Buyya et al., 2009). Cloud computing offers business opportunities and flexibility for organisations to increase their revenues (Marston et al., 2011). Despite all these benefits, some organisations hesitate to migrate their work to the cloud. To help organisations achieve their long-term goals, a number of frameworks have been developed to provide guidelines and recommendations for cloud adoption, such as Chang et al. (2013) and Chang (2015).

An interesting observation about the proposed models and frameworks in previous studies is that they focus on the costs and benefits of cloud adoption. Furthermore, there is a lack of empirical studies conducted to examine the influential factors for adopting cloud technology at enterprise level (Low et al., 2011; Borgman et al., 2013). Additionally, all these adoption cases have focused on deployment cases in the West; the adoption rate in the Saudi Arabia is in the beginning phase. Hence, the aim of this study is to carry out an in-depth investigation of factors that influence an enterprise's decision to use cloud technology in Saudi Arabia. An integrated conceptual model has been proposed in order to identify what could drive an organisation to use cloud services or prevent them from doing so.

The structure of the paper is as it follows. Section 2 begins with the background of cloud computing and then provides a critical review of the existing work and theories in order to identify factors that affect an organisation's decision to adopt cloud computing. Section 3 presents the conceptual model for cloud adoption in Saudi Arabia. The research methodology is discussed in Section 4. Section 5 provides the preliminary results. Finally, the summary and future work are presented in Section 6.

2 LITERATURE REVIEW

2.1 Benefits of Cloud Migration

This section presents the benefits for organisations that adopt cloud computing. First, cloud computing offers cost reductions and savings due to the outsourcing of hardware and services. Organisations can save on operational costs in that they no longer have to buy machines, provide a bigger space for storage, and pay upgrade costs and staffing costs (Chang, 2015). The responsibilities and costs involved in improving and upgrading systems are managed by the cloud service providers (Armbrust et al., 2010; Buyya et al. 2009; Jeffery and Neidecker-Lutz, 2010). Secondly, cloud technology provides an opportunity for organisations to scale their services easily and tailor these to specific needs. For example, customised functions can be designed for the company staff so that they can perform their tasks quickly and easily. Thirdly, cloud computing supports green IT since the costs of buying and maintaining servers are reduced with fewer carbon emissions and less energy consumption taking place (Buyya et al., 2012; Marston et al., 2011). Additionally, enterprises can design, build and run their applications more smoothly, since they can be tested in virtual machines as many times as they like. Finally, the flexibility of delivering computing services can drive organisations to migrate their services to the cloud (Foster et al., 2008).

2.2 A Review of Proposed Approaches to Cloud Migration

This section reviews existing work and models related to the migration to cloud computing in order to explore how far the security issues are considered in them.

First, Khajeh-Hosseini et al. (2010) reported a case study that refers to a legacy migration of system in the gas and oil sector. This study examined the migration of an IT system from an enterprise data centre to Amazon's EC2. The cost analysis of the company is presented. In addition, the case study presents the possible advantages and risks linked to the migration of the system based on the point of view of managers and other staff, except the security manager and other security experts. In fact, the most important views that need to be taken into account for migration process are those of the security staff. Their findings indicate that the use of cloud infrastructure will decrease the enterprise's costs. Their results are also useful for decision-making purposes as they will help analysts to find solutions to upcoming issues associated with the adoption of a cloud by enterprises. However, their work does not take into account the security aspect. In fact, security is a vital factor in cloud migration and it needs to be considered as an essential element in the migration process.

Khajeh-Hosseini et al. (2011a; 2011b) extended their previous study to develop a toolkit that helps decision-makers and organisations address their concerns during the migration process; the toolkit provides a framework that can be used to evaluate the migration of businesses from a enterprise data centre to a public cloud. The first tool consists of a list of questions; this helps enterprises to determine whether a public cloud is a suitable technology for their IT system. The second tool is helpful for the decision-makers in terms of estimating the costs of employing a public cloud. Their third tool is a spreadsheet that demonstrates the possible risks and benefits associated with a public cloud from a general organisational perspective. Their evaluation of the tools based on different case studies focuses only on the cost model. Indeed, the proposed methods are a good starting point for risk assessment and are useful for decision-makers as they cover some issues regarding migration to a public cloud. However, this work only considers the cost of the infrastructure when using one type of cloud (the public cloud).

Klems et al. (2009) proposed a framework to measure the costs of using IT infrastructure in the cloud. They compared it with conventional IT approaches, such as the cost of setting up in-house IT infrastructure or a grid computing service. They dealt with costs in their framework under direct and indirect costs. IT infrastructure resources are an example of direct costs, whereas an indirect cost is incurred by the failure to meet business goals and set

up training courses for the new technology. The framework was evaluated based on two case studies. However, their work was in the development phase and therefore the results are not provided. Also, this study did not consider the security aspect.

Hajjat et al. (2010) proposed a model for the migration of an enterprise's applications to a hybrid cloud. The aim of this study was to identify the costs and benefits of migrating part of the system to the cloud. The effectiveness of this approach was briefly evaluated based on a case study of the migration of applications to the cloud. However, this work does not mention how the cost can be computed and only focuses on one type of cloud (the hybrid cloud). They also did not consider the security aspect.

Hu and Klein (2009) have carried out a study to investigate privacy issues during migrating e-commerce applications to the cloud. Their study suggests that the user's data and critical business information must be encrypted during the migration process. The authors have also studied and compared existing data encryption methods in different layers (storage, database, middleware and application). They argue that the middleware layer encryption is the most effective approach for migrating e-commerce applications to the cloud in terms of performance. The evaluation of their work was based on a case study for an e-marketplace application. Indeed, this approach discussed data encryption, particularly for the transmission of e-commerce applications to the cloud. This method helps to ensure privacy of data and provides protection for applications during the migration process. Nevertheless, the authors did not point out how the data and applications would be migrated to the cloud; they also ignored the other aspects of security and privacy that need to be considered.

Hao et al. (2009) proposed a cost model that can be used to determine the type of services included in migration and their possible location. The model that they developed used a genetic algorithm to provide an effective decision for service migration, by looking for the most optimal migration decisions. In this study, besides considering the cost of service migration, they evaluated the cost of consistency maintenance and communication. It is important to have strong decision support for the infrastructure support, prior to migration. However, the authors omit security in the migration process and they deal only with the security aspect that involves accessing the control process by proposed mutual authentication using certificate authority.

Kaisler and Money (2011) have conducted a study to investigate issues associated with service migration to a cloud, as well as the security problems involved with service implementation. They considered several security challenges. It is noticeable that this study simply lists the possible challenges without any evaluation; it also ignores the security aspects in the migration process.

2.3 A Review of Proposed Models for the Adoption of New Technologies

This section describes relevant theories and frameworks for the adoption of new technologies. It includes the TOE framework, the Diffusion of Innovations (DOI) theory and the institutional theory, which have been widely adopted by researchers.

Tornatzky and Fleischer (1990) proposed the TOE framework to analyse the acceptance of new IT technologies at an organisational level. The TOE framework investigates the impact of three factors, Technology, Organisation and Environment, on the organisation's decision to adopt a new technology. According to Tornatzky and Fleischer (1990) and Chau and Tam (1997), TOE can be summarised as follows:

- The technology aspect describes the internal and external characteristics of the new technology and how adopting a new technology can influence the organisation.
- The organisational context is focused on different measures that can influence the direction of the organisation, for example, firm size and scope of interests.
- The environmental context refers to the characteristics of the environment where an organisation operates its business and might have a significant impact on their decision. Government regulation and competitors are an example of the environmental context.

The DOI was proposed by Rogers (1995). DOI is a widely used theory in information system research to examine user acceptance of new ideas and technologies. The DOI theory presents five attributes that have a direct influence on adoption rate: relative advantage, complexity, compatibility, trialability and observability.

The institutional theory is one of the common theories usually used for explaining the adoption of IT technologies (Scott and Christensen, 1995; Scott, 2001). The different between the TOE framework and institutional theory is that institutional theory contains two important elements (trading partner pressure and competitors) in the environmental

context of the TOE framework which might play an important role in an organisation's decision to adopt new technologies.

The other models which have been built based on previous theories in order to identify the factors that affect on a firm's decision to implement cloud computing are presented in a previous work (Alkhater et al., 2014).

3 CONCEPTUAL MODEL

As discussed in Section 1, some of the proposed frameworks and models do not fully address the in-depth investigations on what factors influence cloud adoption for organisations. The TOE framework has been widely adopted and is a suitable model for improvement since it has a proven track record of successful integration (Tornatzky and Fleischer, 1990; Chau and Tam, 1997). Additionally, another benefit of using the TOE framework is that this framework predicts and examines the adoption of technology based on three aspects: technology context, organisation context and environment context.

In this paper, an integrated model has been proposed to identify factors that impact on an enterprise's intent to adopt the cloud services in Saudi Arabia. The initial model has been constructed by integrating aspects of the TOE framework and combining the most important factors from the DOI theory and institutional theory along with other factors (trust, privacy and physical location) that have not yet been investigated in any previous studies as main factors that may have an impact on the organisation's decision to adopt cloud services. The conceptual model for cloud computing adoption in Saudi Arabia is presented in Figure 1. Moreover, Table 1 identifies factors involved in the cloud adoption model; the details of these proposed factors were discussed in a previous work (Alkhater et al., 2014).

Table 1: The factors identified for cloud adoption.

Factors	Sub-Dimensions
Technological Factors	Availability
	Reliability
	Security
	Privacy
	Trust
	Relative advantage
	Compatibility
	Complexity
Organisational Factors	Top management support
	Organisation size
	Technology readiness
Environmental Factors	Compliance with regulations
	Competitive pressure
	Trading partner pressure
	Physical location

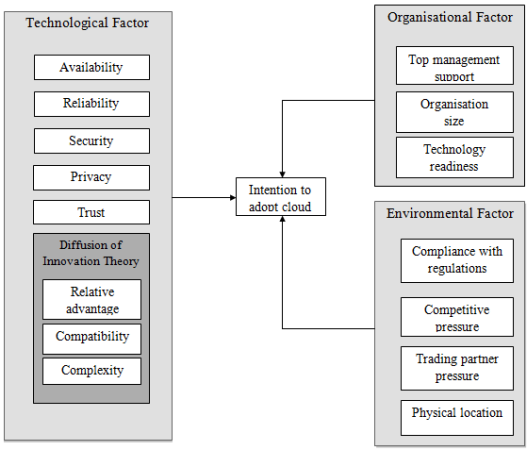

Figure 1: A conceptual model for cloud computing adoption.

4 METHODOLOGY

An expert review is a simple method that enables researchers to collect data from experts who have knowledge of the topic under study. This technique can be used in quantitative, qualitative or mixed methods at different stages of the study (Tessmer, 1993). In this initial study, semi-structured interviews were used for collecting data from twenty IT experts working in IT departments in different Saudi organisations. The study population includes IT staff or managers. The aim of the interviewing IT experts was to review factors that were previously identified in Section 3. A second objective was to discover other factors left unstated in former studies. The interviewees in this study were working in various sectors, such as petrochemicals, oil and gas and engineering, in large organisations and small and medium-sized enterprises with at least five years' working experience in IT. Seven of the participants in this study were working in companies that had already adopted cloud computing, while thirteen (65%) of them were not.

5 RESULTS

This section shows the results of this preliminary study. In this study the participants were asked closed-ended questions about all the factors which were stated previously in Section 3. The purpose of the questions was to measure the importance of the identified factors in the proposed model for cloud adoption from an expert perspective. The closed-ended questions were designed using a five-point Likert scale, which ranged from 5 (very important) to 1 (not relevant). SPSS software was used to analyse the collected data from IT experts; the test value was identified as 3. Table 2 presents the results of using the one-sample t-test.

In this study Bonferroni correction was used for controlling for false positive results by dividing alpha (α) by the number of factors included in the questionnaire.

$$(\alpha/n) = 0.05/15 = 0.0033 \quad (1)$$

Table 2: One-sample t-test.

Factors	p-value	Result
Availability	<0.001	Statistically significant
Reliability	<0.001	Statistically significant
Security	<0.001	Statistically significant
Privacy	<0.001	Statistically significant
Trust	<0.001	Statistically significant
Relative advantage	<0.001	Statistically significant
Compatibility	<0.001	Statistically significant
Complexity	<0.001	Statistically significant
Top management support	<0.001	Statistically significant
Organisation size	.003	Statistically significant
Technology readiness	<0.001	Statistically significant
Compliance with regulations	<0.001	Statistically significant
Competitive pressure	.008	Not statistically significant
Trading partner pressure	.148	Not statistically significant
Physical location	<0.001	Statistically significant

It is interesting to note that most of organisations taking part in this preliminary study were concerned about privacy, security and trust issues and this was one of the major reasons behind their decisions not to use cloud services. Furthermore, there were other factors that were suggested by experts, such as compatibility, compliance with regulations and cost savings, and organisations need to take these into account before employing the cloud services. Most of these factors already exist in the proposed model for cloud adoption.

In order to measure the reliability of the results, Cronbach's alpha was used in this initial study. According to Hinton (2004) and Field (2009), a value from 0.9 and above is considered highly reliable and from 0.7 to 0.8 is acceptable. The Cronbach's alpha coefficient of this study was 0.719, which is considered to be an acceptable value.

6 CONCLUSIONS

The great benefit of cloud technology is that the cloud offers resources to multiple users at any time in a dynamic way and according to user needs. In addition, users only pay for the services that they consume. However, despite the fact that the cloud offers various benefits for enterprises, from flexibility to cost reduction, moving data from an in-house data centre to the cloud is not a simple task. Therefore, this study seeks ways to encourage organisations to adopt cloud services in Saudi Arabia as well as to investigate the factors that affect the implementation of this technology. This paper presents the initial model for cloud adoption in Saudi Arabia and in future a survey will be conducted to validate the developed model. Further outcomes will be published shortly.

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