

AN ENHANCEMENT OF TOE MODEL BY INVESTIGATING THE  
INFLUENTIAL FACTORS OF CLOUD ADOPTION SECURITY OBJECTIVES

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*“My dearest mum, my everlasting father’s soul, my elder brother, and friend”*

This is for all of you

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## ABSTRACT

Cloud computing (CC) is a future technological trend for technological infrastructure development. And it is growing strongly as the backbone of industrial future technological infrastructure. As CC service has a lot to offer, it also has some major downside that clients cannot ignore. For CC service adoption, the potential candidates are SMEs but due to lack of resources, experience, expertise and low financial structure scenario CC can be most helpful. CC faces a major issue in term of cloud security, an organization doesn't understand the cloud security factors in the organization and data owner doubts about their data. In the research paper, an investigation on the cloud security objectives to find out the influential factors for cloud adoption in SMEs by proposing an enhancement of Technology-Organization-Environment (TOE) model with some positive influential factor like cloud security, relative advantages, cost saving, availability, SLA, capability, top management, organizational readiness, IS knowledge, malicious insiders, government regulatory support, competitive pressure, size and type. Some negative influencing factors like technological readiness, cloud trust and lack of standards in cloud security. Data were collected by questionnaires from a selected IT company based on SaaS and public cloud. Case study method has been used for validating the enhance TOE model. The IBM Statistics SPSS v22 tool was used for data analysis. The results of data analysis support the enhancement as well as all the proposed hypotheses. In summary, the results of the analysis show that all the enhancement factors were found to have a significant cloud security influence on adoption of cloud computing for SMEs.

## ABSTRAK

Perkomputeran awan merupakan tren teknologi masa hadapan, dan kini menjadi nadi kepada pembangunan infrastruktur teknologi. Perkomputeran awan diperkenalkan dengan membawa pelbagai ciri dan servis, namun beberapa isu penting perlu dititik beratkan oleh pengguna. Perusahaan kecil dan sederhana (PKS) merupakan platform terbaik bagi mengimplementasi servis perkomputeran awan bagi mengatasi beberapa isu dalam PKS seperti kekurangan sumber, pengalaman, tenaga mahir, dan kelemahan struktur kewangan. Perkomputeran awan tidak terlepas daripada kecacatan keselamatan awan, dek tidak memahami sepenuhnya faktor keselamatan awan bagi sesebuah organisasi, ditambah pula dengan keraguan data oleh pemilik data sendiri. Justeru, kajian terhadap objektif keselamatan awan terhadap penggunaan servis perkomputeran awan bagi IKS telah dijalankan, dengan mencadangkan penambah baikkan terhadap model Teknologi-Organisasi-Persekitaran (TOP) dengan mengambil kira beberapa faktor, termasuk keselamatan awan, kelebihan saksama, penjimatan kos, ketersediaan, kemampuan, pengurusan atasan, kesediaan organisasi, kefahaman keselamatan maklumat, orang dalam yang berniat jahat, sokongan kawal selia kerajaan, tekanan, saiz, dan jenis persaingan. Beberapa faktor berpengaruh negatif seperti kesediaan teknologi, kepercayaan awan, dan kekurangan standard dalam keselamatan awan. Data dikumpulkan melalui soal selidik dari syarikat IT yang dipilih berdasarkan SaaS dan awan awam. Kaedah kajian telah kes telah digunakan untuk mengesahkan peningkatan model TOP. Penggunaan SPSS v22 bagi kajian ini adalah untuk menganalisis data, Secara ringkas, hasil penyelidikan ini menunjukkan bahawa semua faktor penambah baikkan mempengaruhi keselamatan awan yang ketara, terhadap penerimaan pengkomputeran awan untuk PKS.

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## LIST OF ABBREVIATIONS

AWS	Amazon Web Service
CAGR	Compound Annual Growth Rate
DOI	Diffusion of Innovations
IS	Information Security
ISO	International Organization for Standardization.
IT	Information Technology
NIST	National Institute of Standards and Technology
SLA	Service Level of Agreement
SLO	Service Level Objective
SME	Small and Medium Enterprises
TAM	Technology Acceptance Model
TOE	Technology-Organization-Environment Model

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## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Introduction**

As we come to know from NIST (National Institute of Standards and Technology) cloud computing (CC) is a worldwide, suitable, anytime available network, which can share the data and configuration of the computing properties (like desktop, server, software, apps, ERP, data storage, and services) anywhere in the world with remote connection with the slight administration effort or with our any necessity of communicating with service providers (Mell, 2009).

Thus, the on-demand availability and easy use feature increase the CC flexibility in comparison to traditional forms of computing (Tehrani, 2014). In terms of lot of money saving CC consents companies and most importantly for SMEs so that they can be more industrious, similarly improve their work productivities and success. As a result, companies can more focus in their main businesses and profit and they don't have to bother about regular technological upgrading or schedule maintaining the system (Ross and Blumenstein, 2015; Zhao et al., 2014).

As the limitless scalability, resource sharing elasticity and high level of computerization making CC as the future Internet technology. In the cloud environment growing swiftly day by day it is also worried about, it is security, privacy and trust for data and applications on the hosted situation. There are many providers also available for providing CC for consumers and this is also a great situation for the customer to make trust on any provider that it will provide the best service as customer require. This is the most important decision-making time when the customer cannot fix the right provider to move and cannot explore the best of cloud service because of lack of knowledge and provider reliability issues CC adoption is really appealing to the organization as they want this inexpensive and swifter IT resources under their system (Pawar, 2015).

CC is now highly acknowledged technology, that is why cloud providers also introducing many cloud services in the market. Though there are many advantages of CC with it is quick evolution, it faces many issues in terms of privacy, trues and mostly security issues (Pearson, 2013). Those are also important factors that cloud customer should keep in a mind while they negotiate in terms of service with the provider. CC reduces the cost of purchasing and maintaining IT infrastructure for the businesses that use cloud computing. It also provides better flexibility regarding how computing resources can be bought and utilized.

Organizations are still concerned about the security, losing control and other disagreeable results over their data which is affecting the decision making on the migration of the service, software, server or data to the cloud (Phaphoom, 2015). Besides, organizations are typically focused on moving some of their systems into the cloud because of the difficulty in adoption related applications, security concern, less understanding the process as well as the lack of information about agreements (Andrikopoulos, 2013).

The purpose of this study is to understand the determinants of cloud adoption in small and medium enterprises (SMEs). It seeks to investigate whether the determinants of cloud adoption influential factor in cloud security. For this purpose, we develop an enhanced research model of the technological, organizational and environmental (TOE) (Tornatzky and Fleischer, 1990).

## 1.2 Problem Background

In the small and medium enterprises (SMEs), They are the most illegible customer for the CC because of it is various service advantages like organization do not need to build the physical system by their self instead of that they will pay the bill as much as a service they will use in the CC platform (Buyya, 2009). Cloud offers so many appalling officers still most of the SMEs are worried about move in to cloud environment. Be that as it may, some SMEs are yet to be worried about moving a present framework to the cloud. Just a couple of observational examinations inspect the powerful factors in appropriation choice of CC at an association level (Pawar, 2015; Pearson, 2013).

From a recent research that was published in Forbes 2017, saying about cloud adoption in information technology (IT) that 80% of all IT budgets will be considered for cloud solutions and applications within a year (Columbus, 2017). The most demanding technology in CC is security that always needs to take account when ever think about cloud adoption. Security is the most important factor for delaying CC adoption for cloud customers.

As cloud storage is hosted by a third party which is stored in a virtual pool of storage online network model. Cloud provider provide many different kind of storage service. As clines wants to keep their data in the cloud they need to buy or lease the storage with the capacity. As per customer requirement vendor provide the storage and

functionality also take care the background systems. And physical in cloud environment they keep copy in different geo location as per resource utilization by multiple servers. They use API (Application Programming Interface) or web based interfaces as gateway of customers services (Beulah et al., 2016). As with time security issues are growing with time and technology virtualization also need to improve to give security for storages, can't be security with the traditional system for this new age. Cloud network security is must for network traffic analysis and safe data in while transmission like firewall, security to make proper security.

CC security will get vulnerability factors if the cloud adoption terminology gets unbalanced. Few paper advices that CC environment is still not adequately for trust factors. If customer do not trust in the provider and their security factors, cloud adoption result will be affected vastly (Chen et al., 2010; Habib at al., 2010).

For any CC concept, trust is one of the most vital elements for selecting cloud that safeguard the financial profitability and reduce the risk service is. If there is any issue with the security, privacy and confidentiality, it always decreases the efficiency of cloud adoption business success factors. In the CC, most of the users think about location issue, where is the data stored physically and what kind of security, they are using, no one knows but the cloud providers. The increasing factor of cloud adoption growing the security and privacy issues concern also growing This issue generally handles by the security service agreements which guaranty the service (Martin Gilje Jaatun et al., 2012).

Some research paper shows, working with the TOE model for technological cloud adoption is more influential than other, because TOE model theory has been applied individually and successfully to several studies for the adoption of innovation in cloud and technology. There have been numbers of literature, exploring the use of innovative technologies in the past that combine the Technology Organization Environment (TOE) model better for the organizational perspective (Hsu et al., 2006).

On the Low (2013) paper is focused on the management and technology but lacking in the security, support and cost factors. The Chong (2009) paper worked on relevant advantages, compatibility and top management, but it doesn't have data about a technological scenario like security, technical readiness, cost problem. There is some other research which combine the TOE and DOI model, like On the Bose (2011) research shows the process to make adoption decision based on organization type, size and regulatory management these papers don't have strong technical functionality.

Such approach has never been exploited in CC security factors. Most of the previous research have a leaking on privacy, security, technological readiness, availability, malicious insiders, issues. In TOE model focus on the security context of technology adoption and better to explain intra firm technology adoption (Tehrani, 2013). The main advantages of TOE model are doing the support and theoretical aspects of this research.

### **1.3 Problem Statement**

Many researchers prove that beside the beneficially factors of CC technology not everyone is interested to adopt CC solution (Abdollahzadehgan and Trigueros-Preciado, 2013). An efficient enhancement in cloud security in the TOE model is the best approach to assess the cloud adoption security factor. Previous research show that their papers are lacking in specific cloud security features, trust, SLA, malicious insiders, so it is hard for cloud customer to trust in the cloud adoption process. Ma and Xin (2015) study paper gave details in qualitative review of six case studies on a small and medium accounting firm concern with security, but this study lacking core security, privacy, malicious insider, SLA issue. In prior research, it is shown that there are not many papers are focusing on this data protection, data ownership, monitoring) and showed some limitations in their research on technological and organizational aspects. Our study fulfilled the research gap, by assessing influential factor for CC adoption in terms of security.

## **1.4 Research Questions**

To achieve the research goal, the main research questions is –“What are the main influential factor of CC adoption?”

The main research questions supported by two sub-questions as follows,

1. Which technological adopt model can be used to improve CC security factors?
2. What validation approach will be most helpful to finalize the conceptual model for IT cloud adoption?

## **1.5 Research Goal**

Through enhancement of TOE model, this paper provided understanding of the influential factors for IT cloud adoption in terms of security objectives by case study approach.

## **1.6 Research Objectives**

In the research, there are objectives that are necessary to be achieved. There are as follows:

1. To investigate the Technology-Organization-Environment (TOE) Model
2. To propose enhance TOE model for cloud adoption in security perspective
3. To validate the enhancement of TOE model for identifying cloud adoption influential security factor by following case study.

## **1.7 Research Scopes**

Scopes for many researches is very important as it can limit the area of research to a specific field. Although there are some limitations in this study that represent opportunities and recommendations for the further research on cloud adoption. The scopes of the research are as follows,

1. IT related SME companies.
2. Focused on most popular technology adoption TOE model for theoretical perspectives to develop the research model.
3. Worked on the influential cloud security factors
4. Focused on SMEs software as a service (SaaS) and public cloud aspects.
5. Most of the information and data are used for the research contributed from previously TOE model and cloud security research that was done on cloud domains.
6. The method of evaluation and validation used case study qualitative with quantitative validation approach.

## **1.8 Research Significance**

The study has a significant value to researchers toward observing, analyzing and interpreting the importance of a proposed enhance model of cloud adoption. Furthermore, the study will provide the researchers with a lot of information, knowledge about influential factor for security concern in cloud computing. CC is now trendy not only for corporate aspect, but also it has increased the business flexibility and more focus on organization objective rather than technical concern. As most of the big organizations already in the cloud, as SMEs is falling behind because of lack of understanding and knowledge about security aspects so the research showed a

complete view of cloud security perspective. And by this paper clients understand the relation and responsibility as well as important security factors which they need to recognize on CC adoption or migrate to cloud platform. In IT cloud helps with the organization to use the minimum amount of resources and investment to achieve the maximum amount of business growth using cloud services. Using the advantages of technology adoption model (TOE model) this paper will provide a recommendation guideline for SMEs. By this cloud customer can understand why they need to trust on the cloud in terms of cloud security features. This is also a great opportunity for the SMEs to increase their business with more felicity and using the CC attractive service facility to reduce financial expanses. The research will reduce the cloud customer dilemma for adopting CC and provides a clear understanding for security and SMEs influence factors.

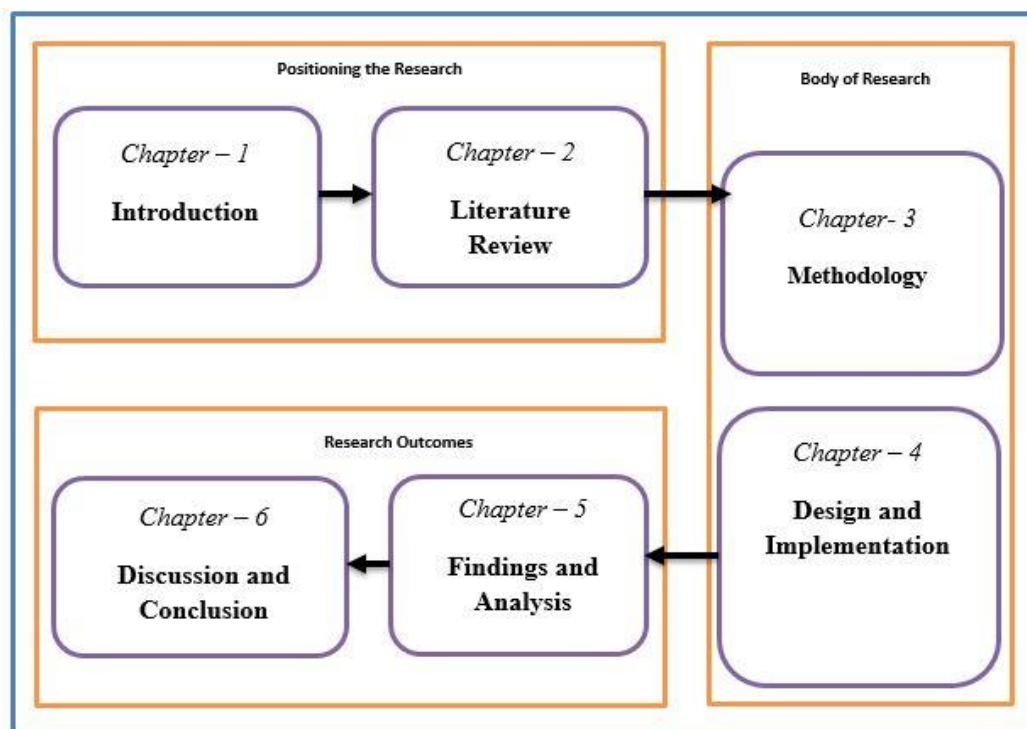
## **1.9 Research Organization**

This thesis is divided into five chapters. A building of the overall thesis is depicted in Figure 1.1 and described in the following sections.

Chapter 1 will bewitho the knowledge regarding research background, research problems, research goall, objectives, in addition tothe scopee and significance of the research.

Chapter 2 presents a detailed literature review of CC covering a brief general background, definitions of CC, functionality, services and deployment models of cloud, special features of CC and advantages. It also describes the SMEs, cloud adoption, cloud security and specifically influential cloud security objectives. Based on the existing literature on technology adoption, focusing on CC security factors.





**Figure 1.1:** Structure of the Research

Chapter 3 discusses the research method using three phase that fulfills the research objectives of this paper. Using A theoretical technology adoption model to develop a TOE model to enhance the security context, is described in chapter 4.

Chapter 4 describes the preliminary study design and implementation, presents the process and outcome of a qualitative study. The qualitative study is conducted through a structured quantitative survey questions and case study IT company SMEs across the ICT sector. Research hypotheses are generated and as a result, a first theoretical enhance model for CC adoption is developed.

Chapter 5, The pilot study, presents the process of questionnaire deployment and how the researcher specifies the constructs as a reflective or formative. Then, the analysis of a pilot study using IBM Statistics SPSS v. 22 software is discussed precisely. Analysis on real responders from the SMEs, explains the findings from the questionnaires. Descriptive analysis using IBM Statistics SPSS v.22 software as

discussed. Then, the chapter provides confirmation or rejection of the research hypotheses based on the results of the analysis. Following this, the findings from the survey are explained in depth.

Chapter 6, Discussion and conclusion, presents the summary of the research and provides contribution of the research findings, based on theoretical, and chapter 5 results perspectives. This chapter acknowledges the limitations of the current research and hence proposes the recommendations for future research outlining the possible directions.

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