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# FACTORS INFLUENCING THE ADOPTION OF CLOUD COMPUTING BY SMALL AND MEDIUM-SIZED ENTERPRISES (SMES)

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## ABSTRACT

The main objective of this study is to determine the factors influencing the cloud computing adoption by Small and Medium sized Enterprises (SMEs). Based on two dominant theories in the field of diffusion of innovation, a conceptual model is proposed. In order to test the model empirically, an online survey was designed and launched. Decision makers of 50 SMEs agreed to participate in this survey. In order to evaluate the internal, convergent and discriminant validity of the instrument, factor analysis and reliability tests of panel data were performed. The logistic regression analysis was deployed to test the research hypotheses. The results of regression analysis reveal that decision maker's knowledge about cloud computing is the main influential factor in adopting this technology. A comparison between two groups of cloud adopters and non-adaptors confirm the recent Gartner's hype cycle model for emerging technology indicating a high expectation from cloud computing in both groups

***Keywords****: MRI, Brain, Image segmentation, Thresholding, K-means clustering, Fuzzy c-means Clustering*

## 1. INTRODUCTION

Economies are comprised of many companies, majority of which are Small and Medium-sized Enterprises (SMEs)[1]. They play a very important role in each market by significantly contributing to each country's Gross Domestic Product (GDP) and its labor market. Therefore proposing new strategies or developing new systems that can help SMEs become more efficient and productive is not only beneficial for SMEs but also for the economy as a whole. One of the strategies that can help SMEs become more efficient is the use of appropriate Information and Communication Technologies (ICT) (Tan, Chong, Lin, & Eze, 2009). Size and structure of SMEs make them face many challenges. The main challenge is to not have access to enough resources (e.g. financial resources). Moreover, in comparison to large companies, small firms have less tolerance in bearing cost and risk of adopting new innovations (Malecki, 1977).

Cloud computing is a new phenomenon which helps SMEs tackling many issues such as cost and risk management. There is no universal definition for cloud computing; but in this research cloud computing is defined as a computing paradigm in which the computing resources are delivered to customers over a network (e.g. Internet). Companies can access the available services on-demand. In other words they can access the computing resources at anytime and anywhere they have access to the network (e.g. Internet). Cloud computing is an alternative of deploying applications and systems on-premises. Customers[2] do not need to install or develop computing resources in-house. Computing resources, which are, but not limited to networks, servers, storage, applications, and services can be accessed by customers over a network (e.g. Internet). One of the main differences between developing a system on-premises and using cloud computing is that customers are not responsible for operating the actual technology. Customers only use the computing resources and pay for the service they used. This significantly reduces the risk and cost of managing the technology. This is specifically beneficial to SMEs. Cloud computing allows SMEs to reduce the investment cost, the project risk, and the operation and maintenance costs (Khan, Zhang, Khan, & Chen, 2011).

Another difference between traditional computing (such as developing in- house systems) and cloud computing is the payment model of cloud computing. The payment model of pay-as- you-go allows companies to only pay for the amount of service that they have used. Companies can access and use the most sophisticated computing services, without being required to invest significant amount of money in advance. They do not need to pay upfront for buying, installing or licensing the system. Moreover, companies are not responsible for maintaining and upgrading hardware and software applications. Although cloud computing has many advantages for companies, there are also some drawbacks related to this new phenomenon. Some of the issues that have been discussed by other researchers are issues related to the cloud's security, reliability, availability etc. There are also some legal concerns about the ownership of the data and the location of data centers where data are saved. Majority of these concerns and issues can be taken[2]. In this research, customers are Small and Medium-sized Enterprises (SMEs) care of by signing a comprehensive Service-Level-Agreement (SLA).

In this research the factors that influence the adoption of cloud computing by SMEs. In order to investigate the factors that influence the SMEs' decision to adopt cloud computing a conceptual model has been proposed. This model is originated from two prominent theories of this field. These two theories are Rogers's Diffusion of Innovation (DOI) theory and Tornatzky and Fleischer's Technology, Organization, and Environment (TOE) framework. Variables that are chosen for this study are measures that are most appropriate in the context of SMEs. The dependent variable of this model is the decision to adopt cloud computing; I asked participants to indicate whether they already adopted cloud computing or not. There are four different categories of constructs which influence the adoption of cloud computing among SMEs. The effect of these four categories of variables on cloud computing adoption is investigated. These four groups of variables are environmental, organizational, human and technological factors. Each of these groups of factors consists of one or more constructs. Environmental factors group consists of External Support and Competitive Pressure. Organizational factors include Employee's IS knowledge, and information intensity. Human factors are decision makers' Innovativeness, and their cloud knowledge. Last but not least, technological factors are cloud computing's Relative advantage, Cost, Security and Privacy, Trialability, Complexity and compatibility with company's norms and technologies.

## 2. RESEARCH PROBLEM

Cloud computing is one the most recent Internet-related computing paradigms which help SMEs become technologically closer to large businesses. This new phenomenon makes it possible for companies to access sophisticated computing services over a network. There is no universal definition for cloud computing that explains all aspects of this new phenomenon.

For the purpose of this research cloud computing is defined as a type of computing paradigm in which the computing services are delivered to the customers over a network (e.g. Internet). Customers can access the service on an on-demand basis, which means they can use the service, anytime they have access to the network (e.g. Internet). They have access to almost unlimited amounts of resources which can instantly be scaled up or down based on customers' demand. Customers do not need to invest in any computing infrastructure. Payment model of cloud computing is a utility-based model, in which customers only pay for the amount of resources that they use.

Although the underlying concept of cloud computing dates back to 1950s (when mainframes were accessed by users from different terminals), it

was during late 1990s when cloud computing started to become a buzz word; and companies gained a better understanding of cloud computing (EzeCastle Integration, 2012). The diffusion of cloud computing has many advantages at both micro and macro level. At micro level the diffusion of cloud is advantageous for SMEs. At macro level, it is beneficial for the economy and environment. Below, these potential advantages will be discussed in more details.

### 2.1. SMEs and Cloud computing

The size and structure of SMEs gives them some advantages including fast communication between employees and their managers and their ability to rapidly implement and execute decision. But in most cases these companies face many disadvantages. Most of the challenges that SMEs face are due to their lack of access to enough resources (Welsh & Wite,1981). These resources include but not limited to financial and human resources. This limitation makes SMEs weaker than large companies in terms of financing, planning, control, training and also information technologies (Bilili & Raymond, 1993). Keeping cost under control is one the biggest challenges that SMEs faces. (Communications News, 2008) It is not feasible for SMEs to spend a significant amount of money on their Information Technology (IT). In addition to their high cost, IT projects usually involve a high risk of failure too. About 20 percent of IT projects are canceled before completion and less than a third are finished on time and within budget with expected functionality (Kappelman, McKeeman, & Zhang, 2006). Overall SMEs have low tolerance in bearing costs and risks that are involved in IT investment.

Cloud computing, as a new computing paradigm, offers many advantages to companies, especially smaller ones. Flexibility, scalability, and reduced cost are just some of many advantages that cloud computing offer to SMEs. Cloud computing enhances companies' competitive advantage (Throng, 2010). It also enables SMEs to access sophisticated technologies without spending significant amount money. These advantages help SMEs grow larger and become more efficient, productive and innovative, by allowing SMEs to focus on their core business. This is applicable to both start-ups and already existing companies. It should also be noted that cloud providers are specialized in providing IT services; therefore the service provided by these companies is better than the service that is delivered by IT department of SMEs. Relying on massive, centralized data centers, results in achieving economies of scale (Ryan, Merchant, & Falvey, 2011). Cloud's security measures are implemented on large scale, which makes it much cheaper. This is another result of levering economies of scale (Cattehhu & Massonet, 2009).

## 3. LITERATURE REVIEW

The underlying concept of cloud computing was first introduced in 1950. During that time large scale mainframes was available for academia and corporations use. Mainframes were too costly and it was not practical to have separate mainframes for each user; therefore a new architecture was developed. Based on this new architecture users from different terminals were able to access the mainframe and share the CPU time and power. By doing so, the return on investment was increased and the mainframes' idle (inactive) time was decreased. Later, in 1960s this phenomenon became more popular after John McCarthy started to argue that computation will someday become a public utility (McCarthy, 1960). Nowadays this idea has become more popular than ever. Many believe that in near future, just like other types of utility (water, electricity, gas and telephony) the basic level of computing will be provided to people to meet their day to day needs (Buyyaa, Yeoa, Venugopala, Broberga, & Brandicc, 2009). Another influential person to the history of cloud is J.C.R. Licklider who developed APRANET[6]. He was probably anticipating the power `of Internet and cloud computing when he was introducing his famous "intergalactic computer network" concept (A Complete History of Cloud Computing, 2012). In 1990s telecommunication companies, who used to deliver their services based on point to point data circuits, changed their service delivery strategies. They offered Virtual Private Networks (VPN) services. It was during those days when the symbol of cloud was first used to depict the connection between providers and users. Later, when computers become more popular, scientists and technologists developed new algorithms by which the computing resources were allocated to users more efficiently. These algorithms were providing the optimal use of computing resources, such as infrastructure, platform and applications (Cloud computing,2013).

Salesforce.com, which started its operation in 1999, delivered the first actual cloud computing service. It was the first company who delivered an application from its own website. After the dot-com bubble collapsed, many companies went out of business. Research shows that only 50% of dot-com companies survived until 2004. Companies which survived had to redesign their business processes, to find new ways to make money. Internet was an opportunity to be used by these companies. For them Internet was not just a medium to do business but a

vital part of their businesses. In 2002 Amazon.com introduced Amazon Web Service; this service was giving customers the ability to store their data and also to allow many people to work on the same task. In 2004 Facebook, which is a social networking website, was launched. Amazon's Elastic Compute Cloud (EC2) was launched in 2006, which was enabling users to run their application on cloud. The pay-as-you-go model of payment which is now the standard for cloud computing was first introduced by Amazon's Simple Storage Service (S3). In 2007, force.com which was a Platform-as-a-Service, was launched by Salesforce.com. In 2009, Google Apps, which was allowing people to create and store their documents online, was launched. Right now major cloud providers are thinking about finding a way by which they can integrate. In 2010, salesforce.com launched a cloud-based database which enabled customers to develop applications on cloud.

Developed application can be used by anydevice, run on any platform and be written in any language. (A Complete History of Cloud Computing , 2012)

### *3.1.2. Definition of Cloud Computing*

To date, there is no universal definition for cloud computing; different researchers defined cloud computing in different ways. Perhaps the most accurate definition of cloud computing is the one offered by the National Institute of Standards and Technology (NIST):

"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)

According to this definition, on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service are essential characteristics of cloud computing.

On-demand self-service allows users to increase the amount of computing resources that they use without any human interaction from cloud provider's side. Broad network access allows users to access the service over the network using any device (e.g. cell-phones, laptop, desktop) that is capable of connecting to the network (e.g. Internet). Using a multi-tenant model allows computing resources to be pooled by customers. This Resource pooling enables providers to serve multiple users by same computing resources. Rapid elasticity allows customers to use as much resource as they want based on their demands. Measured service allows customers and providers to have access to accurate resource usage. Providers and users are able to monitor, control and report their usage easily. (Mell & Grance, 2011)

As it has already been mentioned, cloud computing is the integration of already known computing services such as High Performance Computing (HPC), grid computing, virtualization and utility computing (Gong et al., 2010). There are some differences and similarities between cloud computing and other computing paradigms. Security, programming model, business model, compute model, data model, applications and abstraction are factors that differentiate cloud computing from other types of computing such as grid computing (Foster, Zhao, Raico, & Lu, 2008). Other aspects of cloud computing which distinguish it from other types of computing are cloud's ability to provision an on-demand service; be an autonomic computing system[7]; and finally be a scalable and flexible system (Wang, Laszewski, Younge, & He, 2010). Similar to grid computing, cloud computing uses distributed computing resources to accomplish the objective of the application. However, unlike grid computing, cloud computing uses virtualization to achieve the required objective. Cloud computing and utility computing are similar, because both of these computing services provide on-demand service to customers; and[7] Autonomic computing system is self-management system, which can react to internal and external events without human interaction. Cloud computing uses this type of computing to reduce the resource costs charge them only for resources they used. Virtualization is the basic technology based on which cloud computing has been shaped. It allows customers to pool resources and virtually access resources on an on-demand basis. Finally cloud computing is similar to autonomic computing because it enables autonomic resource provisioning (Zhang, Cheng, & Boutaba, 2010).

Cloud computing has three different service models: infrastructure-as-a-system (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS). IaaS which is the basic level of cloud service is the service of delivering infrastructure services to customers over a network (e.g. Internet). These infrastructure services include both hardware (e.g. storage and network) and software (e.g. operating systems and virtualization technologies). It is similar to hosting but different in a way that customers do not need to have long term contract with the provider of the service; and also they are allowed to provision resources on demand (Bhardwaj, Jain, & Jain,2010).

In this model of cloud computing, providers are only responsible for keeping data centers operational; and the rest such as deploying and managing software are part of customer's responsibilities. Customers have control over operating systems, storage, and deployed applications (Mell & Grance, 2011). In each billing period, customers are only required to pay for the amount of resources that were used. It can be based on the amount of compute usage per hour, storage per GB, data transfer etc. Amazon's Web Services Elastic Compute Cloud (EC2) and Secure Storage Service (S3) are two examples of IaaS.

The second level of cloud computing is called Platform-as-a-Service (PaaS). PaaS is a model of cloud computing by which customers have online access to all the resources that are required to build an application. Some of the services that are offered in PaaS model are application design, development, testing, deployment, and hosting tools (Velte, Velte, & Elsenpeter, 2009). Customers have access to programming languages, libraries, and other tools that are required to develop an application. PaaS allows developer to develop and deploy their applications without being concerned about buying, installing and managing the underlying infrastructure platform. Everything they need is available from the Internet. One potential problem with PaaS is that each cloud provider has its own programming language; therefore if a programmer develops an application using a provider`s programming language it is difficult for him/her to switch to another provider. For example the programming language used by Google's PaaS (AppEngine) are Python or Java, and the programming languages used by Microsoft's PaaS cloud (Windows Azure) are .Net, PHP, etc. (Windows Azure, 2012).

## 4. RESEARCH METHODOLOGY

As it is briefly described in introduction, I am conducting a predictive research. In this research I try to determine the factors that influence SMEs' decision to adopt cloud computing. I am using a positivism research paradigm. Based on this paradigm, reality comprises of a set of events that can be observed by human sense. Usually, knowledge is not considered as part of reality. There is only one exception about knowledge; and that is the knowledge gained from experience (Blaikie, 2009). The knowledge that is based on the experience can objectively be measured; and used to perform positivist research. In order to complete this study a quantitative method is used. According to Blaikie (2009), a quantitative method is a method in which different aspects of a phenomenon are quantified and then measured. In our research I developed a questionnaire; and asked decision makers to fill it out. Decision maker's opinions about different concepts are quantified based on a 5 point Likert-scale type questions. This way decision maker's knowledge which is based on their experience is quantified; and can be analyzed. This research, is a predictive research, and follows a deductive research strategy. Deductive research strategy tries to find an explanation for an association between two concepts by proposing a theory (Blaikie, 2009). The next section of this chapter briefly outlines the data collection and analysis procedure.

### 6.1. Data Collection

Data collection procedure of this research is based on a survey. In this work have developed a questionnaire which was reviewed and modified by a panel of experts. Final version of the survey was launched online. The responses to our questions were captured based on a 5 point Likert-type scale. Participants were able to access the survey online. According to a literature review conducted by Tornatzky and Klein (1982), most of the studies in the field of innovation adoption collected data using surveys or interviews. Similar to many other studies, I used a survey to gather data. I asked both adopter and non-adopter companies to participate in this survey. I inquired about their opinion about different aspects of cloud computing including technical characteristic of cloud computing in addition to organizational, environmental aspects of their company. The questions asked from participants are mainly adapted from already published papers in this field. In addition to the standard questions, I also developed some questions which are specific to the context of cloud computing. The survey was then launched; and responses were collected.

The aim of this chapter is to describe the results of data analysis. I first describe each variable in details by going through the descriptive analysis. The results of reliability test of the model are then going to be explained. Later, I discuss our factor reduction method which is done through factor analysis. Factor analysis allowed us to reduce our factors, and test the convergent and discriminant validity of our instrument. Finally the results of logistic regression and our hypothesis testing are discussed.

## 5. CONCLUSION

This contributes to both academia and business practice. First of all, the model proposed in this study is unique and has never been used in other studies. It is recommended that other researchers use the same model to investigate the adoption of cloud computing in different contexts. The model can also be modified and used to study the other innovations. Cloud providers can use the results of this study to

increase the rate of adoption among SMEs. Based on the results of this study, cloud knowledge is the key factor in diffusion of cloud computing. Cloud providers can use various mass media such as Facebook, LinkedIn and Tweeter to increase awareness about cloud computing. In our sample the main source of information about cloud computing are cloud providers. Also it is recommended that SMEs understand the hype cycle of cloud computing. According to hype cycle, cloud computing will face a phase of disappointment after the peak of inflated expectations. SMEs decision to adopt or discontinue using cloud computing should be based on a detailed cost-benefit analysis, not just based on the publicity generated by media.

This study has its own limitations as well. The size of our sample is the biggest issue in this study. Logistic regression is sensitive to smaller sample size; this may be the reason that I did not get significant results for majority of our independent variables. Due to budget limitation I was not able to collect more data. Also the sample is from different industries. Studies based on specific industries are recommended. Moreover the sample is collected from North American SMEs; it makes the result not being applicable to SMEs from different parts of the world. Overall, the results of this study cannot be generalized. Further researches are required to gain a solid understanding of this phenomenon.

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