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Adoption of Cloud Computing in Organizations

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ABSTRACT

Cloud Computing is gaining popularity as a new IT arrangement in organizations, offering many advantages such as cost reduction and high flexibility that help in coping with high elasticity of demand. This study investigates organization's propensity to adopt Cloud computing services. The decision is viewed as an IT outsourcing decision and as a technology adoption decision through three theoretical perspectives: Transaction cost theory, resource dependence theory and diffusion of innovation theory. Based on these theories, a conceptual model is proposed with research hypotheses for future empirical testing. The study makes an attempt to contribute to the emerging literature of cloud computing, in addition to offering organizations considering adoption a list of benefits and risks of adopting cloud computing.

Keywords

Cloud Computing, adoption, diffusion of innovation, transaction cost theory, resource dependence theory

INTRODUCTION

Cloud computing (CC) is a concept that enables access to computing resources such as applications, networks, storage, and services over the network. The computing resources can be provisioned and released on-demand with minimal user and service provider interaction (Mell and Grance 2009a). CC is believed by researchers to be a promising way for organizations to save on IT expenditure by shifting from capital expenses towards operational expenses (Armbrust et al 2009), in addition to reducing the risks associated with owning and maintaining hardware infrastructure. It is estimated that US government would, in the long run, save up to two thirds of its IT expenses if it adopted CC (Morton and Alford 2009). Another reason that drives companies to adopt CC is elasticity: i.e., an organization's ability to provision and release computing resources instantly as demanded over the network and to pay only for used resources. This gives organizations the illusion of infinite computing resources and virtually eliminates part of the start-up cost and the risks associated with providing IT capacity (Armbrust et al 2009).

The value that CC offers can be seen at different levels; at an organizational level, CC can have a strategic value by offering successfully adopting organizations a competitive advantage through cost savings. In addition there is an increased chance to concentrate on core competencies, which can be very important in highly competitive industries. Naturally, this may put lagging organizations that did not consider possible savings of adopting CC at a strategic disadvantage. At an economy level the aggregated savings on IT Hardware and software spending can have a high economic significance. In fact in a study conducted by Microsoft it is suggested that large organizations can reduce energy use and carbon emissions by 30%, while in smaller companies it can reduce up to 90% of energy use and emission (Bernard 2011). Therefore it can be argued that increased adoption of CC may lead to a higher efficiency in organizations, and a greener planet.

A survey by Taneja group (Taneja 2009) found that around 83% of senior IT managers in large organizations are considering adopting some form of CC, and in another research by the same group it was suggested that 70% of CIOs in US consider the adoption of private CC to be accelerating. However many barriers to the adoption of CC, such as availability and security, are delaying that acceleration (Tanjena Group 2010). On the other hand CC adopters are facing different kinds of trouble. In a study conducted for Compuware (Compuware 2011) it was shown that businesses in USA are losing around $1 million per year due to performance problems of their cloud applications. It was also shown that around half of all companies are still hesitant to adopt CC because of performance concerns.

It can be seen that there are important factors and considerations for the decision to adopt CC. On balance, there can be great savings or great losses based on many variables. This paper presents an academic study to identify the different factors that organizations consider in the decision to adopt CC. This is achieved by first reviewing existing literature to find factors identified by industry and researchers, in addition to reviewing literature related to theories on IT outsourcing and adoption. A conceptual model is created based on the literature review and the theoretical background. An attempt is made to offer an academic base for researchers on CC adoption in organizations. The research question that will be investigated in this paper

is: *What are the factors that affect organizational adoption of CC?* In addition two other research questions are suggested for future investigation: *What interventions can organizations take to improve CC adoption if CC is proved beneficial for that organization*? and *How do the different factors in adoption operate at different stages of adoption?*

LITERATURE REVIEW

The literature suggests several factors that contribute positively to an organization's decision to adopt CC and others that contribute negatively to the decision. Truong (2010) discusses how to use CC to enhance competitive advantage for small businesses and uses the resource based view of the firm to suggest that customizable CC offerings help organizations achieve an un-imitable competitive advantage. Another factor that can help achieve a competitive advantage is inter-connectivity, that is making use of the fact that public CC offers an opportunity to better interconnect and collaborate with partners and customers. This leads to a rare and unsubstitutable competitive advantage.

Berkeley's view of Cloud Computing (Armbrust et al 2009), one of the classic papers in CC, identifies several important factors. The first factor is the elimination of start-up costs for new organizations or organizations starting a new project that requires new computing resources. This benefit reduces the risk associated with that cost in case of failure or less than anticipated demand on resources. The pay-as-you-go feature of many CC services also helps to eliminate risks of purchasing servers and data-centers, and changes in demand associated with that change (Leavitt 2009).

On the other hand, Berkeley's paper sheds a light on some factors that may contribute negatively to the adoption decision, such as security risks. These risks stem from the fact that data is usually stored and maintained by a service provider that may not have adequate security measures. There are also some technical issues that are related to the constant availability of service, Organizations may be concerned about interruption of service caused by problems from the provider's or/and the user's side, such as bugs on provider's machine, interruption of network connection to the server, or service bottlenecks. This can lead to a total disruption of the services of companies that totally depend on the cloud and to huge losses in business (Bisong and Rahman 2011). Another technical concern is data lock-in that may prevent organizations from transferring applications and data to other cloud providers due to lack of standards in CC. Finally, performance unpredictability and limit of elasticity from the provider's side are some of the other risks (Leavitt 2009).

One of the business risks is fate-sharing, which results from the fact that a service provider usually hosts services for a number of different clients, so a problem in one of the server instances for one client may affect the other clients sharing the same service provider. Legal risks include an organization's liability for user's data, and its ability to protect the data while on the cloud, in addition to concerns about the regulations and laws of the countries where the data is hosted that may give that country the legal ability to access or block that data (Armbrust et al 2009; Bisong and Rahman 2011).

Another study by the European Network and Information Security Agency (ENISA 2009) identified both security risks and benefits for adopting CC. The report suggests "security of scale" as a benefit that the cloud can provide to organizations. The fact that a cloud service provider is specialized in building data centers and securing them may insure better security measures than if a single organization built its own security system. A cloud service provider arguably will offer continuous up-to-date security measures to its data centers, and can run backup versions in case of emergencies. This may offer a better availability than if the organization was running those services in-house. However, although an organization can outsource security risks to the cloud provider, it may not be able to outsource the accountability for those risks. Accountability eventually depends on the Service Level Agreement (SLA), therefore it is necessary for organizations to evaluate the security risks related to their decision on whether of adopt CC.

Generally speaking, the security risks associated with CC at provider's level are higher than the risks at a single organization's level, since the area of attack in a cloud configuration is much wider .(Greenwood and Hosseni 2010;Talbot 2009). The fact that one of the main factors making CC an attractive solution, i.e., economy of scale, which is established by distributing data centers' management and securing costs among organizations, creates additional security risks because providers' data centers are accessed by many clients.

In fact Bisong and Rahman (2011) suggest that all cyber attackers such as organized criminals, hackers, terrorists and intruders will see computing clouds as the most important frontier to attack. This is because it has a "high value" as a repository for important information from different companies that attackers may try to get access to, in addition to important services that may tempt attackers to try to disrupt.

ENISA (2009) recognized three other main sources of risks, and identified particular risks within the following categories: Policy and Organizational risks: include risks related to compliance, when a cloud provider doesn't comply with the industry

standards that a certain organization may have adopted. Cloud provider service termination or the acquisition of a cloud provider are among the other risks that may happen because of the provider's business failures, which would leave the organization with a problem if it did not take that option into consideration in the SLA. Supply chain failure may happen if a cloud provider chooses to outsource part of its service to another provider, which may create an additional level of risk.

Technical risks include isolation failure, when the mechanism that separates server instances or data on some physical has some dysfunctionality. For instance in a study of the security of CC, a researcher was able to get past the data isolation, and were able to access sensitive data on other server instances on the same machine. He also notes that a traditional Denial of Service attack is more effective when the attacker and the victim server instances are on the same physical machines (Talbot, 2009).

ENISA (2009) identifies other potential risks such as a cloud provider malicious insider, which is the risk of an insider in the cloud provider, to do malicious activities, which may impact the confidentiality, integrity and availability of data. Also noted are the security of data in transit; the distributed nature of CC means that data will be in transit more often than other architectures. Data will be moving between users and cloud, and in the cloud between several physical servers, between server and clients of the cloud customers. Risk of insecure deletion of data which is related to the fact that data on a storage drive is not usually wiped out entirely until storage disks are destroyed or a proper wipe of data is performed.

Conceptual factors are related to the current immature state of the CC concept as perceived by some organizations. Such issues that can act as barriers to adoption of CC are lack of standards in CC (Leavitt 2009). and lack of a clear definition. For example the term "Cloud Computing" as a whole has been criticized in 2008 by Oracle's CEO Larry Ellison arguing that the term is being used to refer to old technologies in use for some time . (Patrizio 2008). In addition the insufficient expertise in SLA may act as another barrier to adoption.

Table 1 below summarizes some of the main benefits and risks related to adoption decision.

TYPE	Motivators/Benefits	Concerns/Risks
Technical	Elasticity	Service Availability Performance Data Lock-in Elasticity Limit Lack of Monitoring Solutions
Security	Security of Scale	Deletion of Data Multi-Level Risks Physical attacks Isolation Failure Social Engineering
Legal		Licensing Provider's country regulation Liability of Data
Organizational Side	Higher Efficiency	Effect on Organizations Compliance Concerns
Provider's Side		Destiny of Provider Supply chain concerns Provider's Access to data Malicious Insider Fate sharing and Reputation
Financial	Elimination of startup cost Better cost transparency	
Conceptual		Lack of Standards Lack of Definitions Insufficient SLA expertise and policies

Table 1 – Summary of Factors affecting CC adoption decision categorized.

THEORETICAL FOUNDATION

The choice whether to adopt CC in an organization is essentially a make-or-buy decision which is similar to an IT outsourcing decision, with some variations related to additional concerns and benefits which makes the adoption decision a bit more complicated. In addition adopting CC is similar to adopting a new technology in an organization since it requires technological change in the organization. This study will look at the adoption decision using two lenses, first the decision will be studied as an outsourcing decision, where an economic theory (transaction cost theory) and a strategic management theory (Resource dependency theory) will be used to build part of the theoretical foundation of the study. The other lens is through technology adoption in organizations where Diffusion of Innovation theory, one of the most used theories in IS Adoption research, will be employed.

Transaction Cost Theory

One of the important theories that has been used in literature to help with outsourcing is the transaction cost theory (TCT) decisions (Aubert et al 1996; Bahli and Rivard 2003) advanced by Williamson (Williamson 1981). TCT can be used to help define the boundaries of firms by examining production and transaction costs, where transaction costs are the costs associated with monitoring, controlling and managing transactions. The original dependent construct studied by Williamson is the degree of governance in organization (Williamson 1981; Rogers 1995).

Williamson suggested that in some cases outsourcing may reduce production costs due to the economies of scale at providers' end. However the costs associated with the transaction such as negotiating contracts, monitoring and managing the outsourcing relation and its possible outcomes would rise and may make the outsourcing decision less attractive. On the other hand "insourcing" may offer less coordination costs due to the fact that organizations arguably have more control over their internal departments and therefore reduce transaction cost, but my increase the production cost due to the lack of economies of scale. Therefore the decision of whether to outsource or not would depend on the trade-off between production cost and transaction cost. For the sake of this study, the dependent construct to be studied will be an organization's propensity to adopt CC, which affects the decision on whether an organization should adopt CC (outsourcing in original TCT model) or not "insource".

Three other constructs are considered in TCT which may influence the propensity of adoption, namely Asset Specificity (AS), which is related to the degree of customization vs. standardization of the transaction for both sides AS relates to the ability of the provider on one hand to redeploy that asset invested in other business relations, and on the other hand the ability of the firm to migrate to another provider somehow smoothly. If a transaction is Asset specific, this may increase the risk of Lock-in, which can be an issue for the providers if the relation fails after investing in this specific relation, not being able to make use of the investment in other relations, or from the client's (firm) side in the difficulty of migrating to another provider. The asset specificity can be used in the cloud adoption context to indicate the requirement of an organization for a high level of customization for its IT services. In most cases providers offer a standardized offering in terms of service to the customer, or partially customized offerings; therefore it can be assumed that organizations requiring high level of customization will be less willing to adopt CC for lock-in concerns.

CC adoption may have a similar effect from Asset specificity on the customer's end, because of the fear of data lock-in due to difficulty of migrating to other providers which may happen because of the lack of standards among different cloud providers. Therefore AS will be studied as a factor that may affect CC adoption. The lock-in concern is also suggested by several researchers as indicated in the literature review (Armbrust et al 2009; ENISA 2009) According to TCT theory AS increases transaction costs, which negatively affect the decision to outsource a service because of the fear of Lock-in. Therefore we propose:

H_1: High Asset Specificity negatively affects the propensity to adopt CC services.

Uncertainty is another construct considered in this study. Uncertainty refers to the degree of possible variation in the needs of the organization, which may change the outsourcing requirements. In cases of high uncertainty, Williamson (Rogers 1995) proposes either trying to create an elaborate contract to handle possible uncertainties or to insource. In regards to cloud adoption, uncertainties related to major changes in requirements may not be easy to handle in current provider's offering, and therefore an elaborate contract may be able to handle such situations. According to TCT, uncertainty affects the decision of outsourcing negatively because of the risks associated with it:

H_2: High Levels of Uncertainty negatively affects the propensity to adopt CC services.

Resource Dependency Theory (RDT)

The second theory that will be used is Resource Dependency theory (Pfeffer and Salancik 2003) (Pfeffer 1981). The theory explains the relation between an organization and its external environment; specifically it explains how organizations find themselves dependent on other firms in varying degrees. It suggests that an organization would enter into an exchange relationship when it is lacking essential resources internally; the main purpose for an organization for making coalitions is to maximize its power which is viewed as organizational success. The theory also suggests that organizations attempt to change their dependence relationships by having other organizations depend more on them, or by minimizing their dependence on other organizations to achieve more power.

Therefore organizations may alter their structure to acquire outside resources (Uirch et al 1984). The main dependent construct studied in the theory is the power of the organization, which is equal to degree of dependence of an organization on another organization. Looking at CC adoption from the perspective of RDT, organizations tend to adopt CC to utilize resources that are not available internally such as virtualization capabilities, higher elasticity, economies of scale, and arguably more expertise in running IT services or software.

Pfeffer & Salancik (2003) suggest three factors that determine the degree of dependence of one organization on others. First "*importance of the resource"*, which is the degree to which the resource is vital for the organization's operation and continuity. The theory suggests that for resources that are more important, an organization would try to decrease its dependency on outside organizations and therefore may try to allocate the resource internally. In the context of CC adoption, the resources being studied are the IT software or services that would be migrated to the cloud, and therefore the importance of these services to the organizations may affect the propensity to adopt CC negatively.

H_3: High importance of IT resource negatively affects the propensity to adopt CC services.

The second studied factor is the *Control over the resource* which is termed by Pfeffer & Salancik (2003) as "discretion over resource allocation and use*"* which is explained as originating from owning the resource, having access to the resource, having control over who uses the resource, and the ability to form regulations and enforce them on the use of the resource or its possession. This factor is relevant to CC adoption, since one of the main concerns by cloud adopters as supported from literature review are the concern for giving the control to the IT services or software to the cloud provider (Armbrust et al 2009; ENISA 2009).

H_4: The degree of Control over IT resource negatively affects the propensity to adopt CC services.

Last factor considered by RDT is whether alternatives for the resource exist, which may not be relevant particularly to cloud adoption case, since IT services and resources are usually irreplaceable.

RDT makes three assumptions, first that organizations are comprised of internal and external coalitions which emerge from social exchange that are formed to influence and control behavior. Second, that the resources available in the environment are valuable and scarce, therefore there exists a problem of uncertainty in obtaining those resources from the environment, the last assumption is that an organization works towards gaining more control over resources to decrease their dependence on other organizations, and more control on the resources that increases other organizations' dependence on it.

3.3 Diffusion of Innovation Theory (DOI)

Another theory that is commonly used in IS research that helps explaining adoption propensity and decisions in organizations is the DOI theory (Rogers 1995). The theory which is rooted in sociology has been used to understand different innovations adoption patterns in agriculture, technology and IS research. The main thesis of the theory is that innovations are communicated through certain channels over time within a particular social system (Rogers 1995).

Rogers notes that perceived attributes of innovations affects the rate of adoption, the main attributes that have been studied by other researchers in the context of technological innovation (Rogers 1995; Moore and Benbasat 1991) are relative advantage, complexity, and compatibility. *Relative Advantage* of an innovation is the "degree to which an innovation is perceived as being better than the idea it supersedes", in our case it can be seen as how much decision makers in an organization perceive that adopting CC would be better than their current systems. Roger suggests that it relates positively with the rate of adoption. (Moore and Benbasat 1991; Carlton 1979) used it as a predictor for adoption of information technology innovation

H_5: The Perceived relative advantage of CC adoption positively affects the propensity to adopt CC services.

Complexity is another factor affecting the adoption of technology (Moore and Benbasat 1991). The term is defined by Rogers as 'the degree to which an innovation is perceived as relatively difficult to understand and use'. One reason that may keep organizations from adopting CC is if it was perceived by organizations as a complex technology to understand and to

implement, given the amount of change that a high scale adoption of CC may bring to organizations, it may be perceived by some organizations as barrier of adoption.

H_6: The Perceived Complexity of CC technologies negatively affects the propensity to adopt CC services.

Another factor that may help predict the propensity of an organization to adopt CC is degree of organizational innovativeness. It was argued by Williamson that innovative organizations are more likely to adopt new technologies; therefore we anticipate that more innovative organizations are more likely to adopt CC

H_7: High Organizational Innovativeness positively affects the propensity to adopt CC services.

One kind of uncertainty (uncertainty of demand) may be handled by the elasticity feature of CC, mainly in the IaaS and SaaS. As suggested by production cost economics, the proposition is that external service vendors are more efficient in bearing the risk of alternative demand because they can pool demand from different customers and are usually able to fulfill the required changes in demand more efficiently than one single provider (Carlton 1979). This was also supported by prior literature (ENISA 2009), and is considered as one of the most important strengths of CC.

H_8: High Level Uncertainty of demand positively affects propensity to adopt CC services.

One of the most important barriers for the adoption of CC as discussed extensively by prior literature (Mell and Grance 2009b; Armbrust et al 2009; Morton and Alford 2009; Talbot 2009; Greenwood et al 2010) is Security concern of Adoption CC. In the adoption of new technology literature, security concerns have been indicated to be important. For instance for the adoption of financial electronic data interchange (Lee 1998) and the adoption of e-government solutions (Conklin 2007).

H_9: High Security concerns negatively affect the propensity to adopt CC services.

Finally, we make a final hypothesis linking the propensity to adopt CC to the decision to adopt CC based on the Technology Acceptance Model, it is suggested that:

H_{10}: High Propensity to Adopt CC decision positively affects the decision to adopt CC.

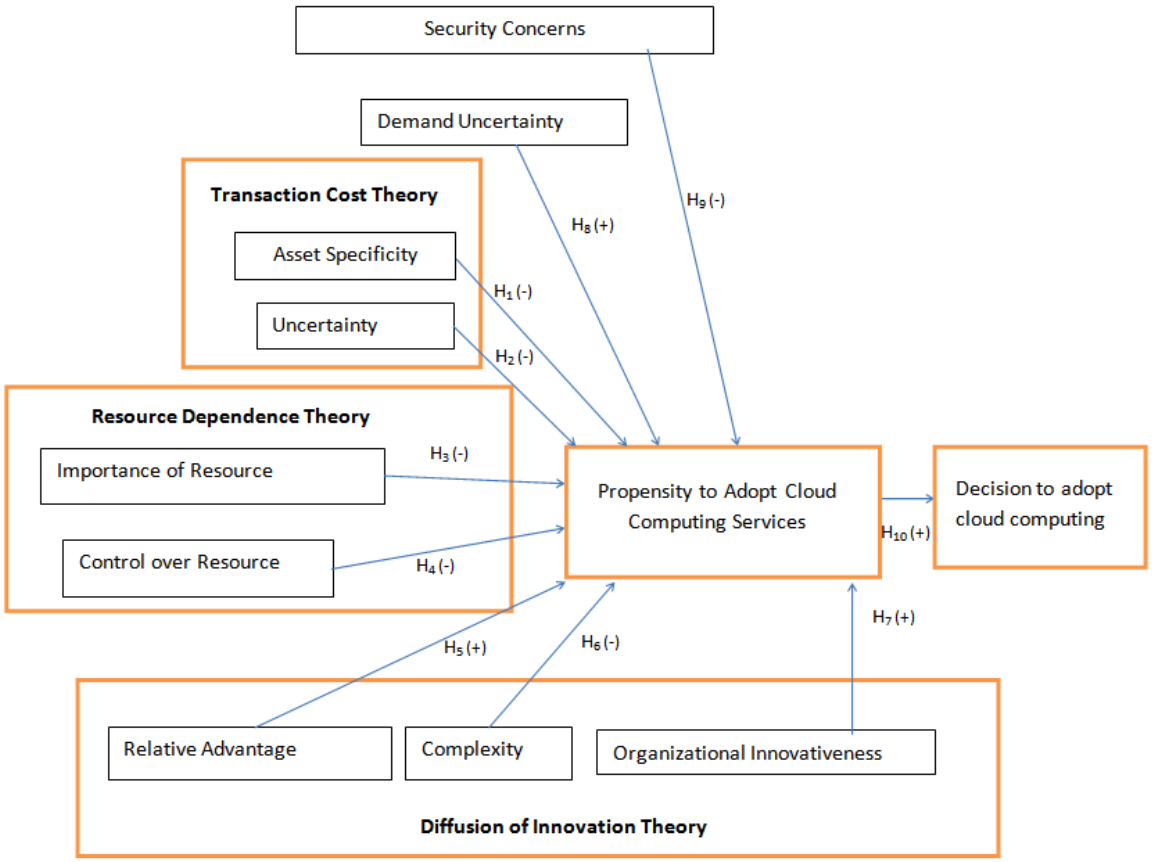

Figure 1: Proposed Theoretical Model

FUTURE DATA COLLECTION

A survey based on the proposed theoretical model will be designed for this study. This scale is based on prior literature in IT outsourcing and technology adoption literature, and in addition new items will be developed for new constructs such as (demand uncertainty and security). A pilot study will be made to validate the measurement tool by having employed advanced MIS students answer the survey questions online based on their experience and knowledge of their workplace. A number of iterations may be necessary to validate the measurement tool.

Next, a number of organizations in USA, Europe and the Middle East will be contacted based on professional contacts of the author's circle. The proposed sample will include educational institutes, corporations, and non-profit agencies. The sample will include organizations that have adopted CC service, and organizations that did not adopt CC services, to understand what distinguishes each and what factors they considered. The data collection will be made by first identifying decision makers in those organizations who make decisions related to infrastructure, and then to ask them to take the survey online.

Structural equation modeling statistical analysis technique will be used to test the model since the model is multistage and the constructs introduced are backed up theoretically.

CONCLUSION

Cloud computing seems to be the next big thing for many people in the IT industry and the academic world, the risk and return for adopting Cloud computing seems to be both high. Potential benefits are numerous and can lead to significant positive impact at many levels of the economy, however it is apparent from prior research and industry review that cloud computing may not be a silver bullet, and that a bad implementation can lead to economical loses, loss of reputation in cases of interruption of service, or data loss/theft. Therefore the decision to adopt cloud computing needs to be investigated thoroughly, and both positive and negative factors should be analyzed thoroughly before making the decision. This research attempts to help better understand the current cloud computing adoption decision factors, which may aid other organizations in making the right decision on whether to jump into the cloud or not.

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