Analysis of Enterprise Virtualized Private Internal Cloud Infrastructure; Cost Reduction, Productivity, and Performance

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Abstract

This proposed study will provide an understanding of the business aspects of cloud computing (CC) in terms of the statistical correlation between change in costs and change in efficiency following implementation. Researchers have referred to CC as a new paradigm and have suggested it is a developing technology that can increase efficiency by providing IT resources and services over the Internet at lower cost. The purpose of this mixed methods study is to investigate the success of virtualized private clouds with respect to user opinions of cost savings and efficiency. This study will contribute to the VPICI environment by investigating the cost, efficiency, and security impact of virtual computing resources on automation and self-provisioning of VMs in private internal clouds. The quantitative portion will be employed since the purpose of this investigation is to calculate the relationship between costs and efficiency. The qualitative portion will add depth to the quantitative responses and will include a content analysis of the qualitative semi-structured interviews conducted with the IT managers.

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Chapter 1: Introduction

This proposed study will provide an understanding of the business aspects of cloud computing (CC) in terms of the statistical correlation between change in costs and change in efficiency following implementation. In recent times, CC has become one of the most utilized and discussed methods of operation in information technology (Bean, 2010). With the increase of computing resources over the past decade, CC has been recognized as a fruitful research topic (Birman, Chockler, & van Renesse, 2009). Researchers have referred to CC as a new paradigm and have suggested it is a developing technology that can increase efficiency by providing IT resources and services over the Internet at lower cost (Gold, 2010). The implementation of CC in an office setting is the focus of this proposed study.

Among the four distinctive CC infrastructures, infrastructure as a service (IaaS) is the primary concern to enterprises (Mangiuc, 2011). While much research in CC has been dedicated to the technical aspects of CC, of similar importance to enterprises is the IT provisioning aspects such as scheduling, allocation, productivity and performance (Shang-Yuan & Shu-Fen, 2009). Even beyond those factors, costs and the relationship between costs and efficiency are the most significant determinants of a successful implementation program. As a result, this mixed methods study will examine the perceptions of IT managers of the implementation of CC using a virtual terminal interface at their offices as well as the relationship between the change in costs and the change in efficiency at these same locations.

Background of the Problem

CC is an emerging field, which has gained notable recognition in recent years because of its technical and economic benefits with respect to the way computing resources are delivered via the cloud (Gong, Liu, Zhang, Chen & Gong, 2010). Business enterprises are leaning toward in-house or on-premise types of IaaS. The rational for these areas of focus are based upon control, cost containment, security, productivity and performance (Creeger, 2010). CC is changing the traditional methodology of operationalizing enterprise IT departments. Costs of operating businesses are expected to decrease in the future based on these changes (Ruiz-Agundez, Penya, & Bringas, 2011). In this new approach, enterprises can divest IT infrastructure into the cloud and benefit from the swift provisioning and scalability of an infrastructure that permits on-demand growth of enterprise IT resources as well as a pay-per-use pricing scheme (Keyes, Romano, Arnold & Luan, 2010). Through these mechanisms, it is expected that the cost of operations will fall while also providing at least a similar if not improved level of efficiency.

CC has also received increased attention from the media as well as technology analysts (Stanoevska-Slabeva, Wozniak, & Ristol, 2010). Gartner, a leading IT market and research firm, indicated that the market for Cloud Computing Services (CCS) will increase from $56 billion per year in 2012 to $146 billion by the year 2014 (Bulford, 2011). It is been forecasted that an increasing number of enterprises will use virtualized private internal cloud infrastructure (VPICI), which moves the processing power and storage from client hardware to centralized cloud infrastructures. This environment

enables a company's storage and processing to grow and shrivel dynamically based on usage (Messmer, 2011). Miller (2009) emphasized that enterprises turn to cloud initiatives to improve agility, eliminate organizational dependencies, and reduce capital costs.

Virtualization is a tactic of separating computer resources into numerous execution environments (Luo, 2010). The virtualization process is carried out through the application of several technological concepts such as hardware and software partitioning, complete and partial machine emulation, time sharing, simulation, and quality of service (Lin & Yen, 2010). Virtual Machines (VMs) play an important role in virtualization, as they are used to combine server workloads to fewer machines, thus saving on hardware, and other costs (Ye, Jiang, Huang, Chen, & Wang, 2011). This study will be based upon the VM user's perception and experience with CC implementation at their office.

Statement of the Problem

IT departments within enterprises face numerous challenges including growth of servers, applications, and storage arrays which strain the volume of existing enterprise resources (Chang, Abu-Amara, & Sanford, 2010). Confronted with the decreasing returns of application based computing, enterprises are more frequently moving to the private cloud model as this conceptual IT model simplifies the automatic deployment of VMs to users (Soror et al., 2010). VM technology provides mechanisms to manage enterprise resource infrastructure (Sotomayor, Montero, Llorente, & Foster, 2009). Transitioning to

a VPICI environment may provide enterprises with the benefits of efficiency, flexibility, and dynamic on-demand resource allocation.

Enterprises such as Amazon, Google, and Microsoft have invested in the CC technology by implementing private external clouds (Doelitzscher et al., 2011). However, several challenges have emerged for enterprises using private external IaaS (Anthes, 2010). Challenges include lack of control of the VMs, security in the cloud service provider (CSP) infrastructure, and the ability to automatically provision VMs for applications on-demand by users (Jamil & Zaki, 2011). The capability to provision VMs to satisfy system performance goals is an open problem for IT departments (Furht, 2010). The challenges mentioned above indicate continuing doubts surrounding costs, security, full control of private external IaaS, and automatic provisioning of VMs (Aljabre, 2012). As a result, the concerns for quantifying costs, efficiency, and security for specific on-demand tasks in a VPICI environment for enterprises suggest a need for further research (Calheiros, Ranjan, Beloglazov, Rose, & Buyya, 2011).

Purpose of the Study

The purpose of this mixed methods study is to investigate the success of virtualized private clouds with respect to user opinions of cost savings and efficiency. This study will contribute to the VPICI environment by investigating the cost, efficiency, and security impact of virtual computing resources on automation and self-provisioning of VMs in private internal clouds. The findings from this research will help IT managers within enterprises, and contribute to VPICI environments. The majority of the researchers in the area of virtualized private clouds have addressed private external

clouds such as Amazon's Elastic Compute Cloud (EC2) and Google App Engine (Creeger, 2010; Sotomayor et al., 2009). This indicates a lack of concentrated perspective on VPICI environments (Phatak, & Kamalesh, 2010). This research will provide valuable insight on cost, productivity, and performance from the perspective of VPICI enterprises.

Research Questions & Hypotheses

The research questions that guide this study will include both qualitative and quantitative components. The first five questions are qualitative and the final question is quantitative. The qualitative questions seek to ascertain the perceptions of the participants regarding VPICI usage and implementation and the quantitative question seeks to determine if there is a statistically significant relationship between the cost reduction of implementation and measure the relationship between cost and effectiveness

Research Question 1. What are participant perceptions regarding the necessity of VM provisioning in VPICI?

Research Question 2. What are participant perceptions regarding how the adoption and implementation of VPICI impact traditional IT departments?

Research Question 3. What are participant perceptions of the deployment of security policies of an enterprise to a VPICI?

Research Question 4. What are the participant perceptions regarding how an IT department can assist in the general satisfaction of stakeholders in terms of cost reduction, productivity, and performance in the adoption and implementation process?

Research Question 5. What are participant perceptions regarding how the management of governance policies over self-provisioning can occur in VPICI environments?

Research Question 6. What is the correlation between efficiency and cost reduction?

$H1_N$: There is no statistically significant correlation between efficiency levels and cost reduction.

$H1_A$: There is a statistically significant correlation between efficiency levels and cost reduction.

Significance of the Study

The current body of scientific literature regarding CC is small. Youseff, Butrico, and Da Silva (2008) were among the first researchers who provided comprehensive understanding of CC and its pertinent components. Prior to identifying a specific case sample that is appropriate for the proposed study, it is proper to identify a few studies previously conducted in this area to provide a basis for the preconceived assumptions about VM automatic provisioning in VPICI environments. While much research has addressed the technical aspects of CC, IT provisioning aspects such as scheduling, allocation, productivity, and performance have proven to be the most important (Shang et al., 2009).

While the current body of scientific literature of IaaS concentrates on public IaaS such as EC2 and Google App Engine, business enterprises are leaning toward in-house or on-premise types of IaaS. Businesses prefer IaaS primarily for control, cost containment,

security, productivity and performance (Creeger, 2010). Thus, a constructive precedent in determining the envisioned context would be the research provided by Khajeh-Hosseini, Greenwood, and Sommerville (2010).

Enterprise systems are traditionally based on complex legacy systems that are not unified across multiple functional areas and might not be available in real time Khajeh-Hosseini et al., 2010). To remain competitive in a constantly changing and technologically advanced business environment, enterprises strive to be strategically ready (Goodwin, 2012). It is noted that more enterprises will embrace CC technology to reduce cost and improve performance and productivity (Dougherty, White, & Schmidt, 2012). Ward and Sipior (2010) associated the inevitable change from traditionally based business networks to CC with the rapid use of Internet-based computing services. Experts have discussed private clouds (PCL) in terms of economics of scale when compared with public external clouds (Armbrust et al., 2010; Khajeh-Hosseini, Sommerville, & Sriram's 2010). Therefore, it is imperative to examine exhaustively the perspective held by these researchers.

The potential cost and benefit equation when migrating from in-house data to a VPICI environment must be ascertained. This research in VPICI will provide an opportunity for the refinement of any possible relationship between VM automation and cost, productivity, and performance for enterprises that have adopted VPICI environments.

Summary

This chapter provided an overview of the proposed mixed method study whose purpose is to evaluate the effectiveness and cost reduction of implementing CC in participating businesses. The significance of the study is to provide recent research on the topic of CC and the relationship between cost reduction and IT department employee effectiveness while also examining the impact on security. Chapter 2 will provide an in depth literature review of previous studies and Chapter 3 will discuss the methodology regarding how the study will be conducted.

Chapter 2: Literature Review

This chapter will provide a discussion of the recent research studies conducted on CC and the findings of these studies. First, a review of CC will be provided followed by a brief discussion of virtualization. There will be a discussion of VPICI usage and implementation along with findings of previous studies on the impact of cost with respect to changes in implementation. The business prospects for CC are then discussed. A summary will conclude the chapter.

Cloud Computing

Recent technological advances have led to a paradigm shift in computing technologies from physical to CC infrastructures (Ahrens, 2010). CC is an emerging field, which has gained notable recognition in recent years due to its technical and economic benefits in the way computing resources are delivered via the cloud (Gong, Liu, Zhang, Chen & Gong, 2010). Gold (2010) noted that certain authors have suggested that CC is a developing technology that adaptably provides information technology (IT) resources and services over the Internet. The cloud is a symbol for the Internet and a concept for the complex infrastructure that it can streamline.

An increasing number of business organizations have migrated or considering moving to a cloud based environment because the CC provides for a cost efficient method of hosting and managing applications (Bean, 2010). With the upsurge of provisions of computing resources over the past years, CC has been an immense research topic (Birman, Chockler, & van Renesse, 2009). CC is also changing the traditional manner in which enterprises are run (Aljabre, 2012). Costs of operating businesses are

expected to decrease in the years ahead due to these changes (Ruiz-Agundez, Penya, & Bringas, 2011). In this new approach, enterprises can divest IT infrastructure into the cloud and benefit from the swift provisioning and scalability of an infrastructure that permits on-demand growth of enterprise IT resources as well as a pay-per-use pricing scheme (Doelitzscher, Sulistio, Reich, Kuijs, & Wolf, 2011). In the subsequent section various CC theories will be explicated to build a foundation, and expand upon to address research findings on CC.

Despite the recent literature focus on cloud computing, the current body of scientific literature of CC is small. There are some learning theories that provide a basis for the preconceived assumptions about virtual machine (VM) automatic provisioning in virtual private internal cloud infrastructure (VPICI) environments. While much research has addressed the technical aspects of CC, IT provisioning aspects such as scheduling, allocation, productivity, and performance have proven to be the most important, and as of yet, not sufficiently researched (Shang-Yuan & Shu-Fen, 2009). Youseff, Butrico, and Da Silva (2008) were among the first researchers to provide a comprehensive understanding of CC and its relevant components. The authors regarded CC as a mixture of numerous old and some limited new concepts in various research areas ranging from distributed and grid computing (DGC), service-oriented architectures (SOA), and virtualization (Youseff et al., 2008). Although the authors provided a good description of the CC environment, they failed to address any potential cost savings by enterprises adopting cloud based infrastructures.

Cloud Computing Cost Savings

Khajeh-Hosseini, Greenwood, and Sommerville (2010) found that enterprises that migrated their in-house data centers to CC infrastructures realized a 37% cost reduction over a five year period. The authors revealed the complexities of how several networked computers make use of virtualization technology to host middleware that is dispersed across the cloud, and can be rapidly supplied with minimal effort on the part of management. However, the researchers addressed cost benefits associated with cloud adoption in a general purpose CC environment, and did not address on premise private cloud environments such as VPICI environments.

Buyya et al. (2009) discussed the relationship between cloud computing and the VPICI environments. The authors provided an outline for how companies would optimally move from their current infrastructure to both CC and CC alongside VPICI environments. Buyya et al. (2009) suggested that cost savings of CC and the security available through the use of the VPICI framework, should provide companies with better outcomes than CC on its own. The authors went further though and discussed the possibility of the creation of a global cloud whereby exchanges and marketing of information would take place. While the VPICI usage discussed by the authors is now coming to the fore, there is yet to be the type of global network envisioned in this article.

Huang (2012), in a similar study investigated the development of a program known as the PROgram Ultra-Dispatcher (PROUD). The PROUD program was used to facilitate the initiation of applications by users in a CC environment. The problem being addressed by the author pertained to the complexity and work involved in manually

provisioning workstations to run applications in a virtualized cloud environment. The method created by the author was based on the capability of users to customize and automatically use VMs in a virtualized cloud environment to run applications on individual workstations or personal computers (PCs). Most of the research was concentrated on how individual users will be able to provision the VMs based on specified or predetermined rules or scripts. These scripts govern specific workstations and VMs that are allowed to run available applications based on CPU utilization, availability of memory on the individual workstations, disk space, input output (I/O) and network activity (Huang, 2012). While the study concentrated on the performance aspect of VMs automation on the host operating system (OS), the study did not associate the performance of VMs automation with cost reduction for enterprises that have adopted VPICI environments.

Virtualization

The move to CC, as will be investigated in this proposed study, will be examined with respect to the virtualization of an organization's IT infrastructure. Lin and Yen (2010) revealed that virtualization is a tactic of separating computer resources into numerous execution environments. The researchers noted that VMs play an important role in virtualization when used in private external clouds (PCL). They explained that VMs are used to combine server workloads to fewer machines, thus, saving on hardware and other costs. The virtualization process is carried out through the application of several technological concepts such as hardware and software partitioning, complete and

partial machine emulation, time sharing, simulation and quality of service (Lin & Yen, 2010).

CC analysts also believe the automation of VMs on demand is vital for enterprises migrating to private internal clouds (Bulford, 2011). The field of automatic provisioning of VMs on demand in a CC environment is relatively new (Raj & Shriram, 2011). While literature in the area of private external CC is abundant, literature specific to VMs studies regarding on demand automation of VMs in a VPICI environment is limited. As noted by Buyya (2009), while there has been limited research conducted on VPICI, this area of study should be fruitful as a means of determining future cost savings for the various implementation methodologies of CC. The next section will discuss the CC theoretical framework.

CC Theoretical Framework

Several interpretations of CC exist. Frequently, CC is erroneously identified as grid computing (GC; Stanoevska-Slabeva, Wozniak, & Ristol, 2010). Some explanations of CC are generalized and do not produce a complete definition of the CC framework. However according to the National Institute of Standards and Technology (NIST), and as authored by Mell and Grance (2011), CC 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. Another key distinction of CC is that it is no longer stationed in a specific area and can be accessed by all users continuously. This cloud model promotes availability and is composed of five

essential characteristics, three service models, and four deployment models (Mell & Grance, 2011).

The five main fundamental characteristics of CC were shown to be (a) On-demand self-service, (b) resource pooling, (c) broad network access, (d) rapid elasticity, and (e) measured service (Krutz, Vines, & NetLibrary 2010). A broadly used CC ontology defined three cloud models contingent on the competences of the CSP (Youseff et al., 2008). They are software as a service (SaaS), platform as a service (PaaS), and infrastructure as a service (IaaS).

With the SaaS model, CSPs typically package software applications, IT infrastructure, storage and other necessary support services, and make use of the Internet to deliver these services on demand to users (Guthrie, Lowe, & Saidel-Keesing, 2011). An increasing number of business organizations are drawn to the SaaS model to meet the continuous changing business and technology requirements, growth opportunities and competitive edge (Haiqing & Jianyuan, 2012). The SaaS concept is appealing to corporations as adopting SaaS shifts the weight of IT operations from the company to the SaaS provider. Google's web search and apps such as spreadsheets, word-processing and presentation apps, or Microsoft's Hotmail are promoters of this technology (Roehl-Anderson, 2010). The use of SaaS can also be expected to lower application costs and provide seamless editing and alteration of business-wide documents and spreadsheets.

In the PaaS environment, the consumer is able to run their own applications, which is supported by the cloud-based infrastructure. Developers favor this form of platform as an entire software environment can operate without the cost and complexity

of purchasing and managing the underlying software and hardware. In this case, web browsers such as internet explorer will be used by developers to prepare software (Buyya et al., 2009; Armbrust et al., 2010).

The IaaS cloud infrastructure model is similar to common virtual server hosting. Enterprises prefer this model for its secure properties (Mangiuc, 2011). Virtualized Virtual Machines (VVMs) is typically the platform that most CSPs offer in terms of IaaS (Hwang & Li, 2010). Software such as Microsoft Azure and XenServer is the method typically used to transform a sole hardware into a physical host that is capable of hosting numerous VMs. The VMs are usually Web servers, application servers, databases or file servers that typically exist in an on-premise network environment.

IaaS makes use of virtualized computing resources that are hosted in the cloud. These virtual resources can be divided, dynamically resized and later assigned as virtual instances (VIs) to consumers. Enterprises benefit from this model by not investing locally in servers and network infrastructure. VIs can be purchased or rented and used on demand as complete VMs that contains an operating system, which the consumer can use to deploy its own applications or simply for storage. However, the CSP is responsible for maintaining the servers, storage and network settings (Armbrust et al., 2010; Buyya et al., 2009).

Irrespective of the cloud service delivery model, there are four cloud models that are commonly deployed. These include: (a) public clouds, (b) private clouds, (c) hybrid clouds, and (d) community clouds (Durkee, 2010). For comparison purposes, the various types of models will be briefly discussed.

As the name implies, public clouds are presented in massive scale offerings to the public in general via the Internet. The CSP owns and manages the infrastructure and the infrastructure is typically located at the CSP (Rapp, 2010). What this implies is that the consumer's data is outside his or her control. Public cloud users are apparently not trusted since they do not have organizational ties or contractual agreements with the CSP (Marks & Lozano, 2010). An example of a public cloud service is the Google App Engine and the Amazon's Elastic Compute Cloud (EC2).

In contrast to public clouds, private clouds are typically owned and managed by a single organization and the resources are not shared by other organizations (Sangani, 2010). This model fits well with the needs of enterprises especially with the current developments in virtualization and data consolidations (Furht, 2010). The location of the private cloud may be physically located on-premise, at a designated location (internal), or at the location of a designated CSP, off-premise or external, (Li, 2010). What this means is that the organization's data is under its own control and all access to this location is granted only to trusted users, such as employees or trusted vendors (Brodkin, 2009).

Hybrid clouds involve a cloud infrastructure with two or more clouds, such as private and public clouds (Skiba, 2010). An example would be when a consumer operates critical security sensitive processes in a private cloud, but chooses to outsource certain noncritical processes to less expensive public cloud environment. These differ from community clouds in that a community cloud is a multiple tenancy infrastructure that is shared by enterprises with similar deployment characteristics (Metz, 2010).

Community cloud users are typically trusted by the organization that belongs to the cloud community (Metz, 2010).

Business Perspective of CC

The business opportunity for enterprises migrating to CC is expected to be enormous (Bulford, 2011). Gartner, a leading IT advisory and research firm, indicated that the market for CC services will increase from $56 billion per year to $146 billion by the year 2014 (Bulford, 2011). Researchers and organizational and IT managers are seeking to comprehend the elements leading entities to accept and utilize technological innovations such as CC (Panetto, 2007). CC can be appreciated as an innovation in diverse ways. From a technological viewpoint, Molen and Brace (2010) found that CC was an improvement of computing history that progressed from bulky mainframe architectures to several networked computers with the ability to run a variety of applications through the use of virtualization technology to host middleware that is dispersed across the cloud.

Enterprise systems are traditionally based on complex legacy systems that are not unified across multiple functional areas and might not be available in real time Khajeh-Hosseini, Sommerville, & Sriram, 2010). To remain competitive in a constantly changing and technologically advanced business environment, enterprises strive to be strategically ready (Goodwin, 2012). Dougherty, White, and Schmidt (2012) noted that more enterprises will embrace CC technology to reduce cost and improve performance and productivity. Ward and Sipior (2010) associated the inevitable change from traditionally based business networks to CC with the rapid use of Internet-based

computing services. Experts have discussed private clouds in terms of economics of scale when compared with public external clouds (Armbrust et al., 2010; Khajeh-Hosseini et al., 2010). Therefore, it is imperative to examine exhaustively the perspective held by these researchers. The potential cost benefits when migrating from in-house data to a VPICI environment must be ascertained. This research in VPICI will provide an opportunity for the refinement of any possible relationship between VM automation and cost, productivity, and performance for enterprises that have adopted VPICI environments.

Summary

Modern business enterprises are beginning to embrace private clouds due to the fear of sensitive business data in public cloud environments. Successful enterprises endeavor to find new approaches to harness the capability of employees to increase productivity and use technological advances to propel profit growth, while reducing cost simultaneously. Implementing an IT enterprise strategy is becoming complex as technology continues to grow at a rapid pace (Ahrens, 2010). Additionally, IT security administrators in charge of audits and compliance are concerned due to the availability of different enterprise VMs in a public cloud (Sarrel, 2010).

Whereas CC offers new functional business models that enable enterprises to consume resources in a cost effective manner, Marston et al. (2011) emphasized areas wherein additional research might be required. This literature review examined several publications on the significances of CC, but none of the studies reviewed were found to include an analysis of VPICI in terms of cost, productivity and performance, as most of

the analysis were performed on private external clouds. As a result, this study will be primarily concerned with the study of VPICI. As such, this proposed research will add more substance to the CC environment. The methodology for this proposed study will be discussed in Chapter 3.

Chapter 3: Methodology

The purpose of this study is to conduct a mixed methods investigation into the cost reduction, effectiveness, and security of CC as implemented through a VPICI. In order to conduct this study, IT departments will be contacted and surveys distributed to IT managers across 300 business enterprises where VPICI has recently been implemented as a means of moving toward CC. This chapter will provide a discussion of the research design, the appropriateness of the study, the research questions and hypotheses, the sampling methodology, data analysis techniques, and ethical considerations for the participants. A summary will conclude the chapter.

Research Design

Since the purpose of this study is to both investigate participant perceptions of a given phenomenon and to analyze whether a statistical relationship exists between cost reduction and efficiency, a mixed methods approach was chosen for this study. The quantitative portion will be employed since the purpose of this investigation is to calculate the relationship between costs and efficiency (Salkind, 2006; Spaulding, 2008). The qualitative portion will add depth to the quantitative responses and will include a content analysis of the qualitative semi-structured interviews conducted with the IT managers. Qualitative research methodologies can utilize semi-structured interviews that can add depth to the numerical data analysis (Creswell, 2003; Glesne, 2006).

As a result, this research study will include both a qualitative and a quantitative component. There is sufficient precedent to consider this research design in terms of the execution of a study on the perception of CC implementation via VPICI and the related

metrics of cost and efficiency while also taking the perception of security into account. The quantitative analytic method will use the Pearson's Correlation Coefficient to conduct the analysis of the survey responses (Creswell, 2009). The qualitative analytic method will involve semi-structured interviews with IT managers. The purpose of the qualitative interviews will be to assess the impact of the change to CC using VPICI. The analytic method will be a content analysis following Krippendorff (2004).

Research Questions & Hypotheses

As noted in the introduction, the research questions and hypotheses of this proposed study will be as follows:

Research Question 1. What are participant perceptions regarding the necessity of VM provisioning in VPICI?

Research Question 2. What are participant perceptions regarding how the adoption and implementation of VPICI impact traditional IT departments?

Research Question 3. What are participant perceptions of the deployment of security policies of an enterprise to a VPICI?

Research Question 4. What are the participant perceptions regarding how an IT department can assist in the general satisfaction of stakeholders in terms of cost reduction, productivity, and performance in the adoption and implementation process?

Research Question 5. What are participant perceptions regarding how the management of governance policies over self-provisioning can occur in VPICI environments?

Research Question 6. What is the correlation between efficiency and cost reduction?

$H1_N$: There is no statistically significant correlation between efficiency levels and cost reduction.

$H1_A$: There is a statistically significant correlation between efficiency levels and cost reduction.

Study Participants

The participants of this study will be IT managers and employees gathered from 300 businesses where the changeover to CC through the implementation of a VPICI has been undertaken. These companies will include an unknown number of IT managers and employees. As a result, the request for dissemination of the surveys will likely result in a larger sample than initially targeted. Targeted managers will be requested to assist in this dissemination, which will lead to an expected 1,500 – 2,000 total responses to the surveys from the 300 targeted companies.

Instrumentation

Since this study has a narrow purpose not previously investigated in the research, and since the study contains both quantitative and qualitative components, an original instrument will be designed for data collection. There are expected to only be two quantitative questions (measuring efficiency and cost reduction) and approximately 10-15 qualitative questions that will be used to ascertain the participant perceptions in order to answer the qualitative research questions. A pilot study will be necessary to conduct to ensure validity and reliability of the instrument.

Data Collection Procedure and Setting

Data collection will be accomplished via various editions of an emailed survey instrument using a hosted application such as Survey Monkey, Qualtrics, or Zoomerang. The various editions are to allow for and facilitate the survey experiment research design. Survey items will be scaled using a five point Likert-type response mechanism (Meltzoff, 1998), with a No Opinion option included (Trochim & Donnelly, 2008). This design and operationalization approach will be easy and convenient for respondents while still leveraging the variety, depth, and richness of the source database. Open ended questions will be provided for the collection of the qualitative data.

To collect data, IT personnel and department heads will be contacted from a list of relevant companies purchased by the researcher. A pilot study of five participants will be conducted first. Pursuant to the validation of the instrument and correct specification of the questions, the survey will then be distributed to the entirety of the sample. While low response rates are expected, the total number of sampled participants is expected to be high and the survey is very short requiring only 5-10 minutes to complete. Following data collection, the export of data will be conducted to SPSS, where data analysis will be performed.

The power analysis of the sample size revealed that an estimated 134 participants will be required for this correlational quantitative research design. The estimation was conducted using G*Power and a medium effect size (0.3), a significance level of 0.05, and a predicted power of 0.95. With a power of only 0.80, the minimum required power

for a study, only 82 participants are required. As a result, it is expected that the approximately 1,500-2,000 sampled participants will return a sufficient number of surveys to at least achieve a power of 0.80.

Validity

The validity of the original survey instrument will be ascertained through a pilot study analysis of the five IT managers and employees completion of the instrument. Should the questions answer what they are expected to provide in terms of data, the survey will be deemed reliable (Creswell, 2009). The qualitative questions will be examined for depth in responses to ensure the research questions are able to be answered from the collected data.

Ethical Safeguards

Because of the nature of the proposed topic, there will be minimal risk of harm to study subjects (Arwood & Panicker, 2011). However, breaching the boundaries of privacy and confidentiality is always a possible concern in a survey of the nature of the one being proposed. As the survey will be administered over the internet, care and caution will be taken to ensure participant comprehension and consent, and that such consent is clearly captured and documented (Hicks, 2011). Further, study participants will be asked to report only on experiences, observations, or interactions personally made or participated in and not report on third-party hearsay, peersay, rumors, or innuendos. Study subjects will not be asked to provide or reveal the names of others. Subjects will not be queried about theirs' or others' personal health information or medical information of any sort (Cushman, 2012).

Operational Definition of Variables

There will be two quantitative variables for this study.

Cost Changes. Cost changes will be an estimate provided by respondents regarding the approximate figure in thousands of dollars that the IT transition has been estimated at changing with respect to their specific role based on the changeover to VPICI. The cost savings will be defined as the approximate number of weekly hours saved multiplied by their hourly salary, normalized for an annual basis.

Change Efficiency. For this study, efficiency will be measured on a 1-5 Likert scale where 1 will be a large negative change in efficiency, 3 will be no change in efficiency, and 5 will be a large positive change in efficiency.

Data Analysis

Data will be analyzed using the Statistical Package for the Social Sciences (SPSS). The data will first be examined with respect to the descriptive statistics. The researcher will report means and standard deviations for all question responses. Initial tests will be conducted to determine whether the assumption for the correlation analysis is met. The main assumption is the normal distribution of the responses to the survey questions. To test this, the Komogorov Smirnov test for normality of data will be conducted. If the data are found to be normally distributed, the parametric MANOVA procedure will be conducted. If the data are not found to be normal, a non-parametric Chi-squared test will be required to test the hypotheses.

The Pearson's Product Moment Correlation coefficient will be calculated for the relationship between the cost reduction and efficiency variables. If there are statistical

differences found between the rounding and non-rounding periods at the 0.05 level of significance, then the null hypotheses for the research questions will be rejected in favor of the alternate hypotheses.

The qualitative research questions will be answered through the qualitative analysis of the semi-structured interviews. The analytic methodology that will be used is content analysis. Content analysis is often used in program evaluations to add depth to the quantitative responses (Spaulding, 2008; Krippendorff, 2004). This analytic methodology will be conducted with NVivo v.9.0™. NVivo is a qualitative analysis software that will assist the researcher in coding the thematic categories and extracting the themes that will be used to answer the qualitative research questions (Krippendorff, 2004).

Limitations

There are a number of limitations that will be present for this study. First, accurate and honest assessments of cost changes in terms of hourly productivity and savings will be required from the participants. These numbers cannot be externally validated so participant honesty will be a limitation. This limitation will be dealt with in part by explaining that this study has no underlying agenda, is entirely confidential, and that honest estimates will not be shared with anybody within the company. The responses of the participants to the qualitative questions will potentially limit the researcher's ability to conduct a content analysis. While it is expected that in depth responses will be given, some participants are likely to provide limited data in this regard. To limit the impact of this limitation, the open ended responses will be given to all participants. Usually only

20-30 participants are sampled, however, since the survey is short, it can be provided to all participants at no expected increased cost of completion.

Summary

The purpose of this mixed methods study is to determine the effect of a move to CC on a VPICI basis has on change in costs and change in efficiency and in terms of overall security and job satisfaction and effectiveness. An original survey will be designed for the purposes of this study and it will be piloted with a group of 5 participants prior to implementation. Data will be analyzed using correlation analysis and content analysis for the quantitative and qualitative data respectively.

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