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I CAN, BUT I WON'T: AN EXPLORATORY STUDY OF PEOPLE AND NEW INFORMATION TECHNOLOGIES IN THE MILITARY

THESIS

Michael Killaly, Captain, USA

AFIT/GIR/ENV/11-M03

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

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THESIS

Presented to the Faculty

Department of Systems and Engineering Management

Graduate School of Engineering and Management

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Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Information Resource Management

Michael S. Killaly, FA53/SC

Captain, USA

March 2011

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Abstract

Cloud computing is a hot topic in Information Technology with providers' worldwide revenues exceeding $130 billion. While new technologies bring great promise, they have the potential for disruption as these new tools potentially change roles, promise unrealized capabilities, and bring unanticipated effects. This research investigates one such technology, examining issues and perceptions of cloud computing in the Department of Defense (DoD). The first part of the study replicates a 2009 IDC Enterprise panel survey of commercial IT professionals. Eighty-three military IT professionals were surveyed for their views on cloud computing. In the current survey, more military IT professionals felt system availability, performance, and in-house integration were significant concerns. Conversely, military personnel were less likely to be worried about unknown on-demand costs or reintegration of IT services. No difference was found in the breadth of security concerns or the ability to customize software. Of particular interest were the concerns on cloud computing costs and reintegration, which are counterintuitive for a technology promising a revolutionary approach to save money over the long haul. Next, the military IT personnel survey data was used to understand the relationship between viability perceptions and willingness to implement the technology. Survey data was analyzed with structural equation modeling. The model showed that a large portion of perceived viability of cloud computing is determined by the cost of the technology, the inertia of the organization, and the fit of the technology with the organization. Furthermore, willingness was significantly related to viability perceptions but not to cost concerns.

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Dedication

For my wife and daughter and their sacrifice over the last eighteen months. This would have not been possible without your love, understanding, and support. The time I had to spend away from both of you was made much easier because of this and hopefully you'll understand the depth of my gratitude.

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Acknowledgements

As this portion of my career is completed, there are many people I would like to thank. My thesis advisor, I am grateful for your time and patience in seeing this to the end. My thesis committee, I have learned so much from our discussions on the numerous topics that gave me the direction I needed to complete the thesis. I would like to thank the Air Force Institute of Technology, the Graduate School of Engineering and Management and the Professors and instructors in the Information Resource Management program. I have learned so much from my attendance at AFIT. I would also like to thank the committee members in the Information Assurance Scholarship Program for allowing me to attend this program. Philippians 4:13.

CPT Michael S. Killaly

المنارة للاستشارات

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Table of Contents

Page

www.manaraa.com

Page

المنارة للاستشارات
www.manaraa.com

List of Figures

للاستشارات المنارة
www.manaraa.com

List of Tables

المنارة للاستشارات
www.manaraa.com

I CAN, BUT I WON'T: AN EXPLORATORY STUDY OF PEOPLE AND NEW INFORMATION TECHNOLOGIES

I. Introduction

Overview

According to the National Institute of Standards and Technology (NIST), cloud computing "is a computing model that enables convenient, on-demand network access to a shared pool of configurable computing resources (hardware and software) that can be rapidly provisioned and released with minimal management effort or service provider interaction." In September 2009, the Federal Chief Information Officer, Vivek Kundra, announced the Federal Government's Cloud Computing Initiative. This initiative laid the groundwork for the future rapid deployment of technology solutions supporting the Federal Government without developing stove-piped systems (GSA, 2009). Currently, the Federal Government, considered the world's largest purchaser of information technology, spends over $76 billion per year on more than 10,000 systems (Kundra, 2009). Correctly implemented, the cloud computing model has the potential to dramatically decrease information system cost via virtualization, reducing related infrastructure, building, power, and staffing expenditures (GSA, 2009) making it attractive to any cost-crunched organization.

Cloud computing centers provide a foundation to run enterprise services securely and reliably across the DoD. By leveraging cloud computing techniques, the Department of Defense (DoD) can transform its infrastructure from its legacy system-specific infrastructures to a shared infrastructure (CIO/DoD, 2010). Some recent examples of

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recent cloud computing successes in commercial industry include Kenworth and Coca-Cola Enterprises. Engineers at Kenworth, lacking organic high-powered computing capacities, rented time on a supercomputer thousands of miles away to help find gas-guzzling design flaws. The Kenworth engineers took advantage of cloud computing and discovered the mud flaps were a major source of drag. Redesigning the mud flaps will save about $400 on a typical truck's annual fuel bill (Fortt, 2009). Coca-Cola Enterprises uses a cloud-based logistics system to optimize operations with merchandisers in the field. Using smart phones and a cloud computing setup, personnel responsible for restocking Coke products in stores stay in constant contact with their bosses and the company's information storehouse. This allows the field personnel to provide automatic inventory updates and last minute changes to merchandising schedules.

Cloud computing, while trendy as a new computing model, it is not new. Since 2009, federal agencies have been able to buy cloud computing applications and services at Apps.gov. GSA's Apps.gov storefront offers an array of business applications, productivity software, and services ranging from social networking, to website hosting, and data storage (Helft, 2009). The government has approved these cloud-based applications and services to replace more costly and demanding computing services that are owned and operated by federal agencies. Government organizations seeking to tap cloud-computing benefits are not constrained to simply the GSA storefront. In July 2010, Google announced the launch of Google Apps for Government; a suite of Federal Information Security Management Act (FISMA) approved cloud services for "moderate"-level security requirements (Google, 2010). With FISMA approval, government organizations can hire Google to provide secure sensitive, but not classified information

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systems, processes, and data. This blend of government and commercial providers affords options for dramatically changing the way organizations answer their IT needs.

Early Successes of Cloud Computing

Williams F1, a Formula 1 race team based in Oxfordshire, U.K., turned to AT&T Global Services for a cloud computing solution. The Williams F1 race team is on the road for 9 months out of the year competing in 19 Formula 1 Grand Prix races that make up the race calendar. Its headquarters contains a fully managed enhanced virtual private network that allows engineers, mechanics, car designers and drivers to run the business while they are on the road. Alex Burns, CEO of Williams F1, states that their IT strategy used to be about speed and the speed of decision-making on testing and accessing the results with little regard for security. While Williams F1 is a tech savvy race team in a competitive and high profile environment replete with espionage, it knew little about security. To correct this, the team turned to a cloud provider for a highly secure infrastructure service, allowing their own IT department to focus on helping the organization build winning racecars. AT&T's cloud security services enables the Williams F1 staff to receive encrypted data from the car to make decisions during the race. Alex Burns said that by using cloud computing, the team saves time and money since security services require constant management, patches, new hardware, and the IT department's time (Del Nibletto, 2010). Burns states that Williams F1's core competency is building racecars, not IT security, nor should it be.

In the military arena, the armed services were assigned the task of finding more than $100 billion in overhead savings over the next five years (Gates, 2010). Any

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savings the services generate can be reinvested in war-fighting modernization. At least one service, the U.S. Army, has recently stepped out and looked toward cloud computing as a means to cut costs and increase efficiency. In a move to reduce its $10 billion IT budget, the Army issued a moratorium on server purchases (Foley, 2010) to reduce server counts and consolidate the 200+ Army data-centers. Spearheading one of these cost-cutting efforts is the United States Army Recruiting Command. Their Army Recruiting Information Support System was over 10 years old and in need of an upgrade (Kundra, 2010). Therefore, they embarked on a pilot program designed to explore new technologies that the Army could leverage to improve efficiencies of its recruiting operations. Initial bids from traditional IT vendors that met the required functions ranged from $500,000 to over $1 million. Instead of accepting these solutions, the Army Recruiting Command chose a customized version of a cloud-based Customer Resource Management (CRM) tool from Salesforce. The CRM tool from Salesforce provided all the functions without needing to acquire all the necessary hardware needed to operate a traditional system. The Army Recruiting Command is currently piloting this cloud-based solution at an annual cost of only $54,000.

In a broader example of the cloud computing movement, in 2011, the Army will start migrating its Microsoft Exchange email users to an enterprise-wide email that will leverage Army-owned Microsoft licenses and the DoD cloud managed by the Defense Information Systems Agency (DISA). The base email service enables the Army to modernize its Microsoft Server software and increase email capabilities while simultaneously substantially reducing hardware and storage expenses. Estimated savings may reach 40% (DISA, 2010). According to the DISA press release, the DISA-managed

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Enterprise Email will employ fewer servers and administrators, increase security and eliminate thousands of existing heterogeneous local networks. This change will expand the email capability with email storage growing to 4 gigabytes for most users. In contrast, the Air Force's Air Mobility Command (AMC) revised its newly restrictive e-mail limit policy in January 2009. The new limits for e-mail size are divided into three Tiers. Tier I, which includes Group CC\CV and CMSgt has unlimited size of e-mail boxes. Tier II includes CC, CV, CEM, First Sergeant, and organization accounts are limited to 250MB. Finally, normal users, Tier III are limited to only 50MB for their e-mail box storage. This is one of the many examples where the use of cloud computing resources can reduce costs and increase efficiencies while maintaining performance and security. These examples of the early success of cloud computing reinforce the need for this research.

Motivations for Research

The motivations for this research stems from personal experiences as a Signal Officer for an Infantry Battalion and a Company Commander for an Operational-base Signal Company. While serving as a deployed Signal Officer at a remote Forward Operating base in Operation IRAQI FREEDOM, there were many areas in which communications efficiency and capabilities could be improved. During the pre-deployment and post-deployment process, the Signal section had to transfer data to hard drives and file servers in order to re-image computers so they could connect to the respective local networks. While the imaging process was not difficult, the process of backing up the users' data multiple times over eighteen months due to training exercises

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and deployments was time consuming. For a training exercise at the National Training Center, users' data had to be backed up so computers could be re-imaged for the network used for training. This process was done after returning to the home station, before deployment to Iraq, and upon returning to home station. By comparison, using a cloud-based data service during the training exercises and deployments would eliminate the need to repeatedly move 150 users' data back and forth from individual computers to a server. Instead, the data would reside in the cloud and always be available.

At another time, as a Company Commander serving in Alaska, I encountered another problem with a potential cloud-computing solution. The Stryker Brigade soldiers possessed multiple email addresses that were used during deployments. There was an Army email address (xxx.us.army.mil), an email address at work (xxx.post.army.mil), an email address for the Brigade that was used for training and deployments (xxx.unit.army.mil), and SIPRnet email addresses for the Army, Post, and unit. Multiple e-mail addresses used during garrison and deployed operations meant multiple accounts to manage at one time; users had to check several accounts for messages, and IT personnel had to provide support for each set of exchange servers. Using a cloud-based email service, like the DISA Enterprise Email, would overcome this obstacle since doing so would eliminate the need for separate post and unit email accounts. Since implementing cloud-computing solutions does not rely on multiple exchange servers, it eliminates the need to manage multiple email accounts. These examples lead to the following question: If cloud computing can provide cost savings while still meeting the computing needs of the organization, then why is it not readily implemented through the Department of Defense?

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Research Goals

In the commercial industry, Kenworth, Coca-Cola Enterprises, and Williams F1 are just a three of the success stories of how cloud computing has helped organizations save time and money. Whether saving money by redesigning the aerodynamics of a truck, or optimizing the workload of merchandisers working in the field, or collaborating on data gathered from a car during a race, cloud computing is providing advantages in commercial industries.

The same advantages are only beginning to be seen in the government sector. The Army Recruiting Command is saving money on a pilot cloud computing solution for the aging Recruiting Information System. Similarly, on a larger scale, the Army is transitioning to a cloud-based Enterprise E-mail system that is supposed to increase capabilities while reducing costs. If there are numerous successes using cloud computing technologies in commercial industries, then why has it not been implemented as quickly in the government sector? The answer to this question is the thrust of this research.

There are two main research goals in the thesis. The first goal is to determine if there is a perceived difference of opinion between commercial and government sectors on issues concerning cloud computing. By comparing the results from a 2009 IDC Enterprise survey with the results from a military IT Personnel survey, the thesis will determine if there is a significant difference in the perception of cloud computing issues. Commercial and government sectors might have a different perception on cloud computing issues due to the nature of their organizations. Government and commercial industries have different customers, stakeholders, and goals driven by the nature of the

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two industries. For one example, expenses and income do not drive the government sector, whereas the commercial sector pays attention to profit of the organization. The differences in public and private industry can mean a difference in technology needs and opinion about a new technology. In fact, studies on information systems (IS) projects in the commercial sector may have limited relevance due to differences between the government and commercial industries (Bozeman and Bretschneider 1986; Bretschneider 1990) and any recommendations derived from commercial sector studies might not necessarily apply to the government sector (Coase 1937).

The second goal of the thesis is to understand the relationship between the perceived viability of cloud computing and perceived willingness to implement it in the organization. Is it possible that cloud computing is not seen as a viable technology in the military environment? Conversely, is it viable and IT professionals in the military are just unwilling to make the changes needed to implement it in their organizations. The previous discussions on the success of cloud computing leads us to the following questions.

Research Questions

With the benefits of cloud computing seemingly apparent, the reasons why it has not yet been adopted may lie in the human element of the people, process, and technology equation. This thesis is an exploratory examination of the opinions military IT personnel of cloud computing in the in the Department of Defense and the Army. The research presented is motivated by a desire to understand two overall research questions:

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(1) Is cloud computing perceived as a viable technology in the DoD/Army?

(2) Is there a perceived willingness to implement cloud computing in the DoD/Army?

The research will provide an understanding of whether DoD IT personnel think cloud computing is a viable technology for their organization as well as examine the connection between the perceived viability of new technologies and the willingness of IT personnel to implement them. Answering these questions will provide a framework for determining whether new technologies are viable for the organization and the perceived willingness to implement the technology.

Thesis Overview

The remainder of this thesis includes four more chapters and supporting information found in the appendices. This next chapter introduces cloud computing, defining and explaining the varying characteristics, service models, and deployment models. Chapter three then discusses the research strategy and survey methodology used to collect the data required to address the research questions. Then, chapter four presents the analysis of the survey data and tests the research model to answer the primary research questions. Chapter five discusses the results, providing recommendations along with possible limitations and future research ideas.

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II. Background

History of Cloud Computing

Recently, cloud computing has become one of the most talked about topics in information technology (Gartner, 2010). The Gartner Group (2010) identified cloud computing as the primary source of growth in IT spending with global revenues surging to over $130 billion in 2013. Cloud computing is on-demand access to virtualized IT resources that are located outside of your own datacenter (Marks and Lozano, 2010). These virtualized IT resources are accessed over the Web, shared by others, easy to use, and paid-for through subscriptions. Significant innovations in virtualization and distributed computing, as well as improved access to high-speed Internet and a weak economy, have accelerated interest in cloud computing (Lee, 2010).

The idea behind cloud computing dates back to the 1960s when John McCarthy, a computer scientist, stated in a speech given at MIT, "That computing may someday be organized as a public utility" (Biswiss, 2011). Cloud computing gets its name from a metaphor for the Internet (Velte et al., 2010) and was probably copied from internet diagrams (Biswiss, 2011) where data is depicted as traveling from one computing device to another through a nonspecific cloud (Figure 1).

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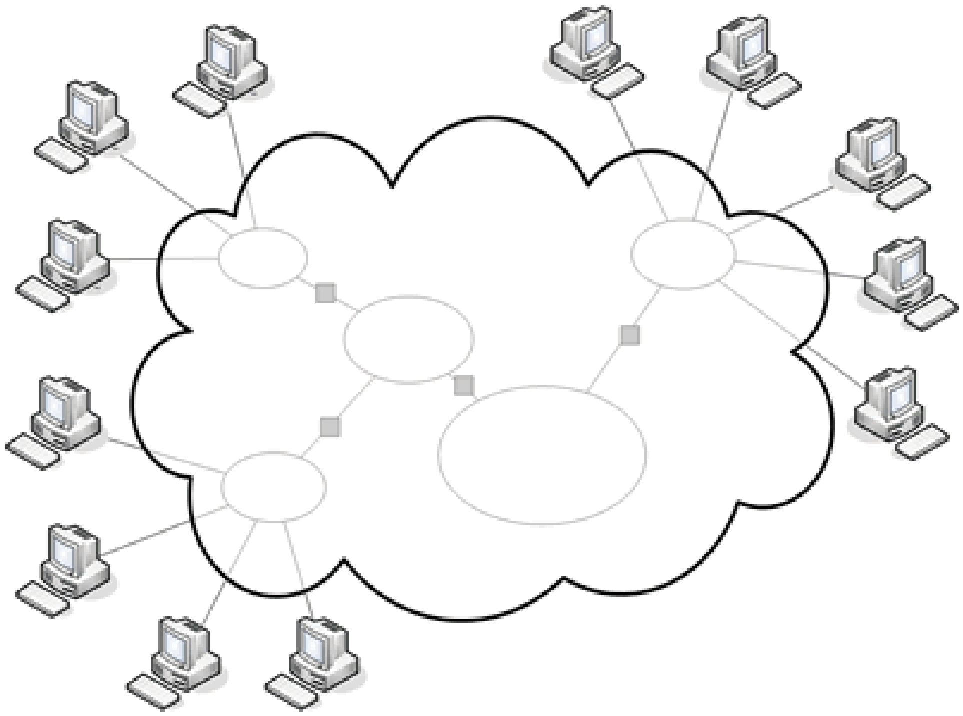

Figure 1. The Internet Cloud
(http://singularityhub.com/)

In such a model, cloud computing providers allow users to remotely access hardware, software, and data resources for a fee. Users essentially store data and applications in the "cloud" for easy access (Figure 2). There are several commercial applications utilizing cloud computing. For example, OnLive, an online gaming service, provides access to games instantly over a broadband connection using a browser. Similarly, Google Docs provides a web-based document editing and management service, while Bing Maps provides an on-line mapping service. The breadth of commercially available services available via this model continues to grow (Geelan, 2009).

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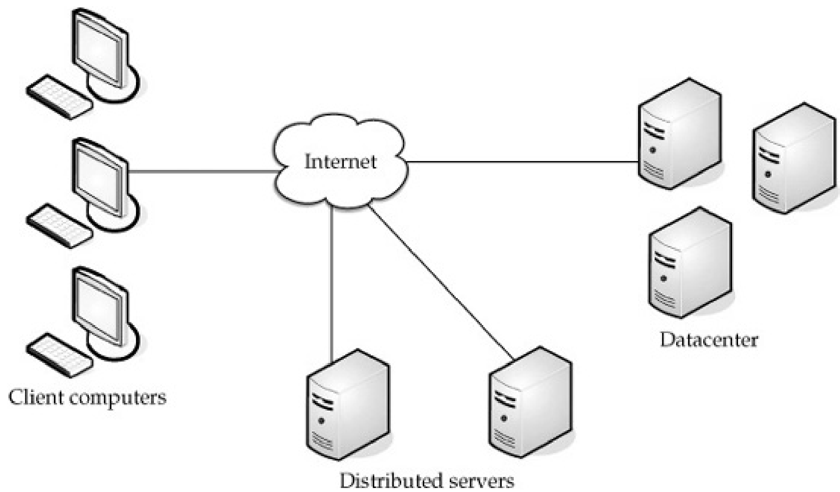

Figure 2. Cloud Computing (Velte, 2010)

What is Cloud Computing?

Commercial industry leaders have many variations of the cloud computing definition and its characteristics. Accenture, a consulting firm, defines cloud computing as the dynamic provisioning of IT capabilities (hardware, software or services) from third parties over a network. In another view, Kevin Fogarty, a contributing editor at CIO magazine (2009), states that the cloud-computing model has all applications, services and networks available to IT and end users via the Internet. Meanwhile, Jeff Kaplan from ThinkITStrategies views cloud computing "as a broad array of web-based services aimed at allowing users to obtain a wide range of functional capabilities on a 'pay-as-you-go' basis (Geeelan, 2009)." While different, at the core these definitions all have organizations or users accessing and purchasing IT capabilities from a third party. Nonetheless, they are not the only ones that show the variety of perceptions about what cloud computing is.

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According to TechTarget, a publicly traded IT marketing company, cloud computing is a general term for anything that involves delivering hosted services over the Internet. Under such a vision, cloud computing has all three distinct characteristics that distinguish it from traditional IT hosting: services are sold on demand (usually by the minute or the hour), services are elastic (so a user can have as much or as little of a service as they want at any given time), and the services are fully managed by an external provider allowing consumers access with nothing more than a personal computer and internet. One consulting firm Lexnet Consulting Group, defines cloud computing as a delivery of services that replace the need for an organization to incur infrastructure costs; it can be thought of as an "outsourced" IT network (Chipman, 2010). This cloud represents a shift away from computing as a product to computing as a service delivered over the Internet (Khajeh-Hosseini, Sommerville and Sriram, 2010). Knorr and Gruman (Infoworld, n.d.) state cloud computing comes into focus when one considers what IT departments and organizations always lack: a way to increase capacity or capabilities when needed without investing in new infrastructure, training, or software licenses. Thus, the term cloud computing can be used to cover any subscription-based or pay per use service that extends existing IT capabilities (Knorr and Gruman, n.d.).

There is one commonality for almost all papers and definitions of cloud computing: they all refer to or reference the National Institute of Standards and Technology (NIST) cloud computing model. For example, see: Bambacus, 2008, Biswas, 2011, Chipman, 2009, DoD/CIO, 2010, Foarty, 2009, Geelan, 2009, Khajeh-Hosseini et al., 2010, Kundra, 2008 and 2010, Knorr and Gruman, 2010, Lee, 2010, Lewin, 2009, Marks, 2010, Rhoton, 2009, Rittinghouse and Ransome, 2010, and Wyld,

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2009 and 2010. Since the NIST model is fundamental to so many commercial cloud computing visions, this thesis will use the government's definition of cloud computing which was published in January 2011 under the Federal Information Security Management Act (FISMA of 2002 in Special Publication 800-145). The NIST defines cloud computing as 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 and effort or service provider interaction." The cloud model promotes availability and is composed of five essential characteristics, three service models and four deployment models that are explained below.

The five essential characteristics are on-demand self-service, broad network access, resource pooling, rapid elasticity, and a measured service. The three service models are Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). The four deployment models outlined by the NIST are private cloud, public cloud, community cloud, and hybrid cloud. Further details are provided below.

Five Essential Characteristics

Characteristic #1: On Demand Self-Service.

On-demand self-service occurs when a consumer can automatically and unilaterally provision computing capabilities, such as server time and network storage, without requiring contact with the providers' customer service representative. It means the consumer can use the cloud service as needed without any customer service interaction with the cloud provider (Ruggles, 2010). One example is from VMware.

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Their vCloud™ Express offers an on-demand service, where developers can use the service at their convenience to address various infrastructure and programming needs such as experimentation, prototyping and testing. A vCloud™ customer can create a virtualized server, add storage, configure a firewall, and scale additional capabilities in and out according to what and when they need it.

Characteristic #2: Broad Network Access.

Broad network access is an essential characteristic defined by the NIST as capabilities that are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, laptops, PDAs). This is the most vital characteristic of cloud computing since it is network based, and accessible from anywhere, from any standardized platform (Velte, 2010). This does not necessarily mean Internet access. A private cloud is accessible only behind a firewall, regardless of the type of network (Ruggles, 2010). The main point of this characteristic is that the service is accessible from anywhere.

Characteristic #3: Resource Pooling.

Resource pooling is the next characteristic. In resource pooling, numerous clients use the same set of resources at the same time (Rhoton, 2009). It works on economies of scale: users do not have their own resources, so a provider gives multiple parties access to a large pool of shared resources at efficiencies no one user could match. The cloud computing service providers make their resources available to anyone who is willing to pay for access.

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Characteristic #4: Rapid Elasticity.

The characteristic of rapid elasticity is defined as the ability to scale computing resources both up and down, as needed. To the consumer, the cloud appears to be infinite, and the consumer can purchase as much or as little computing power as needed (Ruggles, 2010). This characteristic not only allows the services to be scaled both up and down (scalability), but per-usage billing is common with this characteristic and this leads to direct cost savings.

Characteristic #5: Measured Service.

The last characteristic is called a measured service. NIST defines this as the leveraging of a metering capability; usage can be monitored, controlled and reported, providing clear usage details for the provider and consumer, like a utility service model. Measured services allow the cloud provider to charge for exactly what the customer is using. The customer can track usage and costs and align them with their specific business units or functions for cost accountability.

Three Service Models

Besides containing the five essential characteristics, cloud computing implementations are available in three service models: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). These models describe the level of functionality offered by the cloud provider. Figure 3 depicts the relationships between the models as a pyramid. At the highest or software as a service level, the consumer receives more functionality and customization and knows less about the implementation details. At the lower levels, the consumer receives more components

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in the service and a higher degree of control over the infrastructure, platform, and software.

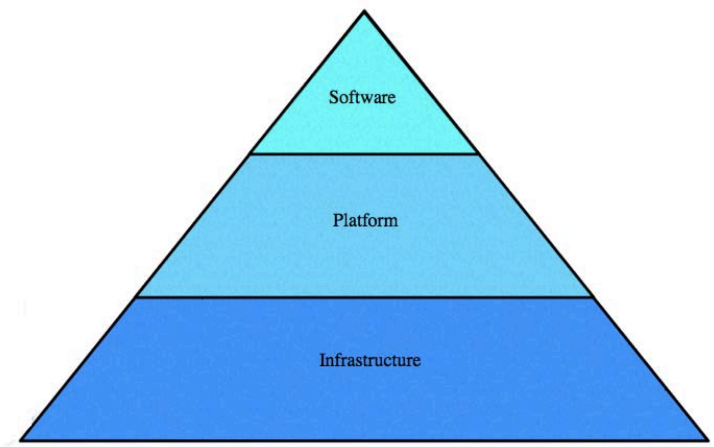

Figure 3. Cloud Service Models

Service Model #1: Software as a Service.

Software as a Service (SaaS) provides the customer the ability to use applications running on a cloud infrastructure (NIST, 2011). SaaS offers fully functional applications on-demand to provide specific services such as e-mail, customer relationship management, web conferencing, and other applications. The applications are accessible from various devices though a thin client interface (e.g., web browser) allowing consumers to avoid upfront investment in servers or software. Salesforce.com is the most well known example among enterprise applications (Knorr and Gruman, 2010). Onlive, Google Docs and Bing Maps are other well-known examples the growing number of SaaS providers. For example, Google Docs allows you to upload files, then edit, and view the documents from any computer or smartphone. This fosters real-time collaboration with other authorized users, while shielding the company from implementation details such as software installation, updates, and patches.

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Service Model #2: Platform as a Service.

NIST defines Platform as a Service (PaaS) as another service model. PaaS allows the consumer to deploy their own applications that are created using approved software tools, onto the cloud. PaaS falls between SaaS and Infrastructure as a Service since it balances functionality with control. Consumers use PaaS to generate custom applications using software development languages and tools offered by the vendor. PaaS offers an operating environment that includes the operating system and application services. These services are constrained by the vendor's design and capabilities. PaaS solutions are development platforms in which the development tool itself is hosted by the provider and accessed through a web browser. Due to this, developers can build web applications without installing any tools on their computer and can deploy those applications without any special system administration tools. Examples include Force.com by Salesforce.com, Google App Engine, and Microsoft's Azure.

Service Model #3: Infrastructure as a Service.

Infrastructure as a Service (IaaS) is where the consumers are provisioned with processing, storage, networks, and other fundamental computing resources on which to deploy and run any software, including operating systems and applications (NIST, 2010). The IaaS vendor provides a virtual machine to the consumer allowing them to manage applications and data while the vendor manages which physical machine executes the code. Virtualization enables IaaS providers to offer almost limitless instances of servers to customers and make cost-effective use of the hosting hardware. IaaS users enjoy

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access to enterprise-grade IT infrastructure and resources that would be prohibitively costly if purchased on their own. Commercial IaaS providers include Amazon's Elastic Compute Cloud (EC2), Rackspace, and GoGrid.

Four Deployment Models

Each of the preceding characteristics and platforms are accessed through different types of clouds, also known as deployment models. The NIST lists four different deployment models in SP 800-145: private, public, community, and hybrid (Figure 4). As explained below, their differences are primarily in the way the consumer or organization access services.

Deployment Model #1: Private Cloud.

Under NIST, one deployment model is the private cloud infrastructure, which is operated solely for the use of one organization. It may be managed by the organization or a third party and may exist on premise or off premise. The private cloud is operated to maintain a consistent level of security, privacy, and governance control. Organizations use their own infrastructure and private cloud to operate and protect mission critical systems. By operating and maintaining a private cloud, the organization has to buy and manage the infrastructure, and does not benefit from lower upfront capital costs (Foley, 2008).

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Deployment Model #2: Public Cloud.

The public cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling some type of cloud services. In such a situation, the cloud service provider makes resources available to the general public over the Internet. These services may be free or on a pay-per-usage model. The benefits of a public cloud service are that they are easy and inexpensive to set up since the provider absorbs the hardware, application, and bandwidth costs. In addition, they are easily scalable to meet the needs of the consumer and are paid per usage.

Deployment Model #3: Community Cloud

A community cloud infrastructure is one shared by several organizations and supports a specific community that has shared requirements (e.g., mission, security requirements, policy, and compliance considerations) (NIST, 2011). This type of model can be managed by the organizations (members of the community) or a third party and may exist on premise or off premise. For example, a financial services community cloud would bring together cloud-based services needed to assist their customers while still meeting industry-specific security and auditing requirements.

Deployment Model #4: Hybrid Cloud.

The last deployment model is a hybrid cloud. NIST states that the hybrid cloud infrastructure is a composition of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability. For example, an organization that keeps

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their data in a private cloud while using the processing resources of a community cloud is one type of a hybrid cloud.

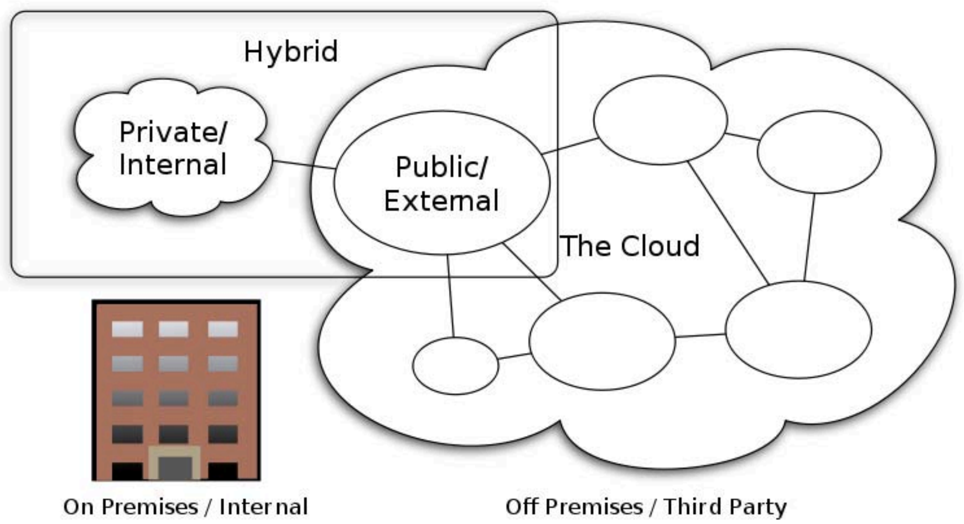

Figure 4. Types of Cloud Deployment Models
(Sam Johnston, 2009)

The Silver Lining of Cloud Computing

In an effort to reduce costs during tough economic times, cloud computing offers a way to significantly reduce waste, increase data center efficiency and utilization rates, and lower operational costs (Kundra, 2010). Cloud computing benefits are analogous to public utilities (Kundra, 2010). Public utilities provide access to clean water and electricity; just turn on the faucet or the light switch and the service is there, and the consumer pays for only what they use. Cloud computing services can be turned on and off, as the organization needs them, and provide a pay-as-you-go capability. In such an approach, only a low initial investment is required to get started (Kundra, 2010). This lowers the barrier of entry for new or small organizations (Jaeger et al., 2008). Besides

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the direct economical benefit, cloud computing can save maintenance and downtime, reduce human capital required to manage a data center, and better accommodate business growth (Joyent, 2009). Organizations can get its cloud service operational in record time at a fraction of the cost of an on-premise solution (Waxer, 2010).

Reducing risk is another benefit of cloud computing. Cloud computing allows individuals and businesses to reduce some risk by stating in the service contract that data protection and disaster recovery provisions are maintained and the provider is liable in the case of failures (Rhoton, 2009). Furthermore, by using a cloud provider, an organization can reduce the likelihood of not provisioning enough resources for fluctuating demand and reducing the risk of lost revenue due to unplanned downtime. Elasticity, which can also be called scalability (Waxer, 2010) allows IT departments to have an abundance of resources for peak demand can add or subtract capacity as its network loads dictate (Waxer, 2010). This elasticity allows for the organization to pay for only what is used (Kundra, 2010) rather than purchasing, installing, and configuring new equipment (Velte et al, 2010).

Cloud computing also offers firms potential security. System security under cloud computing promised to be as good as traditional systems since cloud providers can devote resources to solving security issues that smaller business cannot afford (Marks and Lozano, 2010). Google (2010) states cloud computing provides improved security through multiple levels of redundancy across multiple datacenters, thereby ensuring data integrity while obscuring it from tampering. Cloud providers can offer services that include disaster recovery, monitoring, forensic readiness, password assurance, and security testing (Rhoton, 2009).

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There are several different types of efficiency gains realized through cloud computing. Energy efficiency is gained through the use of higher utilization rates, fewer servers and less energy consumption (Kundra, 2010). Organization and IT department efficiency is gained by allowing IT personnel to concentrate on mission-critical tasks and less time on IT operations and maintenance (Kundra, 2010; Golden, 2008). Moreover, cloud computing allows organizations to convert fixed costs to variable costs, which are only paid by usage and can be tracked by the departments using the service (Marks and Lozano, 2010). Cloud computing allows for the increased efficiencies in several areas that would not be possible using traditional computing methods.

As discussed above, cloud computing offers many potential benefits. From low initial investment, to reducing maintenance and down time costs, to increasing security and monitoring, cloud systems allow the organization to be more flexible. Even though cloud computing implementations offer these potential benefits, no implementation is risk free.

The Dark Side of the Cloud

There are also some risks involved in implementing cloud computing. Despite vendor claims of improved security through improved expertise and redundancy, security remains a sticking point for this new model. Information Security Magazine (2009) states that information security is the most crucial risk associated with cloud computing. Making intellectual property, trade secrets, personally identifiable information, or other sensitive information available on a network requires a large investment in security

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controls. In highly sensitive situations, security and other business requirements may dictate using something other than a public cloud regardless of vendor assurances.

One of cloud computing's characteristics, broad network access, is a both benefit and a risk. The benefit, mentioned above, is that employees can access data from anywhere. The risk involved is that network connections are susceptible to outages and subject to bandwidth issues. If employees try to access their data during "peak hours" (e.g., 0900 hours on Monday), then the connection speed could suffer. Should the organization be driven to purchase more bandwidth to support cloud access, the expensive upgrade would reduce the cost benefit of cloud computing.

Finally, data privacy is another issue. Users are giving their data to a cloud provider. Cloud service providers are the holders of very large amounts of sensitive data and law enforcement officials only need a subpoena to access a user's data (Zittrain, 2009). When users place their data and applications on centralized servers, they lose direct control of that information. Sensitive information that was once stored on organizational computers now resides on the servers of cloud service companies. Examples include user email, banking information, and backups of individuals' hard drive. This creates a risk for the users since storing data in the cloud could increase the possibility that unwanted third parties will access this data. Some cloud computing providers store data in clear text, leaving it vulnerable to a security violation. By stating in the contract with the cloud service provider, data can be encrypted in transit and during storage at a specified provider location.

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The State of Commercial Industry Cloud Computing

Spending on worldwide cloud services is expected to surpass $130 billion in 2013 (Gartner, 2010) and the Cloud Expo in Santa Clara, CA, drew more than 5,000 delegates and over 100 sponsors and exhibitors in November, 2010. Indeed, many organizations in the commercial sector are using cloud computing to attain tremendous savings and reorganize their operations (Kundra, 2010). For example, the NASDAQ is using cloud computing to give customers a snapshot of information about market conditions at the time of the trade (Crosman, 2009). Further, a list of some companies that have saved money by using Google Apps include: Genetech (biotech industry), Virgin America (airline industry), Salesforce,com (customer relationship management industry), and Heinz (U.S.-based food industry). Related to this, Morgans Hotel Group deployed Google Apps for messaging and collaboration needs to its 1,750 employees (Google, 2009). Additionally, JohnsonDiversey, a global provider of commercial cleaning and hygiene products and solutions chose Google Apps. Google helped JohnsonDiversey migrate its 12,000 employees to one communications platform, lowering its IT costs and furthering its commitment to sustainability through the elimination of energy-intensive email servers. These are just a few examples of commercial industry using a cloud service provider to obtain cost savings and reorganize their operations.

The State of Government Sector Cloud Computing

Cloud Computing is currently being implemented in government sectors all around the world. In some instances, government will be the leading sector in the development of cloud computing (Wyld, 2010). In January 2011, the NIST published a

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draft document on the *Guidelines on Security and Privacy in Public Cloud Computing* that provides an overview of public cloud computing and the security and privacy challenges involved with implementing cloud computing in the government sector.

Even though moving to a cloud computing environment can reduce costs, standards must be in place that maintain the security of government information, protect the privacy of the citizens, and safeguard national security interests. The Federal Information Security Management Act (FISMA) of 2002 requires each federal agency to develop, document, and implement a government-wide program to provide information security for the information and information systems that support the operations and assets of the government, including those provided or managed by another agency, contractor, or other source.

Under FISMA, the NIST was tasked with developing the standards and guidelines for categorizing all information and information systems, recommending the types of information and information systems to be included in each category, and developing the minimum information security requirements for information and information systems in each category. FISMA defines three security objectives for information and information systems that serve as the basis for NIST's analysis: confidentiality, integrity, and availability. Confidentiality means, "Preserving authorized restrictions on information access and disclosure, including means for protecting personal privacy and proprietary information." Integrity means "guarding against improper information modification or destruction, and includes ensuring information nonrepudiation and authenticity." Finally, availability means "ensuring timely and reliable access to and use of information" (44 U.S.C., Sec. 3542). Overall, the adoption of cloud computing in the government sector is

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still in its infancy though. NIST's *Guidelines on Security and Privacy in Public Cloud Computing* and other government organizations are still just beginning to examine the concerns and issues of cloud computing.

The General Services Administration (GSA) is one of the larger cloud computing users. Recently, the GSA moved their primary information portal (USA.gov) to Terremark's Enterprise Cloud Service (Staten et al., 2009). In doing so, GSA migrated all core resources for the USA.gov web portal to an IaaS platform giving them the ability to deploy on-demand resources as web traffic increases. Migration to the cloud has brought benefits and savings, such as avoiding idle server costs while still accommodating web traffic spikes, acting on users' requests in real time, and applying security constraints on top of this platform (Staten et al., 2009).

The GSA and NASA are already using cloud implementations to their advantages and realizing some benefits or using the services. As the success stories become more prevalent, the future of cloud computing in the government sector will likely grow.

U.S. Government Public Sector Cloud Providers.

NASA recently launched NEBULA, a cloud computing based service that provides highly-scalable, high performance, on demand infrastructure, platform, and software as a service (Bambacus, 2010). Nebula is an open-source cloud computing project developed to provide an alternative to building new data centers whenever NASA requires additional data processing (NASA, 2010). Nebula's IaaS provides scalable computing and storage for NASA users' scientific applications. Nebula enables significant cost savings through better resource utilization, reduced energy consumption

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and reduced labor costs associated with procuring infrastructure and creating new web applications (NASA, 2010). Additionally, the Nebula cloud computing platform has become the home of the Federal Government's flagship website USAspending.gov (Kundra, 2010). USAspending.gov 2.0 was completely reengineered to take advantage of the cloud computing platform at Nebula. By tapping the capabilities of NASA's Nebula platform, unused capacity is available for use by other government agencies.

Beyond the NASA, the Department of Interior's National Business Center (NBC) provides payroll and personnel services for a number of government agencies (Wyld, 2010), as well. The NBC offers a prepackaged, integrated development environment including a software development tool, applications and testing tools (NBC, 2010). NBC's private federal cloud gives federal users the advantage of using a pool of networks, servers, storage capabilities, and desktop applications (SaaS) in a NIST-certified secure dedicated federal environment. Federal organizations and agencies can take advantage of end-to-end development and production pipelines on an as-needed basis in a hosted environment (NBC, 2010).

These two examples of cloud computing service providers can be classified as government sector clouds that provide for themselves and other government sector consumers. By using available resources from other government agencies, the Federal Government can increase the efficiency of its resources and reduces IT costs.

U. S. Government Sector Cloud Consumers.

GSA anticipates that cloud computing will become a major factor in reducing the environmental impact of technology and help achieve important sustainability goals

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(McClure, 2010), Besides the NASA, GSA and NBC, other examples of federal, state and local government agencies using cloud-computing technology are listed in Table 1.

Table 1. Federal, State, and Local Agencies using Cloud Computing
(Kundra, State of Government Sector Cloud Computing, 2010)

FEDERAL AGENCIES				
DoD (U.S. Army)	Army Experience Center		Department of the Interior	Agency-wide E-mail
DoD (U.S. Army)	Enterprise E-mail		GSA	USA.gov
DoD (DISA)	Rapid Access Computing Environment		GSA	Agency-wide E-mail
DoD (DISA)	Forge.mil		NASA (Ames Research)	World-Wide Telescope
DoD (USAF)	Personnel Services Delivery Transformation		NASA (Jet Propulsion Laboratory)	Be A Martian
DoE (Lawrence Berkeley National Labs)	Cloud Computing Migration		Social Security Administration	Online Answers Knowledgebase
Department of Health and Human Services	Supporting Electronic Health Records		Recovery Accountability and Transparency Board	Recovery.gov Cloud Computing Migration
STATE AND LOCAL AGENCIES				
State of Colorado (Office of Information Technology)	Launching an Enterprise Cloud		City of Canton (Georgia)	E-mail
State of Michigan (Department of Technology Management and Budget)	MiCloud		City of Carlsbad (California)	Communication and Collaboration Services
State of New Jersey (NJ Transit Authority)	Customer Relation Management		City of Los Angeles (California)	E-mail and Office Productivity
State of New Mexico (Attorney General's Office)	E-mail & Office Productivity		City of Miami (Florida)	311 Services
Commonwealth of Virginia (IT Agency)	Application Development Platform		City of Orlando (Florida)	E-mail
State of Wisconsin (Department of Natural Resources)	Collaboration		Klamath County (Oregon)	Office Productivity
State of Utah (Department of Technology Services)	Cloud Computing Services		Prince George's County (Maryland)	School District E-mail

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Foreign Government Public Sector Cloud Computing

Governments in other countries have adopted cloud computing technologies as well. The government of the United Kingdom has created the “G-cloud,” a government-wide cloud computing network, as a basis for funding a standardized environment for running public services (Glick, 2009). European nations are also implementing IT solutions around cloud computing services in health services, management of government sector housing, transportation service networks, and education services (Wyld, 2010). Japan’s Ministry of Internal Affairs and Communications plans to build a massive cloud-computing infrastructure to support all the government’s IT systems allowing the various ministries to integrate hardware and platforms to promote standardization and consolidation of government’s IT resources (Rosenberg, 2009).

China’s efforts in cloud computing have been organized by local governments and leaders. The government of Wuxi, in order to attract more firms to it’s local economic development project, is working with IBM to build a cloud computing center to provide on-demand computing services. (Wyld, 2010). The Vietnamese government and universities are working with IBM to leverage the cloud computing model to help establish a new department called Service Science Management and Engineering in Hanoi (Nystedt, 2009). The government of Thailand is preparing to set up a private cloud-computing platform in efforts to improve development and implementation of e-commerce applications (Hicks, 2009).

Cloud computing is being implemented in both the commercial and government sectors. Both sectors are taking advantage of using either using a public, private, community or hybrid deployment clouds. While cloud computing is still in the beginning

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stages in the government sector, commercial industry is more established in the use of cloud computing. Unfortunately, the successes of cloud computing in the commercial industry might not translate to success in the government sector. By examining current IS theories, the perceived viability and its relationship to the willingness to implement a new technology can be ascertained.

Current Theories

There are several theories that might be used to test the adoption, implementation and success of information systems (IS) and information technologies (IT). Since the seventies, research has contributed to develop a better of understanding of the causes for low success rates of implementing costly information systems. The Technology Acceptance Model proposes that perceived ease of use and perceived usefulness influence other variables on technology acceptance (Davis, 1989). The DeLone and McLean IS Success Model created a multidimensional measuring model with interdependencies between different success categories (DeLone and McLean, 1992). The Computer Self-Efficacy Theory demonstrated the utility of self-efficacy to understand individual computing behavior (Compeau and Higgins, 1995). The Model of PC Utilization confirms the importance of the expected consequences of using PC Technology (Thompson et al., 1991). Task-Technology Fit states that IT will have a positive impact if the IT capabilities match the task performed by the use (Goodhue, 1998). The Fit-Viability Model proposes that the fit and viability of the technology will increase the performance (Liang, 2007), and the Fit-Appropriation Model, which argues that IS performance is affected by fit and appropriation support (Dennis, et al., 2001).

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These theories have been used to both predict and facilitate the use of IS. Several of these theories are reviewed in the following pages.

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) was written by Fred Davis in 1986 as a Doctoral dissertation and published in 1989 in *Management Information Systems, Quarterly* (MISQ). TAM posits that perceived ease of use and perceived usefulness are of primary relevance in the acceptance of computers and IT (Figure 5). Davis defined "perceived ease of use" as the degree to which an individual believes that it would be effortless to use a particular system. He defined "perceived usefulness" as the degree to which an individual believes that use of a particular system would improve job performance. Thus, TAM posits that, taken together, these two beliefs lead to a behavioral intention to use the target information system and that it is this intention that leads to actual system use. He tested his model and survey scales in both a real-world setting and a lab experiment and found good support for it.

Since then, TAM has been used as a foundation to study many different information systems and technologies. For example, Lederer et al (2000) extended TAM to examine the World Wide Web (WWW). They revealed that the ease of understanding a web site by a user and the ease of finding the web site by a user predicted ease of use while information quality predicted usefulness in a revised web site. In another study, *Viability of TAM in Multimedia Learning Environments: A Comparative Study* (Saade, Nebebe, and Tan, 2007) extended TAM to create a Multimedia Acceptance Model. Their testing determined TAM is a solid theoretical model, which can extend to the

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multimedia-learning environment. These examples show the utility of TAM in predicting users acceptance of a variety of technologies.

As applied to cloud computing, the Technology Acceptance Model predicts that cloud computing services would be accepted as long as a user believed it would be easy to use and would improve their job performance. Some of the benefits of cloud computing, such as flexibility, increased efficiency, cost-reductions and reliability, can affect whole organization. Cloud computing is not directly aimed at improving any particular user's job performance, but a benefit is that it allows the organization to devote more resources to running the business instead of running an in-house IT department. The TAM model focuses on the end-user of a system, whereas cloud computing affects the entire organization. Therefore, this individual-level model is not the appropriate model to use to answer an organization-level research question.

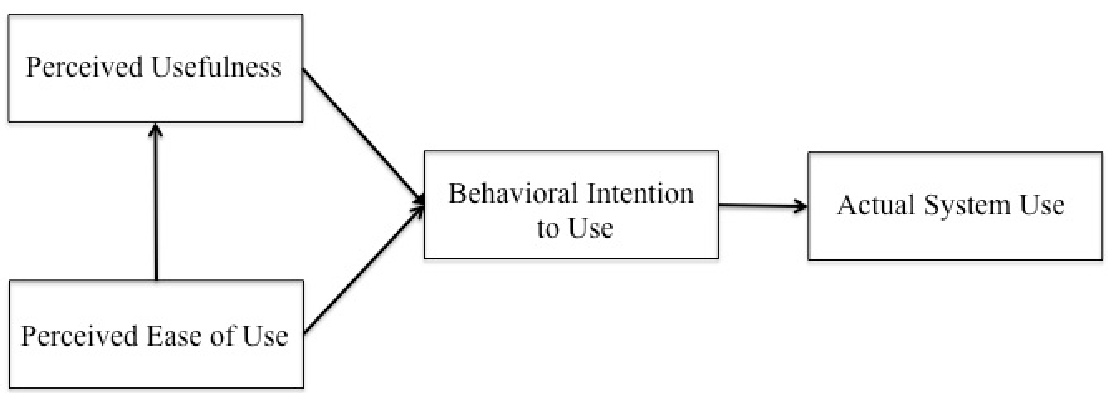

Figure 5. Technology Acceptance Model
Source: Davis (1989), Venkatesh et al. (2003)

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Task Technology Fit (TTF)

While TAM states the perceived usefulness and ease of use are relevant to acceptance of computers and IT, Task Technology Fit (TTF) (Figure 6) can be described as "the extent that technology functionality matches task requirements" (Goodhue, 1995). TTF argues that the use of information technologies can produce different results dependent on the configuration of the technology and the specific task that is used being accomplished. Much like TAM, TTF has been extensively tested.

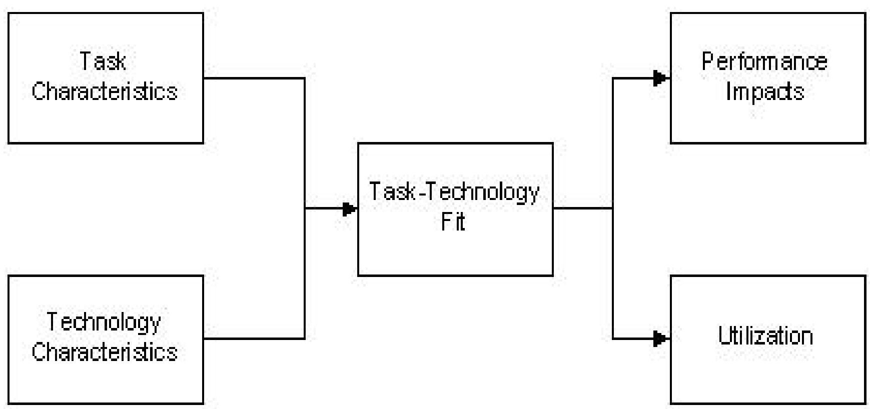

Figure 6. Task-Technology Fit

The Task Technology Fit Theory proposes that when the technology fits the task and user abilities, then performance gains should be expected. Goodhue and Thompson studied TTF and Individual Performance (1995) and their new model asserts that information technology must be used and be a good fit with the tasks that it supports to have a positive impact on individual performance. Zigurs and Buckland (1998) studied TTF and Group Support Systems. Their research showed that an appropriate task/technology fit should result in higher performing groups. They found that fit was

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explicitly defined and linked to group performance. They also found that task complexity is a fundamentally important aspect of task and is relevant in a Group Support System environment.

Fit has been studied at many levels. Task-Technology Fit (Goodhue, 1995 and Goodhue and Thompson, 1995) measure fit at the individual level. Zigurs and Buckland (1998) measure TTF at the group level. TTF has also been measured at the user level in e-tourism, user computer self-efficacy and in knowledge management (Turner et al., 2006). Usoro et al. (2010) combined TTF and TAM to study e-Tourism. They chose TTF since it was reasonable to expect that the consumer will favor e-commerce applications that match their shopping tasks. Another example of examining TTF was by Gebauer, Shaw and Gribbins (2010). They built on previous TTF research and presented a model establishing the fit between managerial tasks, mobile information technology, and the mobile use context, supporting that a good fit positively affects task performance.

Cloud computing provides benefits at the organization level, so expanding TTF to examine if the cloud computing technology would fit with the organizations computing tasks/needs is the next step in examining TTF.

Fit-Viability Model (FVM)

The Fit Viability Model (FVM) expands on the task-technology fit model. Anthony Tijan, founder and executive vice president of a consulting firm, developed the original Fit-Viability Model (FVM) in 2001. Developed from working on more than 100 consulting projects with a wide range of companies that were examining Internet initiatives, Tijan replaced two criteria used in portfolio analysis with business viability

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and business fit. Business viability captured qualitative data about a likely payoff or an investment and fit measured the degree in which the investment matches a company's processes, capabilities, and culture. Taken together, these two constructs were used to predict the eventual performance of a portfolio. With only slight modifications, this model has been used to specifically address the adoption of a new technology.

Liang and Wei (2004) studied the adoption of mobile technology in business. At the time, there were few studies on how organizations decide on adopting new (mobile) technologies and which factors determine the success or failure of adopting this new technology. In the revised FVM (Liang and Wei, 2004; Liang et al., 2007), the Fit-Viability model integrates task-technology fit with the general belief of organizational viability of information technology. According to their model, fit measured the extent to which a feature of a technology matches the needs of the task. Viability measured the extent to which the organizational infrastructure is prepared for adopting the technology (Figure 7).

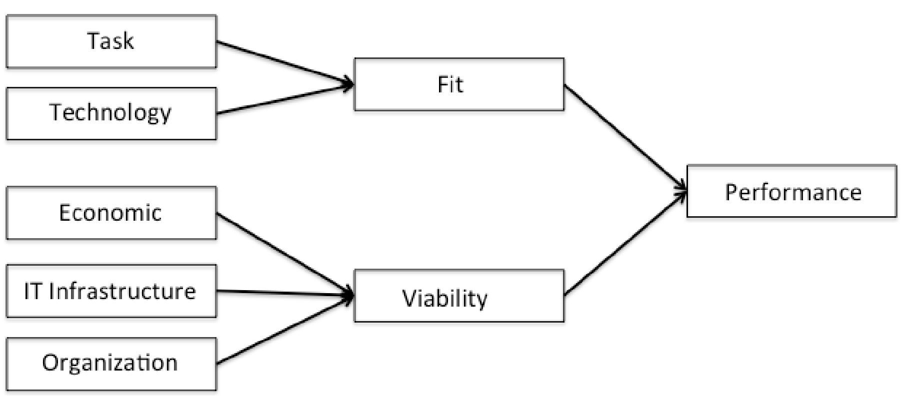

Figure 7. Fit-Viability Model

In FVM, the TTF framework is modified to use more objective assessment of the match between the task and the technology without considering the abilities of the

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individual. In their *Adoption of Mobile Technology in Business* (2007), only the nature of the technology and the requirement of the task were considered for fit. For mobile technology, mobility and reachability were two features for measuring fit. If the requirements of task coincide with these qualities, its fit with mobile technology would be high and higher performance would be expected.

In the FVM, viability was defined as the extent to which the organization is ready for the technology and was posited to be influenced by economic feasibility, technical infrastructure, and the social readiness of the organization (Liang et al, 2007). Economic feasibility was measured by assessing the cost benefit of an IT project to determine whether it can bring financial or intangible returns and determine whether the IT project could bring a competitive advantage. In the Fit-Viability framework (Figure 8), a high viability and high fit would result in the technology being a good target to implement.

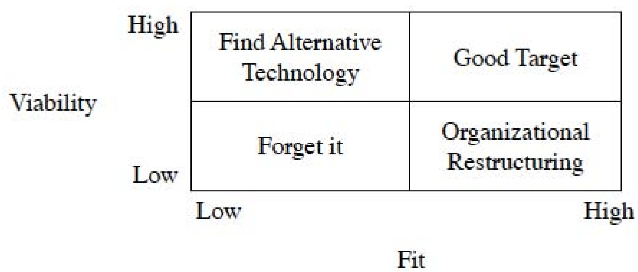

Figure 8. Fit-Viability Framework

In the FVM (Liang et al., 2007), the technical infrastructure was defined as being composed of the IT platform and the information service required for supporting the application. Liang et al., (2007) concluded that the technical infrastructure of an organization includes computing, information management, and the associated

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communication platform. The IT infrastructure provides the basis that supports technological operations and augments business development.

The final factor of viability includes the social readiness of the organization. Liang et al., (2007), state that user satisfaction and system usage are two common criteria for evaluating the success of IS implementation. The organizational factors used in the FVM model include the process reengineering, employee acceptance, and top management support. Liang and colleagues saw the influence of business processing reengineering, user competence and top management support as fundamental influences indicating organizational readiness.

Several theoretical and practical contributions resulted from their study. They concluded that organizations should consider both system fit and viability when considering adoption of a new technology, mobile technology in this case. Previous research focused on either the fit or organizational factors, which were not complete by themselves. The Liang study validated the FVM framework and showed its practical applicability. Using the framework in Figure 8, organizations can determine whether an information technology is fit and viable for the organization, or whether changes need to be made to the organization or the technology.

One limitation of this theory was that it needed to be expanded to other technologies or issues other than mobile technology (Liang et al., 2007). One of the goals of this thesis was to test a new model where fit and viability affect organizational willingness to implement cloud computing.

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Viability-Willingness Model for Cloud Computing

The fit-viability model was adapted to help answer this thesis' second research question. It was specifically adapted to help determine whether a new technology (i.e., cloud computing) is a viable option for implementing in an organization and if the organization is willing to implement the technology. This new Viability-Willingness Model (VWM) posits that the cost of the technology, along with the organizational inertia and the fit of the technology leads to a perception of viability, which in turns leads to a perception of willingness to implement the technology. Cost has both a direct and an indirect relationship with perceptions of willingness. Further definitions and related hypotheses are detailed below (Figure 9).

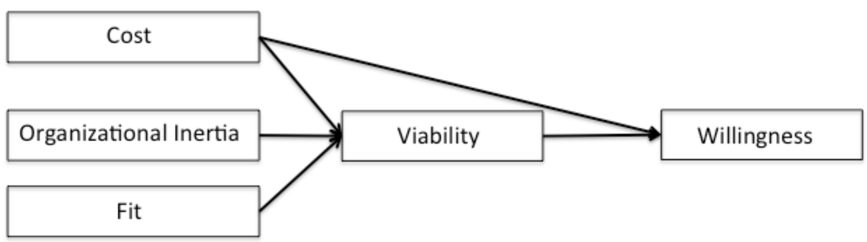

Figure 9. Research Model: Viability-Willingness Model

Cost.

Gartner (2008) states the total cost of ownership (TCO) model includes the cost of hardware installation, software optimization, warranty and any license or maintenance agreements, IT labor and PC support costs, maintaining security assurance and software upgrades. Gartner (2008) also includes cost analysis of mobility requirements; migration costs and planned long-term expenses such as capital expenditures, and lifecycle replacement. The TCO model should act as a framework to help understand major cost

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categories associated with cost-ownership. In addition, cost/benefit analysis must include tangible and intangible costs and benefits including network stability and bandwidth constraints. Cloud computing promises to cut operational and capital costs and let IT departments focus on strategic projects instead of keeping datacenters operational (Velte et al., 2010).

The VWM proposes that if costs of a new technology are perceived to be more than the current technologies, then the perceptions of viability of the new technology would be expected to decrease. Cost, while related to the perceived viability, could also be directly related to the perceived willingness to implement the technology. Perceptions of only a limited cost savings from implementing a new technology would be expected to adversely affect the organization's willingness to adopt that technology. Therefore it is hypothesized that:

H1: Cost is negatively related to the organization's willingness to implement cloud computing in the Department of Defense.

H2: Cost is negatively related to the perceived viability of cloud computing in the Department of Defense.

Organizational Inertia.

Organizational inertial is the degree to which members of the organization have been motivated to learn, use and accept new systems (Seddon, 2010). The unit of analysis chosen for assessing organizational inertia is the organization, not the individual. In older organizations, systems and behavior tend to become institutionalized, acting as a source of organizational inertia, which limits the ability of organizations to adapt

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(Hannan and Freeman, 1977). As organizations age and get better at replicating routine, they also become more inert (Hannan and Freeman, 1984). Hannan and Freeman (1984) also argue that an organizational change creates a liability of newness that exposes organizations to a higher risk of failure.

Change in an older organization creates new roles and new relationships similar to those of a new organization (Brown, 2002). During implementation of the technology and follow-on upgrades, substantial energy is spent on change-management, training, and support to overcome organizational inertia. Each project is different, so organizational inertia is measured for each project (Seddon, 2010). Since cloud computing has different service models, implementing cloud computing is considered one project for this thesis instead of multiple projects encompassing different services. Organizational inertia is important for determining whether the organization is likely to accept change or not. Since inertia limits the ability of the organization to adapt, high organizational inertia would reduce the viability of a new technology. Thus:

H3: Organizational inertia is negatively related to the viability of cloud computing.

Fit.

Drawing from Zigurs and Buckland's (1998) definition of fit, we define fit as the match of the computing platform with the computing needs of the organization. Fit is important to determine whether cloud computing technology is suitable for the organization's computing needs. If the IT staffing personnel do not agree that it is a good fit for the organization, then viability is expected to decrease. Therefore:

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H4: The fit between cloud computing and the organization's computing needs are positively related to viability of cloud computing.

Viability.

Viability is defined as the extent to which the organization is ready to implement new technologies considering the economic feasibility, IT infrastructure, and readiness of the organization (Liang et al., 2007). The viability construct has three influences that determine whether a new technology, cloud computing in this case, is viable for an organization. The total cost of ownership of using or operating the technology determines the economic benefits. The inertia of the organization determines if the organization quickly adapts to new ideas and technologies. Finally, the technology must fit the needs of the organization. Those three forces influence whether a new technology will be viable. Viability is important in determining if the technology is of practical use in the organization and helps determine the willingness to adopt a new technology.

H5: Viability of cloud computing is positively related to the willingness to adopt of cloud computing.

Willingness.

Willingness is defined as being disposed to, inclined toward or openness to something. While there are not many studies in willingness to implement or adopt information systems, there are several conceptual models that discuss willingness. Werner (2004) proposes that a willingness to use telemedicine was affected by the participants' attitudes towards telemedicine, the relationship between the patient and

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physician and the level of anxiety toward technology. Chambers et al. (2003) examined the impact of certain personality types and inclination to use technology. Using the Myers-Briggs Type Indicator and a questionnaire designed to use technology, they found that intuitive/thinking types of personalities were more likely to use technology. Turner, Thomas, and Reinsch (2004) followed communication scholars in predicting that the perceived attributes of a new technology will significantly affect the willingness to try the technology. They argued that task situations (types of medical care in their study) would affect the relative importance of the perceived attributes.

In applying the VWM to cloud computing, the perception of willingness is defined as the openness to implement cloud computing in the organization. The perceived viability of cloud computing and the cost of cloud computing are posited to affect the willingness construct. Perceived willingness is how comfortable or open the organization is to the new technology. Cost is directly and negatively related to perceived willingness since the cost of implementing and using the technology could affect whether the technology is implemented. In addition, viability is positively related to the perceived willingness. If the technology is a viable option for the organization, than there should be an increase in the willingness to implement the technology. Having established the theoretical foundation for this thesis, chapter three discusses how the subsequent research was conducted.

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III. Methodology

The Research Strategy

This thesis examines the appropriateness of cloud computing as an IT model for the DoD. To address the two research questions and test the hypotheses takes two complimentary approaches. The first approach is to compare perceptions of cloud computing between the commercial industry IT personnel and DoD IT personnel. The second approach is to test the theory and relationships in the Viability-Willingness Model for cloud computing in order to examine the relationship between viability and willingness to implement a new technology. The results from these two efforts will provide answers to the research questions.

A survey methodology was selected for both approaches. The survey method was selected since its purpose is to describe attitudes, beliefs, and behaviors and is also a common tool used for testing a certain theory or causal relationships. Surveys are developed to describe the attitudes, beliefs and behaviors of a population (Patten, 2009). Researchers select a sample of the population, study the sample, and then make an inference to the population from the sample data. Surveys can also be quantitative research. That is, results from the survey are easy to quantify which allows for statistical analysis.

Survey Development

This survey was developed specifically to address the viability of cloud computing and the willingness to adopt cloud computing. Throughout the research, it was discovered that there were few studies that addressed cloud computing at the

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organization level. The vast amount of surveys addressed the use or acceptance of a technology that was already implemented. Since such approaches do not specifically meet the needs of this research, a survey was exclusively designed for the VWM. The only construct for which questions were previously validated was the organizational inertia questions. The remainder of the questions was developed to address the constructs in the model and to match a question in the IDC Enterprise panel survey. All questions were tested in a pilot study to verify that they addressed the individual constructs. After editing the questions, the survey was tested one final time before being distributed to the sample.

Survey Structure

All questions that address hypotheses in the model are based on a five-point Likert scale where 1 is represented as the *strongly disagree* or the most negative aspect of the question and 5 represents *strongly agree* or the most positive aspect of the question. The survey is broken down into multiple sections (Appendix B), each section addresses a hypothesis of the model. The sections of the survey are: Cloud Computing, Economic Impact, Organization Information, Reforming Federal Information Technology Management, and Demographics.

The sections relate to hypotheses and have several specific questions that address aspects of each hypothesis. The first part of the survey develops the respondents' knowledge of cloud computing, how well cloud computing aligns with their organization's computing needs, and the issues surrounding cloud computing. The next section, Economic Impact addressed economic aspects of implementing cloud

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computing. The third section of the survey, Organization Information, examines the effect of cloud computing in the organization. The fourth section, Reforming Federal Information Technology Management, analyzes whether organizations are willing to implement cloud computing using different types of service providers. The last section records the demographics of the sample.

Survey Sample

A sample of convenience was used in this study since it was not possible to contact all IT personnel across the Armed Services, the DoD, and the various DoD civilians and contractors. The sample is from a list of IT personnel from the U.S. Army Information Systems Managers Functional Area 53 list hosted by the U.S. Army Military Academy (53Listserve).

Army Information Systems Managers were selected as the primary sample from the DoD IT personnel population. Information Systems Managers are usually trained at Fort Gordon, work in a variety of positions ranging from Automation Staff Officers, who work on computers, networks, and manage information systems to positions in the DoD and Army CIO/G6 that work in policy and procedures. Additionally, other DoD information technology personnel were invited to participate in the survey.

Data Analysis

To determine the appropriate sample size needed to answer the research questions, a power analysis was conducted according to the procedure outlined by Cohen (1992). The power analysis revealed 64 survey responses were required to detect the

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expected medium effect size statistical difference in the sample. Therefore, data collection continued until 83 useable responses were obtained.

To compare the results on the question on the issues of cloud computing between the two surveys, a Z-test is used. A Z-test compares the sample and population means to determine if there is a significant difference between the samples when the sample is large (n>30). The Z-value for the 95% confidence interval is +- 1.960. If the sample returns a test statistic of less than 1.960 then we fail to reject the null hypothesis. If the test statistic is more than +- 1.960, then we reject the null hypothesis since the samples returned are significantly different.

Next, the appropriateness of the Viability-Willingness model was assessed using SmartPLS 2.0. SmartPLS is a structural equation-modeling tool based on Partial Least Squares (PLS). PLS has an advantage over traditional statistical techniques since it is able to concurrently test the measurement and structural models without being covariance based. Additionally, PLS is not constrained to data sets that meet homogeneity and normality requirements (Chin et al., 2003). A significant advantage of PLS is that it can handle smaller sample sizes relative to other structural techniques. These inherent strengths make PLS a highly appropriate approach to analyzing the data set.

Using SmartPLS version 2.0 (Ringle, Wende & Will, 2005), the model was evaluated to assess the measurement model and the structural paths between the constructs. To obtain reliable results and t-values, 200 random samples of 83 were generated using a bootstrap procedure. Finally, the hypotheses were evaluated by assessing the sign and significance of the structural path coefficients using two-tailed t-test statistics. Since SmartPLS does not calculate goodness-of-fit statistics. R^2 values

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were evaluated to assess the ability of various proposed relationships to predict a significant degree of explanatory power in each construct and t-values were evaluated to determine the strength of the various paths (Schuessler, 2009).

Instrument Validation

The validation process started by constructing a PLS model where the individual survey questions were assessed to determine how well they measured their associated construct. First, the internal consistency (reliability) statistics were examined. Reliability tests determine if the set of variables are consistent with the intended item being measured. All reliability measures meet the acceptable lower limits of .70, and one exceeds the lower limit of .60 (see table 2) for a newly defined scale (Hair et al., 2006).

Next, the survey items are assessed for construct validity by performing a factor analysis of each item in the survey and calculating the reliability of the resulting factors. According to Hair et al. (2006), item loadings of .5 or greater represent items of practical significance. After removing any items that that fail reach .5 on any factor, it was determined if the items for each construct loaded higher on their own construct than on other constructs. All survey items loaded above the threshold (see table 3) and were kept for the remaining analysis.

Finally, determining discriminant validity requires testing the average variance shared between a construct and its measures (AVE) (Gefen et al., 2000). The average variance shared between the constructs and their measures should be greater than the benchmark of .5 (Fornell and Larcker, 1981) and greater than the corresponding correlations between constructs themselves (see table 4). The matrix supports the

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discriminant validity of our scales in that the elements in the matrix diagonal are higher than .5 in all cases, and higher than the off-diagonal correlations between the elements in their corresponding row and column. Therefore, the variables and the constructs pass the tests for reliability and validity as noted in chapter 4.

Chapter Summary

This chapter outlined the methodology of this research demonstrating one way to analyze survey samples. By adapting the FVM to a Viability-Willingness model, we are attempting to determine the perceived viability and the perceived willingness to implement cloud computing in the Department of Defense.

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IV. Analysis and Discussion

Chapter Overview

This chapter presents the results from the survey and the tests of the model proposed in Chapter 2. First, the results from the cloud computing survey of DoD IT personnel are compared with the survey results from the International Data Corporation Enterprise Panel, 2009 Survey on Cloud Services. Since government and commercial industries have different customers, stakeholders, and goals driven by the nature of the two industries, a comparison of the question regarding the issues associated with cloud computing is used. The second part of this chapter presents the results of the analysis of the Viability-Willingness Model using SmartPLS.

Comparative Analysis: Commercial and government sectors

International Data Corporation conducted a survey of its commercial enterprise panel in 2009 on the top challenges and issues of cloud computing. Two-hundred sixty-three IT executives/CIOs and their line-of-business colleagues completed the survey about their companies' use of, and views about, IT Cloud Services. As part of the survey, the respondents were asked to rate the challenges/issues ascribed to the cloud/on-demand model (Figure 10). The Y-axis is the concerns with cloud computing, while the X-axis is the number of personnel that stated the concern was significant. The survey used a 5-point Likert scale ranging from 1=Not Significant/Concerned to 5=Very Significant/Concerned.

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The top three issues for the commercial industry as noted from the IDC survey were security, availability, and performance (Figure 10). These issues were also rated as the most significant in 2008. IDC explains this as a call for better service level assurance. The number four issue in the survey was a concern that cloud computing might cost more than current computing models. This perception seems to contradict what proponents of the cloud model tout, which is that implementing cloud computing leads to cost savings (Kundra, 2010). The issue of bringing the data or services back in house was rated as the fifth most important. That is, the survey respondents were concerned that if the cloud computing model did not work, it would be more difficult to move the services back under the organization's control. The last two issues that the survey members stated were an issue was the ability to integrate with in-house services and the ability to customize the service to what is needed. These are important since they both convey the amount of organizational control over their data and services.

The IDC Enterprise panel survey from 2009 shows that there are still major concerns about cloud computing. While it was expected to find that security, performance and availability were issues with a majority of the respondents; on-demand costs and the ability to bring the services back in house were not. There is still uncertainty about the overall cost of cloud computing and whether it will be a success as a computing platform for organizations.

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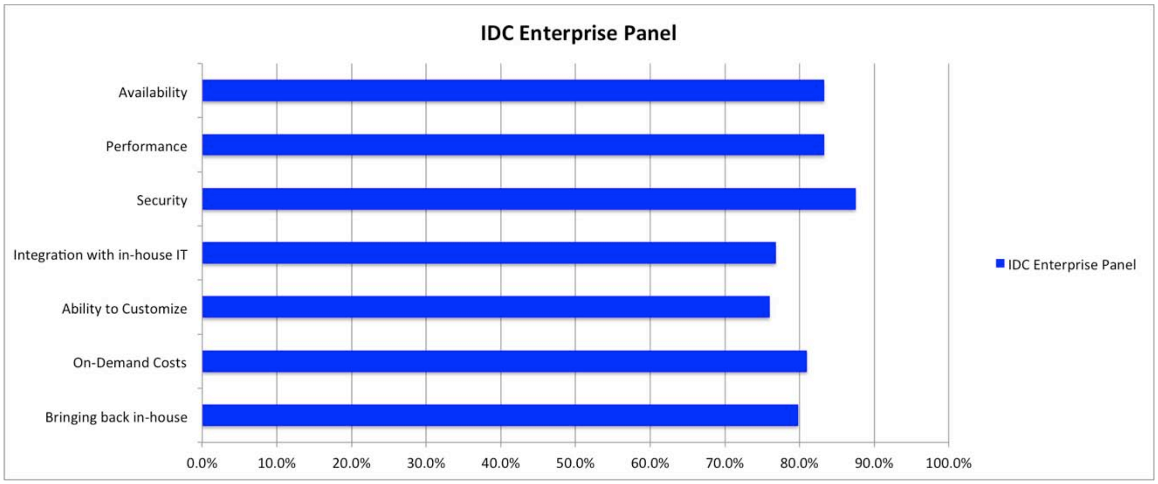

Figure 10. IDC Commercial Enterprise Panel 3Q09 Survey Results

For comparison to the IDC Commercial Enterprise Panel survey, the 2010-2011 cloud computing in the military survey done in this research sampled DoD IT personnel (n=83) on the same issues of cloud computing. On the military IT survey, the respondents rated the challenges/issues ascribed to the cloud/on-demand model (Figure 11). The Y-axis is the concerns with cloud computing, while the X-axis is the number of personnel that stated the concern was significant. Both surveys used a 5-point Likert scale ranging from 1=Not Significant to 5=Extremely Significant. Following the IDC's method, the results were taken from the respondents that selected 3, 4, or 5 and measured in percentages. For an accurate comparison of commercial and government industries, scales and questions were maintained for data integrity.

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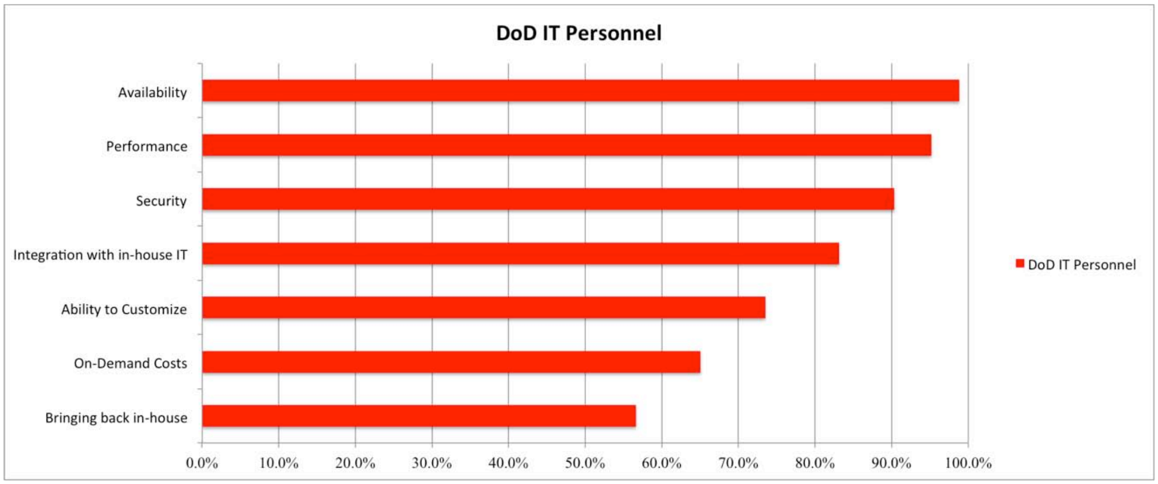

Figure 11. Military IT Personnel Survey Results

A comparison of the results of the question of rate the challenges/issues ascribed to the cloud/on-demand model shows similarities and differences between the two samples (Figure 12). The results are taken, and measured in percentage of the respondents that selected 3, 4, or 5.

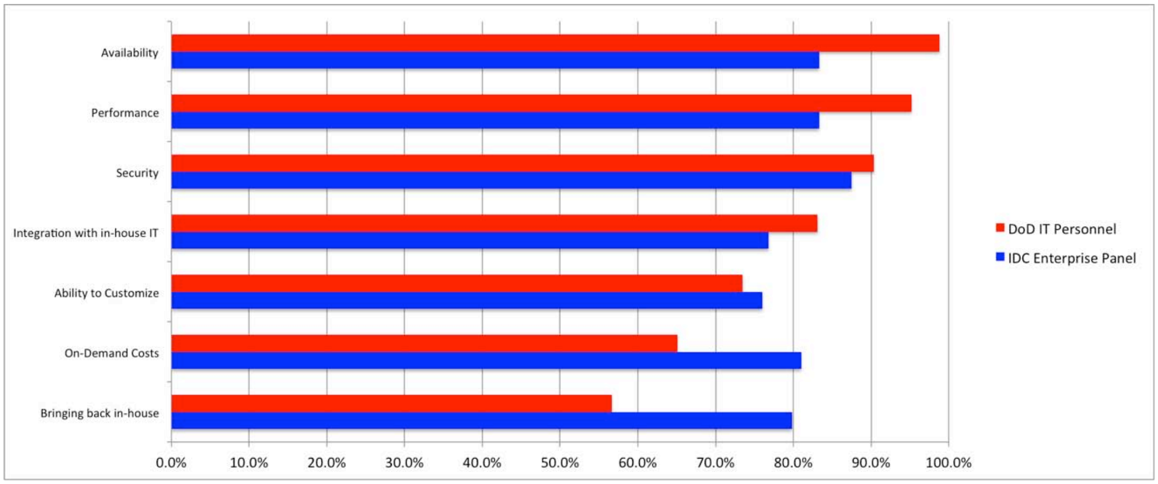

Figure 12. Comparison of Survey Results

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Availability.

Availability is the first issue compared between the two surveys. Availability is the state of being able to ensure users can use any information resource when ever and whenever it is needed. There is a significant difference ($Z = 3.464$) between the numbers of military IT personnel (98.8%) that rated Availability as a significant issue compared to the number of IDC Enterprise personnel (82.9%). Availability depends on the accessibility of the data, the system, the applications and the infrastructure used to access that data. The loss of availability is critical if there is a serious incident, network failure, or natural disaster. The difference between the two surveys for availability is significant. For the military IT personnel, the availability of the data and services could be critical to the completion of mission in a combat zone. For example, the Army mission is to provide to combatant commanders the forces and capabilities necessary to execute the National Security, National Defense, and National Military Strategies. The Army's Signal Corps supports this mission by providing and managing communications and information systems support for the command and control of combined arms forces. The lack of availability of the network, data, or information systems could affect the mission. The commercial industry does not have the same mission as the Department of Defense. Where loss of availability would impact the commercial organization in terms of time and profit, it might not affect National Security, which would be a reason for the significant difference in the number of personnel that annotated availability as a significant concern.

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Performance.

The next issue selected as significant was performance. Cloud computing performance can either be client-oriented or cloud-oriented (Linthicum, 2010). Client-oriented performance is where users constantly interact with the cloud provider where there is latency with the constant back-end machine-to-machine communications that occurs between the SaaS provider and the browser. Cloud-oriented performance is where the processing occurs in the "cloud" and is compared to the performance of completing the processing on-premise. There is a significant difference (Z = 2.553) between the numbers of military IT personnel (95.2%) that rated Performance as a significant issue compared to the number of IDC Enterprise personnel (83.3%). While it was not defined as whether performance was client-oriented or cloud-oriented performance, more military IT personnel thought performance was an issue. Client oriented performance issues may not be as noticeable in terms of latency unless there is network saturation (Linthicum, 2010). Whereas cloud-oriented performance can be an advantage, performing large amounts of processor intensive calculations or queries can take many hours on the local network. The scalable nature of the cloud allows additional processors to be quickly added resulting in calculation or queries taking minutes to complete. Commercial industry has more experience with cloud computing and a lower number of the IDC Enterprise panel survey respondents stated that performance is an issue. For DoD IT personnel, latency on a bandwidth constricted tactical network is not acceptable and therefore more survey respondents would rate this as an issue.

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Security.

While respondents from both surveys feel that security is a significant issue in itself, there was no difference (Z = 0.537) between the numbers of DoD IT personnel (90.4%) and the IDC Enterprise sample (87.5%). While security was not explicitly defined in either survey, as stated in chapter 2, FISMA defines three security objectives for information and information systems that serve as the basis for NIST's analysis: Confidentiality, Integrity, and Availability. In both surveys, the respondents thought security was a significant issue. Security of the cloud service, whether protecting mission essential data or services for the military or protecting the security of the customers' data and information for the commercial sector, is important for their organization. Losing the security of data or information in the cloud for government or commercial industries can have severe consequences. The security of the cloud may provide a roadblock on its implementation.

Integrate with in-house IT.

The ability to integrate cloud computing offerings and services with in-house IT is the next issue compared between the two surveys. There is not a significant difference (Z = 1.009) between the numbers of military IT personnel (83.1%) that rated the ability to integrate with in-house IT as a significant issue compared to the IDC Enterprise personnel (76.8%). Organizations that use cloud computing want to maximize the control of their business core systems, which can be in-house legacy systems and integrate these systems across externally sourced cloud services (Gens, 2008).

Both government and commercial industry can feel this integration between in-house and cloud computing systems is more of an issue. The military has a large number

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of program-managed systems that perform specific functions. For example, the Army uses a number or Army Battlefield Command Systems (ABCS) that provide specific services for the commander and integration with these systems might prove to be difficult. In the commercial industry, an organization's inventory management systems could be core business systems that is proprietary and could be difficult to integrate with cloud services. In both cases, these systems could be more difficult to integrate with other systems that use cloud services.

Ability to customize services.

Next, the number of personnel stating that the ability to customize software and applications is a significant issue is compared between the two surveys. There was no difference (Z = 0.223) between the numbers of military IT personnel (73.5%) that rated the ability to customize services as a significant issue compared to the IDC Enterprise personnel (76.0%). One of the advantages of cloud computing is the ability to quickly customize software, platforms and cloud infrastructures. Organizations want to customize "off-the-shelf" cloud services and tailor these services to the needs of their businesses (Gens, 2008). It is plausible that the need for better fitting services drove a large number of respondents in both surveys to report customization as an issue with cloud computing.

On-demand costs.

On-demand cost is the next issue in the survey. On-demand costs are costs incurred when using cloud computing in the organization. There is a significant difference (Z = 2.878) between the numbers of military IT personnel (65.1%) that rated On-demand costs as a significant issue compared to the IDC Enterprise sample (81.0%).

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The on-demand cost issue may seem to contradict the reason for moving to a cloud computing technology, given that cost savings are purported to be a benefit. One reason behind this discrepancy is organizations fear that employees may use the service more than what is budgeted. Commercial industry is conscious of what they spend and of their profits, where the government sector does not necessarily see the bottom line, but they work within budgets. The difference in the number of respondents stating on-demand costs is an issue between the two samples is expected. The commercial industry has more experience in implementing cloud computing, therefore they may see on-demand costs exceed their initial expectations whereas the government sector is just beginning to implement cloud services. Cloud computing can allow their organization to save money on infrastructure (Del Nibletto, 2010), IT staffing and maintenance costs (Kundra, 2010). If on-demand costs start to exceed the previous budget for the same type of services, then the cloud computing service model would become an issue.

Bringing IT services back in-house.

Bringing IT services back in-house is the last issue compared between the two surveys. There is a significant difference (Z = 4.202) between the numbers of military IT personnel (56.6%) that rated bringing IT services back in-house as a significant issue compared to the IDC Enterprise personnel (79.8%). Organizations wonder whether using cloud services will lead to the same type of proprietary services that are dealt with today. Proprietary services and software make it difficult to move services back in-house if they are not satisfied with the cloud (Gens, 2009). Military IT personnel either do not think they will move to cloud computing or only move limited services to the cloud and leave

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core processes in-house. Therefore, there would be less military IT personnel that thought this was an issue compared to their civilian counterparts.

Summary.

The comparative analysis of the IDC Enterprise panel 2009 IT Cloud Services Survey and the 2010-2011 military IT personnel cloud computing in the military survey had interesting results. More military IT personnel cited availability, performance and in-house integration as significant issues than did personnel on the IDC Enterprise panel. There was also a significant difference between the number of IDC Enterprise panel personnel citing on-demand costs and bringing the IT services back in-house as concerns than the number of personnel in the military IT survey. Cost may be expected to be more important to commercial industry than the government sector, but cloud computing costs are supposed to be lower than current computing methods and technologies. Conversely, there was no difference in the number of respondents that rated security as a significant issue, nor was there a difference in the number of respondents who saw the ability to customize software as a major issue. Interestingly, stating that on-demand costs are a significant issue goes against the reasons for implementing cloud computing. Bringing services back in-house could be an issue if the cloud computing model does not work. Since more than 79% of the commercial industry survey respondents rate this as an issue, it could mean there is a lack of confidence in the long term viability of the cloud computing model.

The survey comparison looked at the issues and concerns with cloud computing. These issues are part of the viability of cloud computing. The needs of the organization are considered when determining if the new information technology, or cloud computing,

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is a viable technology. As noted above, there are ideas in the military about cloud computing, which directly affect the perceived viability and perceived willingness to implement the technology.

The remainder of the data in the military IT cloud computing survey was used to examine the perceived viability and its relationship with the willingness of IT personnel to implement cloud computing in the military. The following section examines the relationship between the perceived system viability and perceived willingness to implement cloud computing.

Discriminant Validity and Reliability

The Viability-Willingness Model for cloud computing looks at the relationship between the perceived viability and perceived willingness. In the VWM, perceived viability is directly determined by cost, organizational inertia and fit. Viability and cost determine organizational willingness to implement. To test the model and its constructs, the validity and reliability must first be tested.

Discriminant validity and reliability of the constructs were tested using Conbach's Alpha, as recommended by Hair et al. (2006). Reliability tests determine if the set of variables are consistent with the intended item being measured. The internal consistency (reliability) statistics using PLS results were: .691 for Fit; .845 for Inertia; .785 for Viability; and .904 for Willingness (Table 2). The reliability thresholds for Inertia, Viability and Willingness meet the acceptable lower limits of .70, while Fit exceeds the lower limit of .60 for a newly defined scale (Hair et al., 2006).

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Table 2. Reliability Statistics

	Cronbach's Alpha
Fit	0.691957
Inertia	0.845359
Viability	0.785395
Willingness	0.904545

Next, the convergent validity was determined by examining whether all items loaded highly on their respective construct on PLS. A common rule of thumb is a loading greater than .70 (Yoo and Alavi, 2001). In the Viability-Willingness Model, all items loaded on their respective constructs from .783 to .899 (Table 3). All values lower than .40 were removed for easier interpretation.

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Table 3. Convergent Validity

	Cost	Fit	Inertia	Viability	Willingness
COST1	1				
FIT1		0.852295			
FIT2		0.894746			
INERTIA1r			0.827469		
INERTIA2r			0.858527		
INERTIA3r			0.811124		
INERTIA4r			0.783988		
VIABILITY1				0.804765	
VIABILITY2				0.871319	
VIABILITY3				0.829887	
WILL1					0.867694
WILL2					0.876659
WILL3					0.899804
WILL4					0.882597

In the cost construct, COST2 and COST3 did not load on the Cost construct and were removed from the model. Additionally FIT3, FIT4, FIT5, FIT6, WILL5, WILL6, WILL7, and WILL8 did not load on adequately on their construct and were therefore removed from the model.

Determining discriminant validity requires testing the average variance shared between a construct and its measures (AVE) (Gefen et al., 2000). Table 4 presents the AVE matrices and construct correlations for the model. The matrix supports the discriminant validity of our scales in that the elements in the matrix diagonal (AVE results are bold) are higher in all cases than the off-diagonal elements in their corresponding row and column. Each construct AVE should be higher than the benchmark of .60 as recommended by Fornell and Larcker (1981). In addition, the AVE

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must be larger than its correlation with other construct, and each time should load more highly on its assigned construct than other constructs (Gefen, 2000).

Table 4. Discriminant Validity

	Cost	Fit	Inertia	Viability	Willingness
Cost	**1**				
Fit	-0.264952	**0.7634**			
Inertia	-0.175177	0.150387	**0.6735**		
Viability	-0.289511	0.601101	-0.208698	**0.6985**	
Willingness	-0.264672	0.396132	-0.02597	0.495498	**0.7775**

Results

After assessing discriminant reliability and validity, the model is then processed using SmartPLS. The results are depicted in Figure 13. All hypothesized relationships except for one were supported. Path significance was estimated using a bootstrapping procedure with 200 resamples, which tends to provide reasonable standard error estimates (Mathieson, et al., 2001; Ravichandran and Rai, 2000). There was not a significant direct affect of Cost on Willingness (-0.132 n.s.), which means that cost was not directly related to Willingness (H1). There was a significant direct effect of Cost on Viability (-0.188*), which supported H2: Cost is negatively related to Viability. Hypothesis 3 theorized that Inertia is negatively related to and has a direct effect on Viability. PLS showed that Inertia had a significant affect Viability (0-0.332*), supporting H3. H4 hypothesized that Fit would be positively related to Viability. H4 was supported in that Fit had a significant direct affect on Viability (0.601*). Lastly, H5 stated that Viability was positively related to Willingness. Viability had a significant direct affect on Willingness (0.457*) and therefore supported H5.

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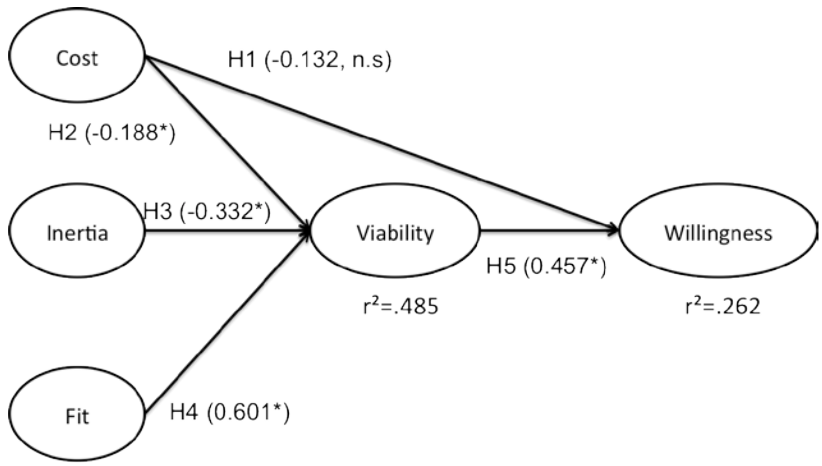

Figure 13. Viability-Willingness Model Structural Results

The Viability-Willingness Model explained 48.5% of the variance for viability perceptions and 26.2% of the variance for the perceived willingness to implement cloud computing. The model measures whether cost, inertia, and fit are significant predictors of viability. Viability of cloud computing is partially formed by cost, organizational inertia and the fit of the technology with the needs of the organization. Willingness is only partially predicted by the viability of cloud computing. Performance, availability and security might be significant factors in predicting viability since over 90% of military IT personnel respondents cited those issues as significant.

The other, unmeasured, perceived attributes of cloud computing could also have a direct affect on the perceived willingness to implement it. While viability contributed to 26% of the variance explained, the attitude towards cloud computing might be more of a factor than whether the technology is viable for the organization. All questions on the issues of cloud computing were selected by more than 50% of the respondents in the

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military IT cloud computing survey as being significant. The perception that cloud computing has multiple significant issues reduces the willingness to implement the technology. Therefore, just because cloud computing is viable for an organization does not mean there is going to be a willingness towards implementation; nonetheless it is a major factor.

Chapter Summary

The collected data from the 2010-2011 Cloud Computing in the Military survey suggests that cost, inertia, and fit were significant in predicting viability; additional modifications to the survey instrument would increase the explained variance at the cost of the parsimony of the instrument. This modification would also increase variance explained in willingness, although adjusting the survey to include personality and attitude might also significantly increase the perceived willingness.

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V. Conclusions and Recommendations

Chapter Overview

This chapter reviews the two research questions and presents the conclusion of this study. Sections discussing research limitations, follow-on research, and recommendations for future research follow this section. In the general conclusion, the benefits of this research are highlighted.

Research questions and Conclusions

This research was an exploratory examination of the opinions military IT personnel of cloud computing in the in the Department of Defense and the Army. Its research was motivated by desire to understand two overall research questions:

(1) Is cloud computing perceived as a viable technology in the DoD/Army?

(2) Is there a perceived willingness to implement cloud computing in the DoD/Army?

The research provided an understanding whether military IT personnel perceive cloud computing as a viable technology for their organization as well as the connection between the perceived viability of new technologies and the willingness of IT personnel to implement them.

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A Difference Between Government and Commercial Industry.

A comparative analysis between IDC Enterprise Panel personnel and military IT personnel demonstrated several differences between commercial and government sectors. Availability, performance, and integration with in-house IT were identified by a higher percentage of military IT personnel as significant issues than the IDC Enterprise panel. Security and the ability to customize had the same significance between the two groups, while the IDC Enterprise panel rated on-demand costs and bringing the IT services back in house as more of an issue than did military IT personnel. The military IT personnel appear more worried about availability, performance and integrating with in-house IT systems and less concerned with cloud computing costs and the ability to bring services back in-house at a later date.

Perceived Viability of Cloud Computing.

The Viability-Willingness Model was an exploratory model designed to understand the interaction of the perceived viability of cloud computing and the willingness to use it. While the model measured 48.5% of the variance in the viability of cloud computing, there are other factors discovered in the survey that might also predict the viability of cloud computing. The VWM demonstrated that cost, inertia and fit play a role in the determining the viability of cloud computing.

Perceived Willingness to Implement Cloud Computing.

Perceived willingness to implement cloud computing can be more of an attitude towards cloud computing. The VWM examined viability and cost as measures that

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would have a direct affect on the perceived willingness to implement. The variance explained was 26.2%, which indicates other measures would also have a direct affect on the perceived willingness. Other measures that could affect the willingness to implement cloud computing include personality traits (Chambers et al., 2003), attitudes towards the technology (Werner, 2004), and actual task situations that would affect the relative importance of the perceived attributes of the technology (Turner, Thomas, and Reinsch, 2004). Successful implementation of a new technology (cloud computing) could partially depend on the willingness to make the changes necessary to make the technology work.

Limitations

There are several limitations to this research. The sample size (n=83) was large enough to perform the needed analysis. However, a larger sample might allow for additional statistically robust analysis, which may lead to an increased accuracy of the inferences about the population, and refined detection of effects in the model. A broader sample will expand the available tools used for analysis to include covariance-based analysis. Expanding the sample demographic to include additional IT personnel more evenly across the Department of Defense and the Federal government would allow for additional analysis. By increasing the sample frame to include every member of the DoD IT community from which the sample is taken increases the randomness of the survey and reduces any biases in the sample.

The survey instrument had limitations. As an exploratory study, some items did not initially load properly and therefore were not included in the analysis. This might

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have occurred due to a misunderstanding of words in the question or the question itself. It can also happen if the questions of the survey measured something other than the intent of the construct. One set of questions was previously validated and two others loaded properly on their respective constructs. Using previously validated questions or survey instrument can lead to an increase of rigor, an increase of data quality and prevent inaccurate conclusions. The wrong instrument of questions could increase the error in the model and analysis.

Recommendations for Future Research

This research provided a starting point on determining the perceived viability and perceived willingness to implement cloud computing in the military. Follow on research should include increasing the sample frame and sample size to further validate this study. Other areas for research should include perception differences among armed services, different IT skill sets, and duty positions. Furthermore, additional research into the top issues of cloud computing would be valuable in determining why those issues are thought to be so significant. Additional research is also needed to clarify the relationship between viability and willingness. This research highlighted that a technology can be a viable in the organization, yet the organization still won't implement it. Additional research should be conducted on why an organization is not willing to implement a technology it sees as viable. Further analysis is also needed on the difference between government and commercial industry and the possible implications of implementing a new information technology.

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The VWM can be refined through additional research to increase the variance determined in viability and willingness. A redesign of the cost construct by adding more dimensions would help to see if a multidimensional construct plays a greater role in the viability and willingness to implement a new technology. There may be specific parts of the cost of implementation that affect viability and willingness differently. The willingness construct should be examined for the influence of personality characteristics, attitudes toward the new technology and possibly positive and negative affect. A more in-depth study examining the perceptions of the different types of deployment cloud models would provide the framework that organizations could use in examining the viability and willingness to implement the latest technology trends.

Conclusion

Overall, findings suggest that cloud computing may be a viable option for the Department of Defense, but willingness to implement cloud computing is not the same as viability. This research indicates that simply because a technology has the potential to improve an organization, it still may not be implemented. This thesis defined criteria for measuring the viability and willingness to implement cloud computing. Viability was affected by cost, organization inertia, and the fit of the technology with the organization. Willingness was partially determined by viability perceptions, which supports previous research that organizational attitude toward the technology also affects the willingness to implement a new technology.

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Today, the federal government is concentrated on reducing the budget deficit, while completing the same missions and functions at a reduced cost. Whether it is freezing pay wages, reducing work force, reengineering business processes or improving efficiencies, technology can be used as an enabler for working smarter and more efficiently. There are several areas discussed in the thesis that demonstrated the ability to use cloud computing to support non-core business functions. Different commercial industries use cloud computing differently. The DoD can learn from other government agencies and commercial industries in ways to use cloud computing to reduce costs, either through reduced hardware purchases, reorganization of personnel and jobs, or by shifting non-mission essential processes to a cloud provider which would reduce personnel needed to perform those functions. This research showed that just because cloud computing is a viable alternative to the current desktop computing platform, the organization might have a perception that cloud computing would not work. This perception could hinder how quickly cloud computing is accepted in the DoD.

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Appendix A: SRB Information

DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE OF TECHNOLOGY
WRIGHT-PATTERSON AIR FORCE BASE OHIO

17 Nov 2010

MEMORANDUM FOR DR. MICHAEL GRIMAILA

FROM: Alan Heminger, Ph.D.
AFIT IRB Research Reviewer
2950 Hobson Way
Wright-Patterson AFB, OH 45433-7765

SUBJECT: Approval for exemption request from human experimentation requirements (32 CFR 219, DoDD 3216.2 and AFI 40-402) for study titled "Fit-viability of Cloud Computing in the Department of Defense"

1. Your request was based on the Code of Federal Regulations, title 32, part 219, section 101, paragraph (b) (2) Research activities that involve the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior unless: (i) Information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) Any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

2. Your study qualifies for this exemption because you are not collecting sensitive data, which could reasonably damage the subjects' financial standing, employability, or reputation. Further, the demographic data you are collecting cannot realistically be expected to map a given response to a specific subject.

3. This determination pertains only to the Federal, Department of Defense, and Air Force regulations that govern the use of human subjects in research. Further, if a subject's future response reasonably places them at risk of criminal or civil liability or is damaging to their financial standing, employability, or reputation, you are required to file an adverse event report with this office immediately.

ALAN HEMINGER, PH.D.
AFIT Research Reviewer

cc: Capt. Michael Killaly
Co-investigator
Judith Copler, Contractor
AFIT Sponsored Programs Office

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Appendix B: Survey Instrument

AFIT survey
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Fit-viability of Cloud Computing in the DoD

Survey meets criteria for exclusion for a SCN under 32 CFR 219, DoDD 3216.2, and AFI 40-402

Privacy Notice

The following information is provided as required by the Privacy Act of 1974:

Purpose: The purpose of this survey is to gain a better understanding on the perception of implementing Cloud Computing and Thin Client Computing in the Department of Defense. The survey is designed to target members of the Information Technology community in the Department of Defense and the U.S. Army Information Systems Managers.

This survey is intended to gather opinions of the Information Technology community regarding the appropriateness and viability of cloud computing and thin client computing. Participation is highly encouraged since your opinion is important. We will only use the statistical results for our research, so your responses are completely anonymous. The survey has 30 questions and should take 10-15 minutes

There are also three sets questions addressing the 25 Point Implementation Plan to Reform Federal Information Technology Management that was released on 9 December 2010.

Participation: We would greatly appreciate your participation in our data collection effort. Your participation is **COMPLETELY VOLUNTARY**. Your decision to not participate or to withdrawal from participation will not jeopardize your relationship with the Air Force Institute of Technology, the U.S. Air Force, or the Department of Defense.

Confidentiality: We ask for some demographic information in order to interpret results more accurately. Only summarized, statistically evaluated and completely anonymous data will be used for publishing purposes. Each participant will have an opportunity to receive the processed results.

Instructions

- Base your answers on your own thoughts & experiences
- Please make your answers clear and concise when asked to answer in a response or when providing comments
- Be sure to select the correct option button when asked

Contact information:

If you have any questions or comments about the survey, contact **CPT Michael Killaly** at the number, fax, mailing address, or e-mail address listed below.

AFIT/ENV BLDG 640 / Room 104A
2950 Hobson Way
Wright-Patterson AFB, OH 45433-7765
Email: Michael.Killaly@afit.edu
Advisor: xxxxxxxx.xxxxxxx@ afit.edu
Phone: DSN 785-3636x7395, commercial (937) 255-3636x7395
Fax: DSN 986-4699; commercial (937) 656-4699

Please enter your email address below: (The email address is used to create a unique ID to ensure data integrity)

*** Email Address:**		
Do you want statistical results from this survey?	**Yes** ○	**No** ○

Start Survey

13% complete

NOTICE & CONSENT BANNER:
Use of this DoD computer system, authorized or unauthorized, constitutes consent to monitoring of this system. Unauthorized use may subject you to criminal prosecution. Evidence of unauthorized use collected during monitoring may be used for administrative, criminal, or other adverse action. Use of this system constitutes consent to monitoring for these purposes.

Read the **Privacy and Security Notice**

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AFIT survey
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Section I: Cloud Computing

	Cloud Computing	Not at all knowledgeable	Not Very Knowledgeable	Fairly Knowledgeable	Very Knowledgeable	Highly Knowledgeable
		1	2	3	4	5
1	How knowledgeable do you consider yourself when it comes to cloud computing?					

	How do the following tasks align with cloud computing in a deployed environment?	Not at all align	Slightly not align	Neutral	Slightly align	Closely align
		1	2	3	4	5
2	Accessing mission critical data or services					
3	Performing Disaster Recovery/Continuity of Operations tasks					

	How do the following tasks align with cloud computing in a garrison environment?	Not at all align	Slightly not align	Neutral	Slightly align	Closely align
		1	2	3	4	5
4	Accessing mission essential data or services					
5	Performing Disaster Recovery/Continuity of Operations tasks					

	How much do you agree with each of the following?	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
		1	2	3	4	5
6	My organization's computing task requirements closely align with cloud services on a private cloud					
7	Current applications can be easily adapted to the cloud					

	Cloud Computing Term	Short Term	Maybe Short Term	Not Sure	Maybe Long Term	Long Term
		1	2	3	4	5
8	Do you see cloud computing as a short-term fad or a long-term shift in computing technology?					

	Rate the Challenges/Issues ascribed to the cloud/on-demand model?	Not significant	somewhat significant	significant	very significant	Extremely Significant
		1	2	3	4	5
9	Security					
10	Performance					
11	Availability					
12	Integration with in-house IT					
13	Ability to customize					
14	On-demand costs					
15	Bringing back in-house					
16	Prohibitive Regulatory requirements					
17	Number of vendors currently available					

Continue

38% complete

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Section II: Economic Impact

	Total Cost of Ownership (TCO)	Less Expensive	Slightly Less Expensive	About the same	slightly more expensive	More expensive
		1	2	3	4	5
18	Compared to desktop computing, the Total Cost of Ownership (TCO) of cloud computing is:	○	○	○	○	○

	Additional IT support staff training	Not Important	Somewhat Important	Important	Very Important	Extremely Important
		1	2	3	4	5
19	How important is additional IT support staff training to implementing cloud computing?	○	○	○	○	○

	IT Staff reorganization	No reorganization is needed	little reorganization	not sure	Some reorganization	A great deal of reorganization
		1	2	3	4	5
20	How much IT Staff reorganization is needed with the adoption of cloud computing?	○	○	○	○	○

	How well do you agree with the following statement?	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
		1	2	3	4	5
21	The cost advantages of cloud computing outweigh the potential disadvantages	○	○	○	○	○

Continue

50% complete

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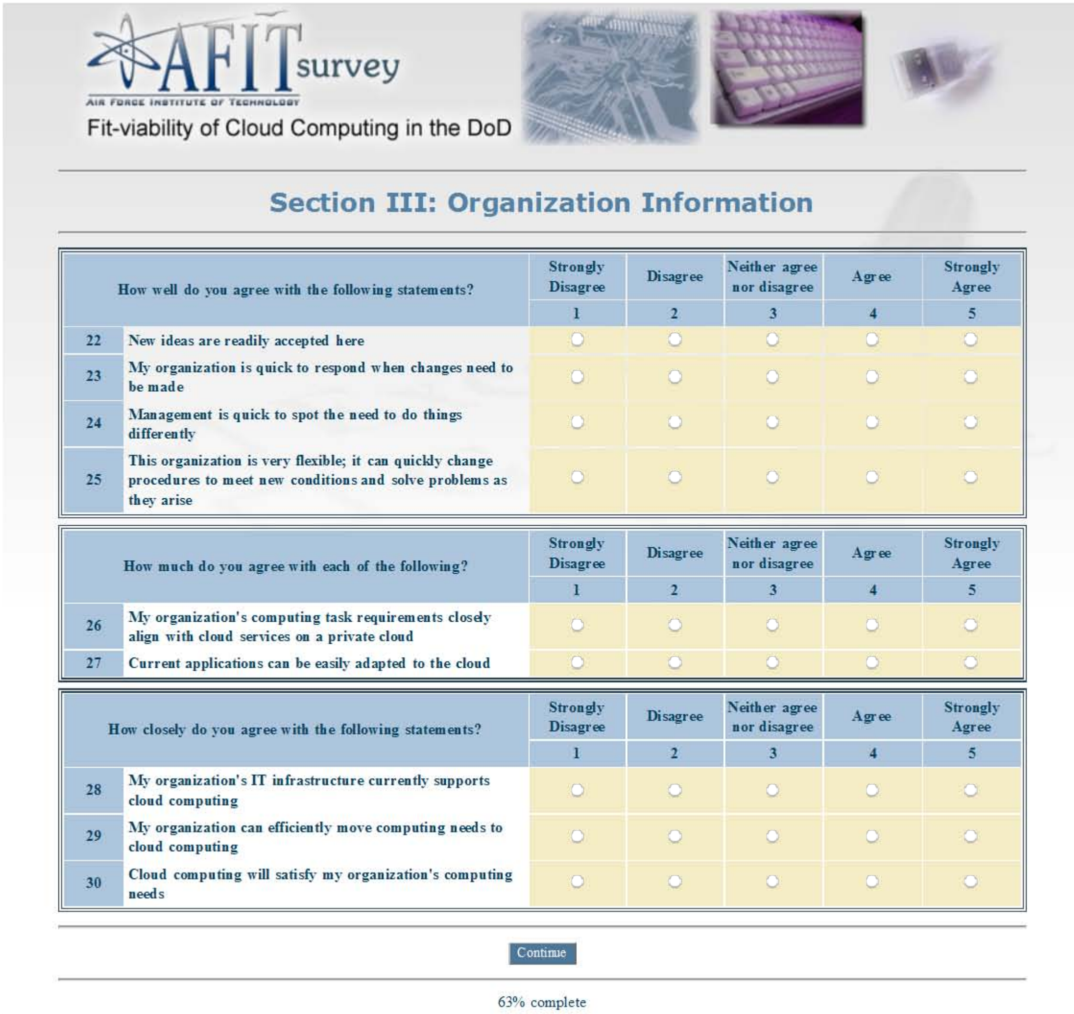

AFIT survey

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Fit-viability of Cloud Computing in the DoD

Section III: Organization Information

	How well do you agree with the following statements?	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
		1	2	3	4	5
22	New ideas are readily accepted here	○	○	○	○	○
23	My organization is quick to respond when changes need to be made	○	○	○	○	○
24	Management is quick to spot the need to do things differently	○	○	○	○	○
25	This organization is very flexible; it can quickly change procedures to meet new conditions and solve problems as they arise	○	○	○	○	○

	How much do you agree with each of the following?	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
		1	2	3	4	5
26	My organization's computing task requirements closely align with cloud services on a private cloud	○	○	○	○	○
27	Current applications can be easily adapted to the cloud	○	○	○	○	○

	How closely do you agree with the following statements?	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
		1	2	3	4	5
28	My organization's IT infrastructure currently supports cloud computing	○	○	○	○	○
29	My organization can efficiently move computing needs to cloud computing	○	○	○	○	○
30	Cloud computing will satisfy my organization's computing needs	○	○	○	○	○

Continue

63% complete

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Fit-viability of Cloud Computing in the DoD

Section IV: Reforming Federal Information Technology Management

How closely do you agree with the following statements?		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
		1	2	3	4	5
31	I am comfortable hosting my organization's mission applications and data in an infrastructure managed by a commercial provider (e.g. Google or Amazon)?					
32	I am comfortable hosting my organization's mission applications or data in an infrastructure managed by another federal agency (e.g. DISA, apps.gov).					
33	I am comfortable hosting my organization's mission applications or data in an infrastructure managed by another group within your organization (e.g. Area Processing Centers).					
34	I am likely to retain my organization's mission applications or data within your own group (e.g. acquire, maintain and operate all aspects from software to hardware).					

Administrative applications include websites, e-mail, office applications and data		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
		1	2	3	4	5
35	I am comfortable hosting my organization's administrative applications and data in an infrastructure managed by a commercial provider (e.g. Google or Amazon).					
36	I am comfortable hosting my organization's administrative applications and data in an infrastructure managed by another federal agency (e.g. DISA, apps.gov).					
37	I am comfortable hosting my organization's administrative applications and data in an infrastructure managed by another group within your organization (e.g. "Area Processing Centers").					
38	I am likely to retain my organization's administrative applications and data within your own group (e.g. acquire, maintain and operate all aspects from software to hardware).					

Continue

75% complete

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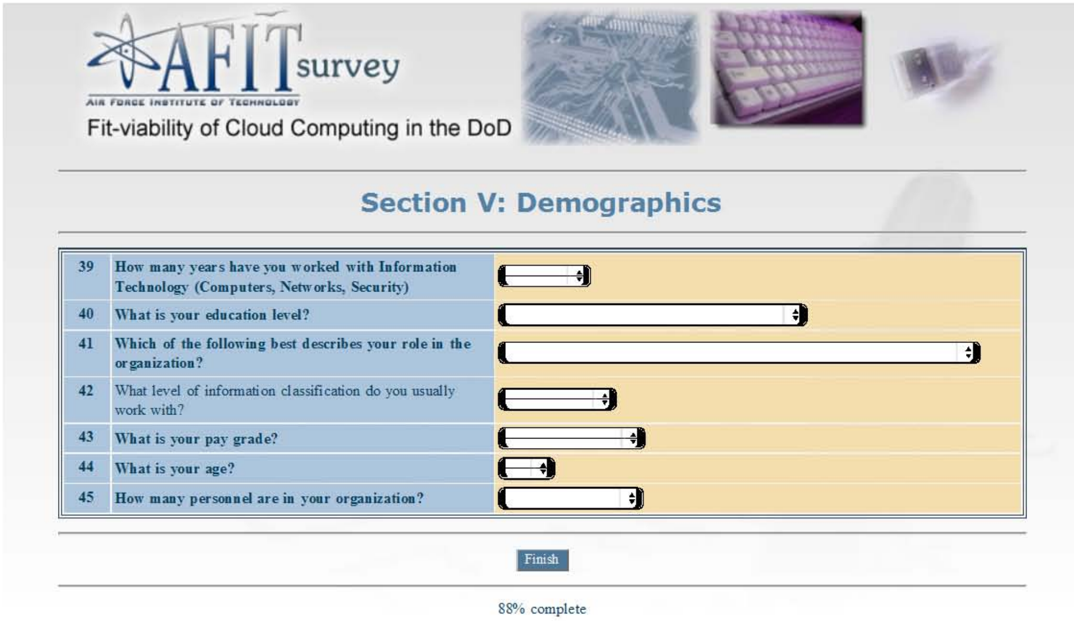

AFIT survey

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Fit-viability of Cloud Computing in the DoD

Section V: Demographics

39	How many years have you worked with Information Technology (Computers, Networks, Security)	
40	What is your education level?	
41	Which of the following best describes your role in the organization?	
42	What level of information classification do you usually work with?	
43	What is your pay grade?	
44	What is your age?	
45	How many personnel are in your organization?	

Finish

88% complete

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Appendix C: Survey Data

Survey ID	CCKN	FIT1	FIT2	FIT3	FIT4	FIT5	FIT6	FAD	ISS1	ISS2	ISS3	ISS4	ISS5	ISS6	ISS7
1	5	4	2	2	3	5	5	5	2	5	5	2	2	1	2
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6	4	4	5	3	4	3	3	5	5	4	5	4	3	2	2
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13	4	2	1	2	1	4	4	1	4	5	5	4	1	5	5
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39	4	5	4	4	5	5	5	5	3	5	5	5	2	2	3
40	4	4	5	2	2	4	5	4	5	4	4	3	4	3	4
41	3	3	2	2	4	2	4	1	2	4	5	2	2	2	3
42	5	5	4	5	5	5	5	5	4	3	3	5	4	5	4

Page 1 of 12

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Survey ID	ISS8	ISS9	COST1	COST2	COST3	COST4	INERTIA1	INERTIA1R	INERTIA2	INERTIA2R
1	2	2	1	2	2	5	3	3	3	3
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39	4	3	1	5	4	4	4	2	2	4
40	3	2	2	4	3	5	2	4	2	4
41	2	1	3	4	4	1	2	4	3	3
42	3	3	1	4	4	5	1	5	3	3

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Survey ID	INERTIA3	INERTIA3R	INERTIA4	INERTIA4R	FIT7	FIT8	VIABILITY1	VIABILITY2
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2	4	2	4	2	4	5	4	4
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41	3	3	2	4	3	2	1	2
42	3	3	2	4	5	4	3	4

Page 3 of 12

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Survey ID	VIABILITY3	WILL1	WILL2	WILL3	WILL4	WILL5	WILL6	WILL7	WILL8	WorkedIT
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3	1	1	2	3	4	1	4	1	4	12
4	5	4	4	4	4	3	3	3	3	10
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9	2	2	2	2	2	4	2	4	2	Over 30
10	3	1	2	1	2	1	4	1	4	13
11	3	4	4	5	5	3	4	5	2	18
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19	3	4	5	4	5	1	2	1	2	Over 30
20	3	4	3	4	3	4	3	4	3	20
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25	3	3	4	4	4	1	3	2	2	Over 30
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33	4	4	5	5	5	3	3	2	3	26
34	4	5	5	5	5	4	2	5	2	5
35	4	4	2	4	2	4	3	4	3	12
36	2	2	3	2	3	1	4	1	4	7
37	4	2	4	4	4	2	4	1	4	3
38	4	3	4	4	5	1	5	2	5	19
39	4	4	5	4	5	4	4	4	2	20
40	4	4	5	5	5	1	4	4	2	15
41	2	3	3	3	3	1	4	2	4	24
42	5	5	5	5	5	4	1	4	1	20

المنارة للاستشارات

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Survey ID	Education	OrgRole
1	Masters Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
2	Bachelors Degree	Command, Executive Management
3	Bachelors Degree	Administration, Operations, Acquisition, Contracting
4	Masters Degree	Command, Executive Management
5		
6	Bachelors Degree	Command, Executive Management
7	Bachelors Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
8	Masters Degree	Other
9	Above Masters	Other
10	Bachelors Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
11	Masters Degree	Other
12	Masters Degree	Command, Executive Management
13	Masters Degree	Administration, Operations, Acquisition, Contracting
14	Some College or some technical training	Administration, Operations, Acquisition, Contracting
15	Masters Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
16	Bachelors Degree	Other
17	Masters Degree	Command, Executive Management
18	Bachelors Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
19	Masters Degree	Other
20	Bachelors Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
21	Bachelors Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
22	Masters Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
23	Bachelors Degree	Administration, Operations, Acquisition, Contracting
24		
25	Bachelors Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
26		
27	Masters Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
28	Masters Degree	Command, Executive Management
29	Masters Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
30	Some College or some technical training	Other
31	Masters Degree	Command, Executive Management
32	Bachelors Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
33	Above Masters	Other
34	Masters Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
35	Bachelors Degree	Administration, Operations, Acquisition, Contracting
36	Masters Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
37	Bachelors Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
38	Above Masters	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
39	Bachelors Degree	Other
40	Masters Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
41	Bachelors Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
42	Bachelors Degree	Administration, Operations, Acquisition, Contracting

المنارة للاستشارات
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Survey ID	classification	PayGrade	Age	PersonnelCount
1	Secret	retired	51	More than 2500
2	Top Secret	O-4	40	0-100
3	Secret	O-3	35	501-2500
4	Top Secret	SES/O-6	49	101-500
5				
6	Unclassified	O-3	41	0-100
7	Secret	O-2	41	101-500
8	FOUO	GS-14	44	501-2500
9	FOUO	GS-9	59	More than 2500
10	Top Secret	O-4	35	501-2500
11	Secret	O-5	41	0-100
12	FOUO	GS-14	40	0-100
13	Secret	SES/O-6	47	More than 2500
14	FOUO	GS-11	48	101-500
15	FOUO	GS-14	51	More than 2500
16	FOUO		0	0-100
17	FOUO	GS-15 or above	35	101-500
18	Secret	O-5	47	101-500
19	Unclassified	retired	59	More than 2500
20	Unclassified	GS-12	54	0-100
21	FOUO	O-2	38	101-500
22	Secret	O-4	40	0-100
23	FOUO		38	501-2500
24				
25	Secret	GS-13	57	More than 2500
26				
27	FOUO		49	101-500
28	FOUO	GS-14	48	0-100
29	Unclassified	retired	45	501-2500
30	Unclassified	WO-3	39	More than 2500
31	Unclassified	O-5	45	501-2500
32	Unclassified	O-4	31	0-100
33	Unclassified	O-5	43	More than 2500
34	FOUO	GS-11	29	101-500
35	FOUO	WO-2	48	501-2500
36	Secret	O-3	28	More than 2500
37	Secret	O-3	34	0-100
38	Top Secret	O-5	42	501-2500
39	Secret	retired	46	101-500
40	Unclassified	O-4	45	101-500
41	FOUO	O-5	41	501-2500
42	Top Secret	O-5	43	101-500

Page 6 of 12

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Survey ID	CCKN	FIT1	FIT2	FIT3	FIT4	FIT5	FIT6	FAD	ISS1	ISS2	ISS3	ISS4	ISS5	ISS6	ISS7
43	4	1	3	1	5	5	5	4	2	2	5	4	5	3	3
44	4	4	2	5	5	5	5	4	5	5	4	4	4	5	2
45	4	3	2	4	4	2	4	4	5	4	4	3	4	4	4
46	2	2	2	3	4	4	4	5	4	4	5	3	4	2	2
47	4	1	1	5	5	5	5	5	4	4	5	3	3	3	2
48	5	4	5	3	5	5	5	4	3	2	3	2	1	1	2
49	4	4	3	2	4	4	5	4	5	4	4	2	2	3	4
50	3	1	2	1	4	2	5	2	2	5	5	4	3	4	3
51	4	4	4	5	5	5	5	5	5	4	5	3	4	2	2
52	3	2	3	1	4	4	2	2	2	1	4	5	2	2	4
53	2	5	5	3	3	5	5	5	5	5	5	5	5	5	5
54	5	4	5	4	4	4	5	4	4	5	4	4	4	5	4
55	2	5	5	2	1	5	5	5	5	4	5	2	2	3	2
56	4	3	4	2	5	4	5	4	4	2	5	3	3	2	2
57	3	4	4	1	1	4	2	4	4	4	4	3	3	3	3
58	3	4	4	1	4	3	5	2	1	5	3	4	5	2	5
59	3	4	5	5	5	5	5	3	5	4	4	3	5	2	2
60	3	4	4	2	4	4	4	4	3	5	5	3	3	2	2
61	3	4	4	3	4	4	5	3	4	4	4	3	3	3	2
62	3	5	5	4	4	5	5	5	5	5	5	4	3	2	1
63	3	2	4	4	4	4	4	4	4	4	4	4	3	4	3
64	1	3	2	3	4	3	4	1	5	4	4	5	4	1	5
65	2	1	1	1	1	4	5	3	5	4	5	2	2	2	5
66	4	3	3	2	2	5	4	4	3	5	3	2	2	1	1
67	5	5	3	5	5	5	5	5	5	4	4	3	5	5	1
68	5	5	5	2	2	5	5	5	3	5	5	3	1	1	1
69	4	4	3	5	4	5	4	5	4	5	4	5	3	3	4
70	4	4	2	4	5	4	5	5	5	4	4	3	2	1	1
71	4	5	5	2	2	5	5	5	5	5	5	3	1	1	1
72	2	2	2	2	4	4	5	3	5	5	5	3	2	1	1
73	3	3	2	2	4	4	5	4	5	5	5	3	3	3	2
74	4	4	3	4	5	5	5	4	5	5	5	3	3	3	3
75	3	4	4	3	4	4	4	4	4	4	3	3	2	3	2
76	3	2	3	3	5	3	5	4	5	5	4	5	3	3	3
77	4	3	3	2	3	4	4	4	4	5	4	4	3	3	3
78	2	5	5	4	4	4	4	4	5	3	3	4	3	4	4
79	3	2	2	1	2	3	4	1	3	4	5	2	2	2	3
80	3	4	4	1	1	5	5	5	3	5	4	3	4	5	3
81	3	2	2	5	5	5	5	4	4	4	4	3	3	3	3
82	4	4	3	4	4	5	5	5	5	4	5	4	4	4	5
83	3	4	4	5	5	5	5	5	4	4	5	3	3	3	3

المنارة للاستشارات

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Survey ID	ISS8	ISS9	COST1	COST2	COST3	COST4	INERTIA1	INERTIA1R	INERTIA2	INERTIA2R
43	3	2	2	3	4	2	2	4	2	4
44	5	1	2	4	3	4	4	2	2	4
45	4	2	5	4	2	4	3	3	3	3
46	3	3	4	4	3	1	2	4	1	5
47	3	3	2	3	5	5	5	1	5	1
48	2	1	1	3	4	5	1	5	2	4
49	1	3	2	4	4	4	4	2	3	3
50	4	2	3	5	5	1	4	2	4	2
51	1	3	3	4	4	4	5	1	4	2
52	2	1	1	2	3	1	4	2	3	3
53	5	5	2	2	3	3	2	4	2	4
54	4	4	2	3	3	3	3	3	3	3
55	1	3	4	4	5	2	5	1	4	2
56	3	1	1	2	4	4	2	4	2	4
57	4	3	2	2	2	2	2	4	3	3
58	5	1	2	1	1	1	2	4	2	4
59	3	1	2	3	1	4	4	2	3	3
60	1	1	3	2	4	3	3	3	3	3
61	2	2	1	4	4	4	4	2	4	2
62	1	1	1	3	4	2	4	2	3	3
63	3	3	2	3	4	4	3	3	3	3
64	3	2	2	3	3	2	3	3	4	2
65	4	1	5	2	4	1	4	2	4	2
66	2	1	3	2	5	3	3	3	2	4
67	3	2	1	4	4	5	4	2	4	2
68	2	2	1	4	4	5	4	2	4	2
69	1	5	3	5	5	4	4	2	3	3
70	2	2	1	1	4	3	4	2	3	3
71	2	3	1	2	2	5	4	2	3	3
72	2	2	2	3	3	2	3	3	4	2
73	2	2	3	4	4	2	3	3	3	3
74	2	2	2	4	4	4	4	2	3	3
75	2	2	3	4	3	3	3	3	3	3
76	3	2	1	4	2	4	3	3	2	4
77	2	3	3	3	3	4	4	2	3	3
78	5	4	2	4	3	4	4	2	3	3
79	3	3	3	5	4	1	3	3	4	2
80	5	3	2	5	5	2	4	2	2	4
81	3	3	1	3	5	2	4	2	2	4
82	5	5	2	5	5	4	3	3	2	4
83	3	3	4	4	4	4	4	2	4	2

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Survey ID	INERTIA3	INERTIA3R	INERTIA4	INERTIA4R	FIT7	FIT8	VIABILITY1	VIABILITY2
43	2	4	2	4	1	3	3	3
44	3	3	1	5	4	2	3	3
45	3	3	4	2	3	2	2	2
46	2	4	1	5	2	2	3	2
47	5	1	5	1	1	1	4	3
48	2	4	3	3	4	5	5	5
49	3	3	2	4	4	3	4	4
50	2	4	3	3	4	2	1	2
51	3	3	4	2	4	4	2	3
52	3	3	4	2	2	2	2	2
53	2	4	2	4	4	4	2	2
54	3	3	3	3	4	3	3	3
55	2	4	2	4	5	5	4	4
56	2	4	2	4	3	3	3	3
57	3	3	3	3	4	4	4	4
58	2	4	2	4	3	2	2	2
59	3	3	3	3	4	5	4	3
60	2	4	2	4	4	4	2	4
61	3	3	2	4	4	4	4	4
62	3	3	3	3	5	5	5	5
63	3	3	3	3	3	4	2	4
64	3	3	3	3	2	2	1	2
65	3	3	4	2	1	1	1	1
66	4	2	3	3	3	3	2	2
67	4	2	4	2	5	4	4	4
68	2	4	4	2	5	5	5	5
69	2	4	2	4	2	2	4	2
70	3	3	4	2	3	2	2	2
71	2	4	2	4	5	5	5	5
72	4	2	3	3	3	3	3	3
73	2	4	2	4	3	2	3	2
74	3	3	2	4	4	3	4	3
75	3	3	4	2	3	3	3	3
76	2	4	1	5	4	4	2	3
77	3	3	2	4	3	3	3	3
78	4	2	3	3	4	4	3	3
79	2	4	3	3	1	2	2	2
80	2	4	1	5	4	4	4	4
81	3	3	2	4	3	2	2	4
82	3	3	2	4	4	2	4	3
83	4	2	3	3	4	4	4	4

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Survey ID	VIABILITY3	WILL1	WILL2	WILL3	WILL4	WILL5	WILL6	WILL7	WILL8	WorkedIT
43	3	3	4	3	4	2	3	2	3	
44	3	2	4	2	4	2	3	4	2	Over 30
45	2	2	2	3	3	2	3	2	3	20
46	2	3	4	2	2	1	4	1	4	3
47	3	4	2	4	2	2	4	2	3	15
48	5	4	4	4	4	3	3	2	3	12
49	4	4	4	5	5	2	4	3	5	13
50	4	1	1	1	1	1	4	1	4	11
51	4	1	5	1	5	1	1	1	1	17
52	2	3	4	3	4	1	2	1	2	25
53	4	2	2	2	2	1	4	1	4	16
54	3	3	4	3	4	2	3	2	3	
55	5	5	5	5	5	5	2	5	2	23
56	3	4	4	4	4	2	4	2	4	25
57	3	3	3	3	3	2	2	2	2	4
58	2	4	5	4	4	2	4	2	4	12
59	4	4	5	4	5	1	4	3	4	2
60	3	2	4	4	4	1	4	2	4	10
61	4	4	5	4	5	2	4	3	4	20
62	5	5	5	5	5	5	1	5	1	5
63	4	4	3	4	3	2	3	2	3	12
64	2	2	3	2	3	1	3	1	3	3
65	1	1	1	1	1	1	5	1	5	27
66	3	2	2	2	2	4	3	4	3	6
67	4	3	4	4	4	2	4	4	3	25
68	5	4	5	4	5	1	4	1	4	27
69	4	1	2	1	2	1	4	1	4	25
70	4	3	4	4	4	1	3	1	3	22
71	5	4	5	5	5	1	1	1	1	17
72	2	2	2	2	4	2	4	2	4	24
73	2	4	4	4	4	2	5	2	5	11
74	3	4	4	5	5	2	5	3	5	12
75	3	3	3	3	3	2	4	2	4	16
76	4	4	4	4	4	4	4	4	4	2
77	2	4	4	5	4	4	3	5	3	26
78	3	4	4	4	4	3	3	3	3	16
79	2	3	3	3	3	1	4	1	4	12
80	4	5	2	5	2	4	3	4	3	10
81	2	4	4	4	4	2	3	2	3	10
82	4	4	4	4	4	3	3	3	3	25
83	4	4	4	4	4	4	4	4	4	17

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Survey ID	Education	OrgRole
43		
44	Bachelors Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
45	Some College or some technical training	Other
46	Bachelors Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
47	Bachelors Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
48	Masters Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
49	Bachelors Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
50	Masters Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
51	Bachelors Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
52	Bachelors Degree	Administration, Operations, Acquisition, Contracting
53	Some College or some technical training	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
54		
55	Masters Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
56	Above Masters	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
57	Masters Degree	Other
58	Masters Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
59	Bachelors Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
60	Above Masters	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
61	Masters Degree	Administration, Operations, Acquisition, Contracting
62	Bachelors Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
63	Bachelors Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
64	Masters Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
65	Bachelors Degree	Command, Executive Management
66	Masters Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
67	Masters Degree	Command, Executive Management
68	Above Masters	Other
69	Masters Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
70	Bachelors Degree	Administration, Operations, Acquisition, Contracting
71	Masters Degree	Command, Executive Management
72	Masters Degree	Other
73	Some College or some technical training	Other
74	Bachelors Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
75	Masters Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
76	Some College or some technical training	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
77	Masters Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
78	Above Masters	Command, Executive Management
79	Bachelors Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
80	Above Masters	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
81	Masters Degree	IT/MIS/IRM, Prog./Proj. Mngmt, Ent. Architecture
82	Above Masters	
83	Masters Degree	Command, Executive Management

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Survey ID	classification	PayGrade	Age	PersonnelCount			
43							
44	Unclassified	GS-14	50	More than 2500			
45	Unclassified		50	More than 2500			
46	Secret	O-3	42	501-2500			
47	Secret	Contractor	43	101-500			
48	Top Secret	GS-14	28	501-2500			
49	Unclassified	O-3	44	101-500			
50	Top Secret	O-5	42	501-2500			
51	FOUO	GS-13	43	101-500			
52	Unclassified	retired	46	501-2500			
53	Unclassified	GS-11	38	101-500			
54							
55	Unclassified	O-5	48	101-500			
56	FOUO	GS-14	45	More than 2500			
57	Top Secret	O-4	40	101-500			
58	Top Secret	O-5	46	501-2500			
59	Unclassified	O-4	31	0-100			
60	Top Secret	O-5	41	501-2500			
61	Unclassified	Contractor	39	101-500			
62	FOUO	O-3	28	501-2500			
63	Secret		33	101-500			
64	Unclassified	O-4	39	More than 2500			
65	Secret	O-3	43	0-100			
66	FOUO	O-5	42	More than 2500			
67	Unclassified	retired	56	101-500			
68	FOUO	O-5	45	101-500			
69	Top Secret	GS-15 or above	50	More than 2500			
70	FOUO	Contractor	41	0-100			
71	FOUO	O-5	38	101-500			
72	Top Secret	WO-2	49	0-100			
73	Unclassified	E-5	32	101-500			
74	Unclassified	WO-2	33	501-2500			
75	Unclassified	O-2	28	501-2500			
76	Secret		27	0-100			
77	FOUO	SES/O-6	48	101-500			
78	Unclassified	O-5	47	0-100			
79	Unclassified	O-5	41	501-2500			
80	Secret	O-5	41	101-500			
81	Secret	O-4	43	101-500			
82	Unclassified	GS-15 or above	57	501-2500			
83	FOUO	O-4	42	101-500			

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Appendix D: SmartPLS Report

Cross Loadings

	cost	fit	inertia	viability	willingness
COST1	1.000000	-0.264952	-0.175177	-0.289511	-0.264672
FIT1	-0.236876	0.852295	0.185243	0.481584	0.320945
FIT2	-0.227624	0.894746	0.085833	0.564070	0.368675
INERTIA1r	-0.109283	0.109694	0.827469	-0.201456	-0.058347
INERTIA2r	-0.218048	0.099498	0.858527	-0.148874	-0.004516
INERTIA3r	-0.110787	0.160601	0.811124	-0.196712	-0.049526
INERTIA4r	-0.175709	0.115351	0.783988	-0.085278	0.101325
VIABILITY1	-0.203887	0.374463	-0.260587	0.804765	0.319953
VIABILITY2	-0.178400	0.452789	-0.320048	0.871319	0.528174
VIABILITY3	-0.342609	0.662744	0.049104	0.829887	0.371739
WILL1	-0.243832	0.270462	0.022472	0.431683	0.867694
WILL2	-0.239663	0.453971	-0.002378	0.432329	0.876659
WILL3	-0.204982	0.291138	-0.020901	0.454964	0.899804
WILL4	-0.245830	0.383365	-0.091208	0.428251	0.882597

AVE

	AVE
cost	1.000000
fit	0.763489
inertia	0.673584
viability	0.698519
willingness	0.777512

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Outer Loadings

	cost	fit	inertia	viability	willingness
COST1	1.000000				
FIT1		0.852295			
FIT2		0.894746			
INERTIA1r			0.827469		
INERTIA2r			0.858527		
INERTIA3r			0.811124		
INERTIA4r			0.783988		
VIABILITY1				0.804765	
VIABILITY2				0.871319	
VIABILITY3				0.829887	
WILL1					0.867694
WILL2					0.876659
WILL3					0.899804
WILL4					0.882597

Path Coefficients

	cost	fit	inertia	viability	willingness
cost				-0.188419	-0.132310
fit				0.601123	
inertia				-0.332106	
viability					0.457193
willingness					

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14. ABSTRACT
Cloud computing is one of the hottest topics in Information Technology accounting for growth in IT spending with global revenues surging to over $130 billion in 2013. According to the Federal CIO, the U. S. Government is considered the world's largest purchaser of information technology with spending more than $76 billion per year. Since the commercial industry uses cloud computing to reduce costs, optimize business functions and collaborate on real-time data for decision making, should the Department of Defense implement cloud computing? Research examined the possibility that cloud computing is not seen as a viable technology and if the IT professionals in the DoD who are unwilling to implement cloud computing. Data from a survey of DoD IT professionals was compared to data from a survey from the commercial industry and was used in a model to determine perceived viability and perceived willingness to implement the technology. Perceived viability of cloud computing is determined by the cost, organizational inertia and the fit of the technology with the organization. The perceived willingness is only partially measured by the viability. Perceived willingness is an attitude toward the technology and changing that attitude towards could assist with the willingness to implement the technology.

15. SUBJECT TERMS
Cloud computing, viability, willingness, fit, inertia

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