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Factors That Influence Application Migration To Cloud Computing In Government Organizations: A Conjoint Approach

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FACTORS THAT INFLUENCE APPLICATION MIGRATION TO CLOUD COMPUTING IN GOVERNMENT ORGANIZATIONS: A CONJOINT APPROACH

BY

BARRY C. WEST

A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree

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ACCEPTANCE

This dissertation was prepared under the direction of the *Barry C. West* Dissertation Committee. It has been approved and accepted by all members of that committee, and it has been accepted in partial fulfillment of the requirements for the degree of Doctoral of Philosophy in Business Administration in the J. Mack Robinson College of Business of Georgia State University.

H. Fenwick Huss, Dean

DISSERTATION COMMITTEE

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LIST OF ABBREVIATIONS

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ASP	Application Service Provider
CIO	Chief Information Officer
CTO	Chief Technology Officer
DoD	Department of Defense
DV	Dependent Variable
FEMA	Federal Emergency Management Agency
GSA	General Services Administration
IaaS	Infrastructure as a Service
IBM	International Business Machines Corp.
IC	Intelligence Community
IRB	Institutional Review Board
IRS	Internal Revenue Service
IS	Information Systems
IT	Information Technology
NGO	Non-governmental organization
NWS	National Weather Service
OMB	Office of Management and Budget
PaaS	Platform as a Service
PBGC	Pension Benefit Guaranty Corporation
R&D	Research and Development
RBT	Resource-Based Theory
RBV	Resource-Based View
SaaS	Software as a Service
SLA	Service Level Agreement
SPSS	Statistical Package for the Social Sciences
TCE	Transaction Cost Economics
USDA	United Stated Department of Agriculture

ABSTRACT

FACTORS THAT INFLUENCE APPLICATION MIGRATION TO CLOUD COMPUTING IN GOVERNMENT ORGANIZATIONS: A CONJOINT APPROACH

BY

BARRY C. WEST

JULY 2014

Committee Chair: *Balasubramaniam Ramesh, Ph.D.*

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Cloud computing is becoming a viable option for Chief Information Officers (CIO's) and business stakeholders to consider in today's information technology (IT) environment, characterized by shrinking budgets and dynamic changes in the technology landscape. The objective of this study is to help Federal Government decision makers appropriately decide on the suitability of applications for migration to cloud computing. I draw from four theoretical perspectives: transaction cost theory, resource-based theory, agency theory and dynamic capabilities theory and use a conjoint analysis approach to understand stakeholder attitudes, opinions and behaviors in their decision to migrate applications to cloud computing. Based on a survey of 81 government cloud computing stakeholders, this research examined the relative importance of thirteen factors that organizations consider when migrating applications to cloud computing. Our results suggest that trust in the cloud computing vendor is the most significant factor, followed by the relative cost advantage, sensing capabilities and application complexity. A total of twelve follow-up interviews were conducted to provide explanation of our results. The contributions of the dissertation are twofold: 1) it provides novel insights into the relative importance of factors that influence government organizations' decision to migrate applications to cloud computing, and 2) it assists senior government decision makers to appropriately weigh and prioritize the factors that are critical in application migration to cloud computing.

INTRODUCTION

Government Chief Information Officers (CIOs) frequently find they need to acquire IT resources to fulfill previously unknown or short-term requirements. Cloud computing offers an economical alternative to procuring these resources. It enables convenient, on-demand network access to a pool of ubiquitous, shared, configurable technology resources (such as networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction (Mell and Grance, 2011). Cloud computing is an evolving paradigm that capitalizes on available, unused resources in a shared pool. Thus, the technological capabilities required can be provided quickly when needed. In addition, when organizations share resources, they share the costs as well, and in turn reduce individual costs.

Currently cloud computing is continuously explored to determine how to best leverage this application across business and government enterprises. Along with cyber security and mobility, cloud computing is one of the most fervently discussed topics and highest priorities for CIO's in government today. Increased operating costs, characterized by higher licensing, maintenance and labor costs are coupled with requests for more services while experiencing shrinking government-wide IT budgets; CIOs and stakeholders are continuously exploring alternatives to procuring IT resources, both applications and services.   As cloud computing offers the potential for significant savings in IT resources and expenditures, it is becoming an extremely viable option. Thus, it represents both a technology and an economic shift in an organization's use of IT resources (Rosenberg and Mateos, 2011) as compared to other common models for setting up and managing IT (See: Appendix E).

A new general-purpose technology such as cloud computing has the potential to significantly impact the economics of computing in a wide variety of domains. It can provide huge savings and more efficiency in private and public sector organizations, including healthcare (e.g., to provide provisional information and information technologies in remote or poorer locations), education (e.g., for e-learning), and government agencies (e.g., in situations in which they experience periodic spikes in usage) (Etro, 2011). Excellent examples include both the National Weather Service (NWS) and the Federal Emergency Management Agency (FEMA) which utilize cloud computing to meet the spikes in IT requirements, necessitated by the need to track unpredictable severe weather events such as hurricanes and tornadoes, and assist in providing the substantive items needed by the victims of such events.

I study the use of cloud computing in government organizations for several reasons including the following: 1) our government is becoming a very aggressive customer of cloud computing over the past three to five years, 2) the American public expects to receive the same level of service regardless as to when the service is requested, 3) government agencies are forced to examine alternatives to meet their basic mission as well as accommodate new demands imposed by stakeholders, such as the Office of Management and Budget (OMB), during the past several years of severe budget constraints, and, 4) government organizations need up to date technical knowledge to make critical decisions about the appropriate use of cloud computing. While government organizations are traditionally characterized as being cautious, inflexible, and lacking innovation (Rainey *et al*., 1976), their IT organizations are increasingly becoming more innovative by embracing technologies such as cloud computing. This shift may be explained by the recent economic crisis that has led governments to place increasing emphasis on technological innovation in order to increase the efficiency and effectiveness of public sector enterprises (U.S. Government, 2009).

Engaged scholarship is defined as a participative form of research for obtaining the advice and perspectives of key stakeholders (researchers, users, clients, sponsors, and practitioners) to understand a complex social problem (Van deVen, 2007). During my research, I have brought the practitioner view to cloud computing and applied the four theories (transaction cost, resource-based, agency and dynamic capabilities) as a lens to view the processes and factors. I outline the various engaged scholarship components and how they are aligned to the research components (See: Appendix I).

There are significant similarities and differences between public sector government organizations and private sector organizations. Whereas private sector organizations exist to maximize shareholder wealth, public sector organizations exist to meet the mission established by laws. Both types of organizations typically focus on ways to maximize organizational performance to meet the needs of particular client groups (Collins, 2005). Public sector organizations do not focus on profits, but they are increasingly required to benchmark customer service performance against the best in the business (White House, 2011). This focus is highlighted by the growing recognition that organizational performance is strongly influenced by individual actions at multiple levels of a public sector organization (Currie and Proctor, 2005). As such, key decision makers involved in migrating applications to cloud computing need to understand the factors and implications to the use of organizational resources, costs, performance and service. There has been increasing recognition that public organizations need to be more strategic, innovative and results oriented. While the development of dynamic capabilities in private sector organizations has been studied extensively, the development of such capabilities in public sector organizations has not received much attention in the literature (Pablo *et al*., 2007).

The government continues to see an increased use of cloud computing over the past three to five years as a result of looking at cost cutting measures and looking at alternatives in order to be more agile and dynamic in meeting business requirements. Cloud computing is currently playing a significant role in the federal government because the Office of the U.S. Federal CIO is a strong proponent of the economic benefits that the government can realize from cloud computing. Since the U.S. government IT budget is nearly $76 Billion (Rosenberg and Mateos, 2011), even incremental improvements in performance and cost savings facilitated by cloud computing are likely to result in significant reductions in government IT budgets. In addition, the adoption of cloud computing may help public organizations achieve dynamic capabilities that are essential for organizations to succeed in dynamic environments. Therefore, it is critical to understand the factors that will shape such adoption.

Identifying software applications that are appropriate candidates for migration to cloud computing is a critical step that senior government executives and managers need to undertake as a part of their strategy towards embracing cloud computing. All applications that reside in a given enterprise are not necessarily candidates for cloud computing, and those that are cannot all be migrated to a cloud computing platform at the same time. The decision to migrate applications is typically based on the stakeholder's (i.e. executive, business owner, CIO, project manager, etc.) perceptions of risks associated with the migration along with the potential cost savings and efficiencies that can be realized. Recent research suggests that a variety of factors influence these decisions. As the Federal Government moves more and more applications to the cloud, it must be vigilant to ensure proper security and management of government information in order to protect the privacy of citizens and national security (Kundra, 2011). Although cloud computing has gained wide attention, there is paucity of research on factors that drive decision makers to transition their applications to cloud computing.

Against this backdrop, the objective of my research is to develop an approach that will help government decision makers weigh relevant factors to decide on the suitability of migrating an application to cloud computing. Hence, this research addresses the following research question: What factors influence application migration to cloud computing in government organizations?

MIGRATING APPLICATIONS TO CLOUD COMPUTING

The concept of migrating applications to cloud computing shares similarities with outsourcing of applications development. A literature review of outsourcing over the past two decades demonstrates that theoretical perspectives such as transaction cost theory, resource-based theory, agency theory and dynamic capabilities theory suggests they are excellent candidates for the study of the migration of applications to cloud computing because cloud computing and outsourcing are common models for setting up and managing IT (Rosenberg and Mateos, 2011). In both instances, resources from an outside source are used to perform IT functions versus that of the traditional internal IT model where all resources are internal and on premise (Appendix E). With the current rapid movement toward cloud computing, the lines are increasingly blurred between traditional IT infrastructure outsourcing vendors and "pure" cloud computing vendors (Craig-Wood, 2009). However, differentiators do exist. For example, cloud computing provides shorter contract start-ups (typically hours, days, weeks, several months) as opposed to typically at least six months, or longer, for traditional outsourcing. In contrast to outsourcing, cloud computing also provides for nearly instant scaling and adding of resources. Moreover, cloud computing may involve no up-front costs (i.e., the capital expenditures and installation are absorbed into the service charges) unlike traditional outsourcing which involves up-front setup costs (Craig-Wood, 2009). To support the cloud, a huge data-center build-out is now underway. Google, Microsoft, Yahoo, Expedia, Amazon, and others are deploying massive data centers (Rosenberg and Mateos, 2011).

Executive decisions to migrate to cloud computing can be driven by four broad types of motivations: (1 it is possible to realize substantial cost savings by migrating an application to cloud computing (Tiwana and Bush, 2007), (2 organizational performance can be improved by the efficient use of organizational resources (Schwarz, *et al*., 2009), (3 it is possible to reconcile the divergent interests of the client and vendor to produce an outcome that is valuable to the client (Tiwana and Bush, 2007), and, (4 it can offer the agility that is necessary to respond rapidly to a changing environment (Helfat *et al*., 2007). The first three motivations correspond to situations that have been studied using theoretical perspectives of transaction cost theory, resource-based theory and agency theory. Further, dynamic capabilities theory is an excellent choice for understanding the fourth motivation for migrating applications to the cloud.

To address the research question on the decision to migrate to cloud computing in government organizations, we draw from each of the four theories. Figure 1 below presents the research model that has been developed by drawing constructs from each theory that influence the likelihood of application migration to cloud computing. The details of the model are explained in the following sections.

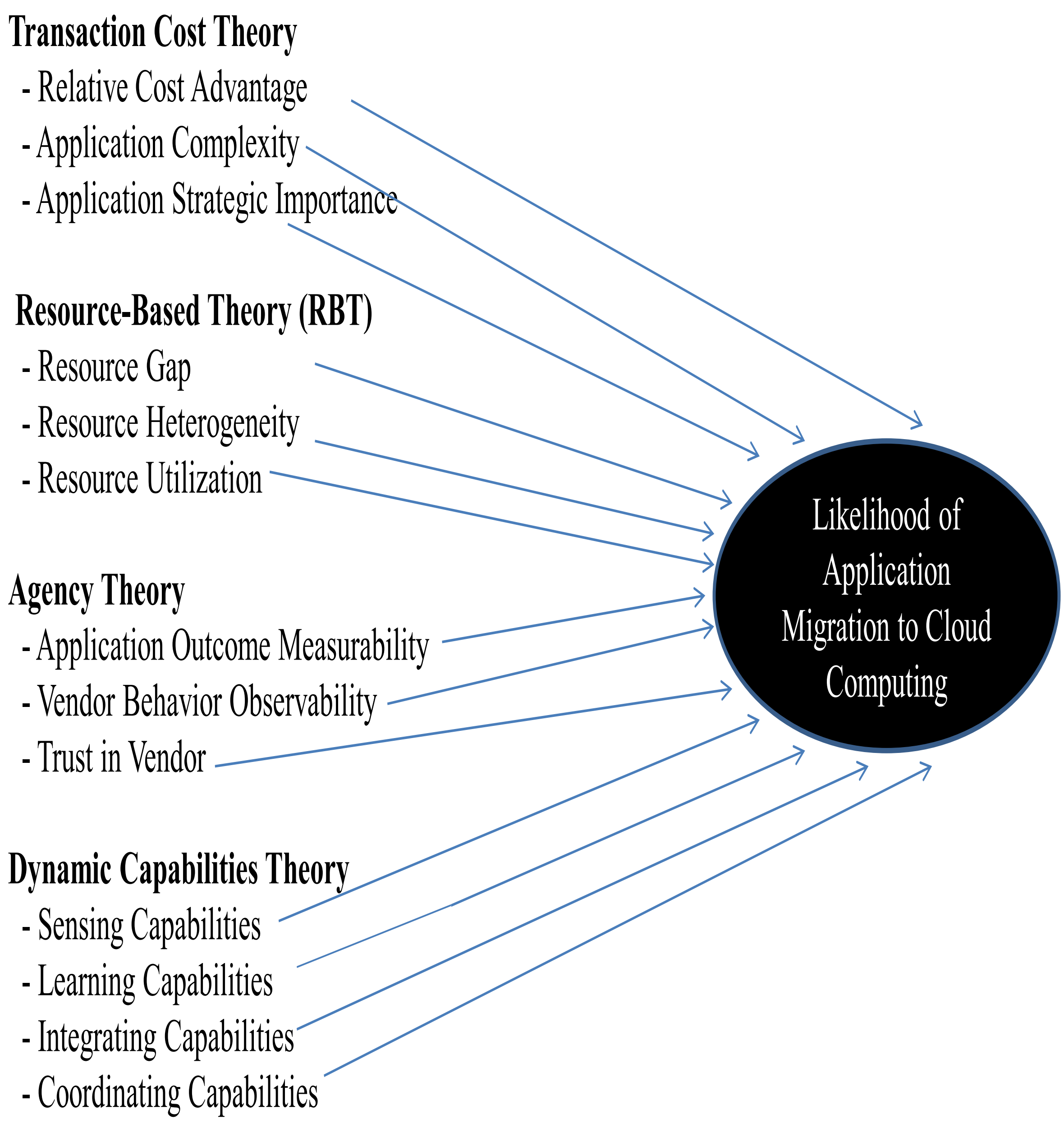

Figure 1: The Research Model

TRANSACTION COST THEORY

The first major theoretical perspective that we use to examine factors that drive managers' cloud computing migration decisions in government organizations is Transaction Cost Theory, also known as Transaction Cost Economics (TCE) theory. TCE proposes that the primary objective of a firm is to structure governance arrangements to economize the cost of transactions (Coase, 1937; Williamson, 1975, 1981, 1985). According to Ronald Coase, (Coase, 1937) people begin to organize their production in firms when the transaction cost of coordinating production through the market exchange, given imperfect information, is greater than within the firm. Transaction costs are defined as the direct or indirect expenses of negotiating, monitoring, and enforcing explicit and implicit contracts between firms (Tiwana and Bush, 2007). It is considered as a cost incurred in making an economic exchange.

A number of different types of transaction costs exist. They include: search and information costs, bargaining costs, policing and enforcement costs (Kumar, et al. 1998 & Malone, et al. 1987). Search and information costs are incurred when determining if a particular product or service is available in the marketplace, and who has the lowest price, etc. Bargaining costs are those type costs that are required to reach an acceptable agreement with the other party, e.g., drawing up an appropriate contract, etc. Policing and enforcement costs are the costs of ensuring that the other party adheres to the terms of the contract, and taking appropriate action (often through the legal system) if this turns out not to be the case (Kumar, *et al*. 1998 & Malone, *et al*. 1987).

III.I Relative Cost Advantage

Relative cost advantage in the context of this research is defined as the expected overall cost savings from migrating an application to cloud computing instead of pursuing it internally (Tiwana and Bush, 2007). The extent to which managers perceive high relative cost advantage from using cloud computing will therefore increase the likelihood that they will choose to use it. Using the economies of scale argument, cloud computing can be thought of as being more cost effective because an organization utilizes virtualized resources that are dynamically allocated, also known as "provisioned" only at the time of need (Rosenberg and Mateos, 2011).
When external transaction costs are lower than the internal transaction costs, prudent organizations will look to cost saving measures such as migrating applications to cloud computing. Applications that lower transaction / production costs are likely to increase the likelihood that managers will choose to migrate them to cloud computing. In contrast, those applications that increase net transaction costs when migrating to cloud computing will decrease the likelihood that managers will chose to use cloud computing. This leads to my first hypothesis:

Hypothesis 1: The higher the expected savings from using cloud computing deployment when compared to deploying the application internally, the greater the likelihood that stakeholders will choose to migrate to cloud computing.

III.II Application Complexity

Task, transactional, or project complexity is another important variable in transaction cost economics (Bensaou and Anderson, 1999). Project complexity is defined as the complexity of a project due to its size, scope, or technical novelty (Xia and Lee, 2004). TCE theory proposes that managers' decisions to migrate applications to cloud computing are influenced by two opposing tensions that come into play as applications and IT environments grow in complexity within an organization: 1) the depth of skills needed to cope with a complex technical application requires deeper specialized expertise, motivating the use of cloud computing, and, 2) greater control is desired by managers, motivating internalization (Tiwana and Bush, 2007). More complex IT projects are riskier and more prone to failure, although this factor has not directly been examined in prior empirical studies on IT outsourcing or cloud computing (Andres and Zmud, 2001; Gopal, 2003). A government organization may be more inclined to rely on a specialized cloud computing vendor, equipped with the skills and experience to handle technical complexity rather than focusing on internal skill sets. Therefore, benefits that managers perceive from utilizing a cloud computing vendor in managing its applications will likely outweigh the perceived costs from loss of direct control. This leads to my second hypothesis:

Hypothesis 2: The higher the perceived technical complexity of the application, the higher the likelihood that stakeholders will choose to migrate to cloud computing

III.III Application Strategic Importance

A final factor related to transaction cost theory is the strategic importance of the application to the organization. Applications with greater strategic importance are viewed as having greater asset specificity from a TCE perspective – that is, the intended outcome is likely to be relatively idiosyncratic to the client firm (Dyer, 1996). Mission critical applications and systems are less likely to be migrated to cloud computing until they have been assessed/evaluated and the organization is willing to assume the risk. The strategic importance of a project to the organization's business drives attempts to closely control its development through both formal and informal mechanisms (Kirsch, 1996). Both informal and formal forms of control are generally easier to exercise when a project is internalized and uses the client's IT staff (Kirsch, 1996). Further, the strategic importance of transactions is likely to influence the decision to migrate to cloud computing because it may impose significant transaction costs in the long term. This leads to my third hypothesis:

Hypothesis 3: The higher the perceived strategic importance of the application's transactions to the organization's business, the lower the likelihood that stakeholders will choose to migrate that application to cloud computing.

RESOURCE-BASED THEORY

The second major theoretical perspective that should be used to drive managers' cloud computing migration decisions is Resource-Based Theory (RBT). The central idea in RBT is that it views the organization as a collection of resources. The resource-based view of the organization and transaction cost economics are viewed as complementary because the latter is a theory of firm rents whereas the former is a theory of the existence of the firm (Barney, 1991). RBT proposes that a firm can gain competitive advantage by acquiring and deploying resources that are rare, valuable, difficult to imitate, and relatively immobile and non-substitutable (Penrose, 1959; Barney, 1991). This advantage can be sustained over long periods, to the extent that the firm is able to protect against resource imitation, transfer, or substitution.

IV.I Resource Gap

The resource gap is defined as the extent to which there are internal people with technical skills to provide the application service (Schwarz, *et al*., 2009). Skills and expertise needed to support applications such as email or collaboration tools are likely to be more readily available with a cloud provider when compared to those needed to support specialized or customized applications. Many federal organizations have migrated their email, collaboration tools and other applications such as human resource management tools to cloud computing initially because the skills and expertise needed to support them are common and cloud computing vendors have gained more expertise with these type application migrations. With these applications in the cloud, management can focus their attention and resource dollars gained from any potential savings, to acquiring and retaining of specialized skills. This helps reduce the risks associated with gaps in resources.

Government organizations are created to fulfill responsibilities established by law and are expected to develop policies for the delivery of services mandated by the law. In western societies, public agencies are often created to contribute to the common good (e.g., providing social security for the common good) or prevent a future recurrence of a past experience (e.g. preventing another market failure leading to an economic downturn). In the case of public sector R&D organizations, their role is also to contribute to the development of industry, and the creation of markets (Matthews and Shulman, 2005). The RBT perspective argues that a firm seeks to identify sources of competitive advantage grounded in the resources and capabilities it possesses or has access to (Day, 1994). This perspective is very relevant in examining the migration of applications to cloud computing. In developing a resource-based strategy, organizations must assess their existing resources and evaluate them against future requirements. If the firm concludes that new or complimentary resources are necessary, it may prefer to acquire them from an external source rather than expend the resources to develop them in-house (Grant, 1991). This is especially true when government organizations are going through constant and unpredictable change. Today, more than ever, government agencies are going through increased budget pressures and reduced staffing. They must still meet the mission requirements and fulfill resource shortfalls. They need to quickly acquire or shift resources to maintain or improve their posture in meeting their mission objectives and fulfilling the needs of the public. Government organizations also have the risk of losing services to central organizations (i.e., payroll), if the organization is not competitive. If an organization has no explicit gaps in its IT capabilities, retaining applications in-house that have a low strategic value may necessitate the use of internal resources that might be used to better advantage elsewhere (i.e., focus on core competencies) (Roy and Aubert, 2002). As organizations assess their IT resources and capabilities, they will need to weigh them against current and anticipated needs as well as against resources and capabilities available in the cloud computing marketplace. If an organization determines that its IT capabilities do not match up with it needs, it enters into arrangements with external vendors to resolve the situation (Grover *et al*., 1994). This leads to my next hypothesis:

Hypothesis 4: The higher the resource gap that stakeholders encounter with their internal resources, the higher the likelihood that stakeholders will choose to migrate the applications to cloud computing.

IV.II Resource Heterogeneity

Resource Heterogeneity is defined as the extent to which the application differentiates the organization (Schwarz, *et al*., 2009). Typically low heterogeneity will result in an application being migrated to cloud computing because it provides low levels of differentiation. Barney (Barney, 1991) argued that sustained competitive advantage derives from the resources and capabilities a firm controls that are valuable, rare, imperfectly imitable, and not substitutable. These resources and capabilities can be viewed as bundles of tangible and intangible assets, including a firm's management skills, its organizational processes and routines, and the information and knowledge it controls (Barney, 1991). Kay (1995) presents the notion of sustained competitive advantage in organizations obtained through relational architecture, reputation, innovation and strategic assets. The government continues to migrate applications such as website hosting, collaboration and communications tools to the cloud first as they are common, and provide lower levels of resource differentiation. This leads to my next hypothesis:

Hypothesis 5: The higher the resource heterogeneity for a given application, the less the likelihood that stakeholders will choose to migrate that application to cloud computing.

IV.III Resource Utilization

We can view resource utilization as the extent to which resources (both personnel and IT) are efficiently and effectively utilized (Schwarz, *et al*., 2009). In the case of cloud computing, resource utilization is lower when a smaller number of users access the application, and resource utilization is higher when a larger number of users access the application. Many organizations experience extreme peaks and lows in resource utilization throughout their business cycle. Because of their varying resource utilization, websites such as www.whitehouse.gov, www.irs.gov and www.weather.gov, among others, have become perfect targets for migrating their applications/portal to cloud computing. Factors that can influence resource utilization are 1) number of average website hits per day, 2) relative cost of the application per user if configured on a per user basis, 3) purpose and ease of use of the application, 4) content management resources, and, 5) maintenance costs of the hardware, etc. Drawing upon a standardized application enables the customer to achieve efficiency by building a broad internal use of expertise at a low cost (Schwarz, et al., 2009). This leads to my next hypothesis:

Hypothesis 6: The greater the variation in resource utilization for a given application, the higher the likelihood that stakeholders will choose to migrate that application to cloud computing.

AGENCY THEORY

The third major theoretical perspective that may be used to drive managers' cloud computing migration decisions is agency theory. The core idea in agency theory is the notion of goal incongruence between an agent (the external vendor) and a principal (the client) (Jensen and Meckling, 1976). Various mechanisms can be used to align the interests of the agent and that of the principal such as commissions, profit sharing, etc. Although agency theory was originally conceptualized at the individual level of analysis, it has previously been applied to understand principal– agent conflicts in inter-firm relationships such as outsourcing alliances because its basic assumptions hold true irrespective of whether the involved entities are individuals or organizations (Reuer and Ragozzino, 2006). The central problem is that the principal and the agent may prefer different actions because of the differences in their risk preferences. A general proposition of agency theory is that those in control of resources will serve their own interests, rather than those who own the resources (Stewart, 1999).

V.I Application Outcome Measurability

Application outcome measurability is the ability to measure the cost, schedules, risks and performance metrics of a given application (Harrison, 1988). Establishing performance metrics at the outset of a project allows a client firm to tie incentives and penalties with vendor performance (Harrison, 1988). When moving applications to cloud computing, it is critical to measure the performance of vendors. Without performance metrics in place, the performance of the cloud computing vendor cannot readily be measured and it is thus difficult to develop contractual service-level agreements (SLA's) that adequately govern the cloud computing relationship.

Is it possible to take the different interests of the client and vendor and reconcile so that there is value-added for the client? When clearly defined evaluation criteria can be specified to assess project outcomes, market-based arrangements are more feasible because ambiguity about vendor performance is lower (Ouchi, 1980). It will be less likely for applications to be migrated to cloud computing when the application's performance metrics cannot be easily measured. A good example of this is email or collaboration tools that have been migrated to cloud computing and no performance metrics are available to gather data on helpdesk calls, downtime, etc. This leads to my next hypothesis:

Hypothesis 7: The higher the measurability of an application's outcome (i.e. metrics of performance outcomes and results), the higher the likelihood those stakeholders will choose to migrate that application to cloud computing.

V.II Vendor Behavior Observability

Vendor Behavior Observability occurs when the vendor/employee behavior and relationship with the governmental client can be effectively monitored during and after the migration of an application to cloud computing. In agency theory, behavior monitoring is an important form of process control that discourages potential agency problems (Kirsch, 1996). In today's virtual environments, it is not essential to have co-located vendor and client employees. In some cases, customers requesting the cloud computing services may be physically hundreds or thousands of miles away from the cloud computing vendor that is performing the service. Imposing frequent deliverables, weekly face-to-face meetings and the use of web-based project tracking software have been shown to facilitate monitoring vendor progress (Choudhury and Sabherwal, 2003). In cases of low vendor behavior observability, it will not be easy to monitor the behavior of the cloud computing vendor and thus it is less likely that stakeholders will choose to migrate an application to cloud computing. This leads to my next hypothesis:

Hypothesis 8: The higher the observability of a cloud computing vendor's behaviors for a given application, the higher the likelihood those stakeholders will choose to migrate an application to cloud computing.

V.III Trust in Vendor

Trust is a key ingredient for any successful vendor / client relationship. Trust is defined as the willingness of one person to increase his or her vulnerability to the actions of another person whose behavior he or she could not control (Kim, *et al*., 2005). Without trust, a vendor has to continually prove themselves and be questioned about their performance and output. Trust is often earned from the client by the vendor by providing dependable service. Having a trustworthy vendor is vital in today's government environment where the use of telework and virtual offices continue to increase. Cloud computing requires fast and dependable resources to be provisioned quickly and accurately. Having trust with a cloud computing vendor that can deliver resources quickly and dependently is essential for the success of a true partnership between the government and industry and where cooperative transactions are necessary. This leads to my next hypothesis:

Hypothesis 9: The more trust that the vendor gains with its government customer, the higher the likelihood that the customer will choose to migrate an application to cloud computing.

DYNAMIC CAPABILITIES THEORY

The fourth and final major theoretical perspective that may be used to understand managers' cloud computing migration decisions is the dynamic capabilities theory. The dynamic capability theory describes the ability of organizations to adapt their assets and resources to rapidly changing environments (Eisenhardt and Martin, 2000). The concept of dynamic capabilities arose from limitations of the resource-based view, which considers resources as static and is thus unable to explain how organizations deal with changing environments (Klievink and Janssen, 2009). Dynamic capabilities can help organizations reconfigure their resources to adapt to changing environments. Like the resource-based view and the literature on organizational strategy more generally, research on dynamic capabilities is centrally concerned with organizational performance (Helfat *et al*., 2007).

The dynamic environment in which today's government organizations operate is shaping the way they use IT resources and capabilities. Simply improving the operational efficiency of IT-enabled business processes may no longer be sufficient to achieve agility that is essential to operate in turbulent environments. Instead, organizations need to achieve significant transformation of their IT enabled business processes (Venkatraman, 1994).

Dynamic capabilities are defined as the ability to integrate, build, and reconfigure internal and external competencies to address rapidly-changing environments. This theory draws upon research in multiple areas including management of R&D, technology transfer, manufacturing, and organizational learning (Teece *et al*., 1997). It extends the resource-based view (RBV) which theorizes that "firms have resources that are valuable, rare, inimitable, and non-substitutable and that they can achieve sustainable competitive advantage by implementing fresh value-creating strategies that cannot be easily duplicated by competing firms." (Eisenhardt and Martin, 2000)

Attempting to add clarity to the literature, Eisenhardt and Martin (2000) suggest that dynamic capabilities are of different types. While some integrate resources, others focus on reconfiguring resources within firms. And still others are related to the gain and release of resources. Public sector organizations are increasingly experiencing rapidly changing environments (Pablo *et al*., 2007). While the development of dynamic capabilities in private sector organizations has been studied extensively, the development of such capabilities in public sector organizations has not received much attention in the literature (Pablo *et al*., 2007). Indeed, some researchers argue that the public sector faces even more environmental changes than the private sector, due to frequent changes in policies and the imposition of short-term time horizons tied to election cycles (Boyne, 2002).

A variety of dynamic capabilities for adapting to changing circumstances have been identified in various domains including outsourcing (Feeny and Willcocks, 1998), innovation (Eisenhardt and Martin, 2000), and e-business transformation (Daniel and Wilson, 2003). Teece *et al*, (1997), have suggested three types of capabilities: (1 coordination and integration, (2 learning, and, (3 reconfiguring and transformation. Feeny and Willcocks, (1998), have identified nine core capabilities and categorized them in the following three groups: (1 business and IT vision, (2 design of IT architecture, and, (3 delivery of services. While many studies focus on identifying capabilities in one particular situation, very little attention has been paid to understanding which type of capabilities are needed over time (Klievink and Janssen, 2009). The dynamic capabilities can also help firms reconfigure existing functional competencies so they can build products and services that better match emerging customer needs and take advantage of technological breakthroughs (Iansiti and Clark, 1994).

What makes cloud computing applications different from other applications is their elasticity and agility. Therefore, dynamic capabilities theory that has been used to study capabilities of technologies and processes that provide the ability to respond to dynamic environments is an appropriate theoretical lens to study cloud computing. At the core, the main difference is the consumer's appetite for sharing the "product" and the level of commitment to demand. The difference therefore is the user (Muller, 2011). In this study, we seek to examine the impact of dynamic capabilities enabled by cloud computing on the decision to migrate applications to cloud computing in government organizations.

VI.I Sensing Capabilities

Sensing the environment is defined by El Sawy and Pavlou (2008) as the ability to spot, interpret, and pursue the need for changing the enterprise's operational capabilities by understanding market needs and identifying new internal and external opportunities. Sensing ability is similar in spirit to the idea of "capability monitoring," the distinct ability to spot outdated or rigid operational capabilities that no longer match the environment (Schreyogg and Kleisch-Eberl, 2007). The capability to sense and monitor may be enhanced by the configuration management and centralization characteristics of cloud computing. Effectively sensing the environment is reflected by market orientation (Kohli and Jaworski, 1990). By migrating applications to cloud computing, sensing capabilities may be enhanced because of the increased accessibility and reach of the application by potential customers that may help the organization better understand market needs and identify new internal and external opportunities ahead of time. Government organizations, such as the Internal Revenue Service (IRS) during tax season, the Census Bureau during the decennial census count and the Pension Benefit Guaranty Corporation (PBGC) during the filing season of their premium pension holders are examples of where cloud computing applications could be used to enhance sensing capabilities required to accurately assess the changes in user needs. As such, they can use cloud computing to dynamically allocate resources as required. This leads to my next hypothesis:

Hypothesis 10: The higher the likelihood of increasing sensing capabilities provided by migrating an application to cloud computing, the higher the likelihood that stakeholders will choose to migrate that application to cloud computing.

VI.II Learning Capabilities

Learning capabilities are defined as the acquiring, assimilating, and developing of new knowledge needed to revamp operational capabilities (El Sawy and Pavlou, 2008). Learning relates to knowledge creation and development processes, knowledge sharing and integrating processes as well as procedures of experience-based learning (Protogerou, *et al*., 2007). Knowledge development comes from in-house learning and on the job training. Effectiveness in learning is reflected by the absorptive capacity (Cohen and Levinthal, 1990). More recent work develops the absorptive capacity construct to represent a change-oriented dynamic capability consisting of acquisition, assimilation, transformation, and exploitation capabilities (Zahra and George, 2002). It may be cheaper and easier for a cloud computing vendor to track performance statistics and operational metrics on applications that they host and are leveraging across many customers in a virtualized environment, versus each government organization's setting up individual systems to collect and monitor information. The information that could enhance learning capability includes customer service complaints, suggestions, type of return customers, etc. We argue that the migration of applications to cloud computing may help organizations acquire additional knowledge about their customers and requirements that can be used to revamp existing processes and procedures.

This leads to my next hypothesis:

Hypothesis 11: The higher the likelihood of increasing learning capabilities provided by migrating an application to cloud computing, the higher the likelihood that stakeholders will choose to migrate that application to cloud computing.

VI.III Integrating Capabilities

Integrating capabilities is defined as the ability to combine individual knowledge into the unit's new operational capabilities (Pavlou and El Sawy, 2011). Reconfiguration relies on integrating new resources, and assets (Galunic and Eisenhardt, 2001). In cloud computing, information technology resources are reconfigured to accommodate and support the application migration to cloud computing. Teece (2007) views the integration of knowledge as a foundation of dynamic capabilities. Cloud computing may help integrating existing capabilities into new capabilities resulting in reconfiguration and collective sense-making. The potential benefits of reconfigurable IT infrastructures can help organizations cope with change in turbulent environments (El Sawy and Pavlou, 2008). This leads to my next hypothesis:

Hypothesis 12: The higher the ability for applications to integrate capabilities, the higher the likelihood those stakeholders will choose to migrate that application to cloud computing.

VI.IV Coordinating Capabilities

Coordinating capability is defined as the ability to orchestrate and deploy tasks, resources, and activities in the new operational capabilities (Pavlou and El Sawy, 2011). Although the integrating capability is positively associated with the coordinating capability because coordinating is enhanced by a shared language (Galunic and Eisenhardt, 2001), the integrating and coordinating capabilities are theoretically and empirically distinct (Kogut and Zander, 1996). Teece et al. (1997) suggest that the lack of efficient coordinating and combining of different resources and tasks may explain why apparently slight technological changes have overwhelming effects on incumbent firms' competitive positions in a market (Protogerou, *et al*., 2007). A great example is Dell Computer that changed the industry from building and selling a standard computer to building computers that are customized to meet the unique needs of its customers. This business model created a significant level of coordination among the various business units in Dell, but resulted in lower inventory, more streamlined and efficient processes and more satisfied customers. Although coordination focuses on orchestrating individual tasks and activities, integration focuses on building an overall collective sense-making and understanding (Crowston and Kammerer, 1998). Coordinating capabilities enables reconfiguration by administering tasks, activities, and resources to deploy the reconfigured operational capabilities (Pavlou and El Sawy, 2011). I argue that cloud computing will improve the ability to orchestrate and deploy reconfigured resources by providing better organizing, tracking and reporting capabilities. This leads to my last hypothesis:

Hypothesis 13: The higher the ability for a cloud enabled application to enhance coordinating capabilities, the higher the likelihood that stakeholders will choose to migrate that application to cloud computing.

The following two tables (Table 1 and Table 2) provide a breakdown of the factors for each theory, along with its definition, levels for conjoint analysis and expected hypothesis.

Table 1: Theory, Attributes, Definitions and Levels of Conjoint Analysis

Theory	**Attribute**	**Definition of Attribute**	**Levels for Conjoint Analysis**
Transaction Cost Theory	Relative Cost Advantage	The expected overall cost savings from migrating an application to cloud computing instead of pursuing it internally (Tiwana and Bush, 2007).	• Low: The expected savings from using cloud deployment will be low when compared to deploying the application internally. • High: The expected savings from using cloud deployment will be high when compared to deploying the application internally.
	Application Complexity	The complexity of the applications due to its size, scope, or technical novelty (Xi and Lee, 2004).	• Low: The perceived technical complexity of the application being migrated is low. • High: The perceived technical complexity of the application being migrated is high.
	Application Strategic Importance	How important is the application to the organization and is there risk if something goes wrong (Tiwana and Bush, 2007).	• Low: The application has low strategic importance to the organization. • High: The application has high strategic importance to the organization.
Resource-Based Theory	Resource Gap	The extent to which there are internal people with technical skills to provide the application service (Schwarz, *et al*., 2009).	• Low: The application being migrated to cloud computing requires internal people with technical skills that are relatively common. • High: the application being migrated to cloud computing requires internal people with technical skills that are relatively rare.
	Resource Heterogeneity	The extent to which the application differentiates the firm (Schwarz, et al., 2009).	• Low: The application does not serve as a differentiator for the organization. • High: The application does serve as a differentiator for the organization.
	Resource Utilization	The extent to which resources are efficiently and effectively utilized (Schwarz, et al., 2009).	• Low: A small number of users access the application. • High: A large number of users access the application.
Agency Theory	Application Outcome Measurability	Ability to measure the cost, schedules, risks and performance metrics of a given application (Harrison, 1988).	• Low: The outcomes of the application being migrated cannot be measured easily. • High: The outcomes of the application being migrated can be measured easily.
	Vendor Behavior Observability	Extent to which vendor / employee behaviors can readily be monitored (Kirsch, 1996)	• Low: It will not be easy to monitor the behavior of the cloud computing vendor. • High: It will be easy to monitor the behavior of the cloud computing vendor.
	Trust in Vendor	Willingness of one person to increase their vulnerabilities to the actions of another person whose behavior they cannot control (Kim, *et al*., 2005)	• Low: Your trust in the cloud computing vendor is low. • High: Your trust in the cloud computing vendor is high.
Dynamic Capabilities Theory	Sensing Capabilities	The ability to spot, interpret, and pursue the need for changing the enterprise's operational capabilities by understanding market needs and identifying new internal and external opportunities (El Sawy and Pavlou, 2008).	• Low: The ability provided by the application to sense the environment to understand market needs and identify new internal and external opportunities is low. • High: The ability provided by the application to sense the environment to understand market needs and identify new internal and external opportunities is high.
	Learning Capabilities	Acquiring, assimilating and developing new knowledge needed to revamp operational capabilities with new knowledge and skills (El Sawy and Pavlou, 2008).	• Low: The ability provided by the migrated application to acquire additional knowledge and skills is low. • High: The ability provided by the migrated application to acquire additional knowledge and skills is high.

	Integrating Capabilities	The ability to combine individual knowledge into the unit's new operational capabilities (Pavlou and El Sawy, 2011).	• Low: The ability provided by the migrated application to help integrate new capabilities into a new reconfigured environment is low. • High: The ability provided by migrated application to help integrate new capabilities into a new reconfigured environment is high.
	Coordinating Capabilities	Orchestrating and deploying discrete reconfigured tasks, resources, and activities embedded in the new operational capabilities (El Sawy and Pavlou, 2008).	• Low: The ability provided by the migrated application to help coordinate activities that influence application migration to cloud computing is low. • High: The ability provided by the migrated application to help coordinate activities that influence application migration to cloud computing is high.

Table 2: A Summary of the Four Complementary Theoretical Perspectives on Stakeholders' Decisions to Migrate Applications to Cloud Computing in Government Organizations

Theory	Application Characteristics from the Theory	Reference	Explanation of Cloud Computing Decision	Expected Influence	Hypothesis
Transaction Cost Theory	Relative cost advantage Application complexity Application strategic importance	(Tiwana and Bush, 2007); (Xia and Lee, 2004); (Schwarz, *et al*., 2009).	The attributes of applications that lower transaction costs with an external vendor should increase the likelihood that managers will choose to migrate the application to cloud computing.	(+) (+) (-)	H1 H2 H3
Resource-Based Theory	Resource Gap Resource Heterogeneity Resource Utilization	(Tiwana and Bush, 2007); (Schwarz, *et al*., 2009).	If the application requires relatively rare technical skills and expertise, the more likely the application will be migrated to cloud computing.	(+) (-) (+)	H4 H5 H6
Agency Theory	Application Outcome Measurability Vendor Behavior Observability Trust in Vendor	(Tiwana and Bush, 2007); (Harrison, 1988 and Kirsch, 1996).	Application characteristics that lower potential principal-agent conflicts between the client and vendor should increase the likelihood that managers will choose to migrate applications to cloud computing.	(+) (+) (+)	H7 H8 H9
Dynamic Capabilities Theory	Sensing Capabilities Learning Capabilities Integrating Capabilities Coordinating Capabilities	(El Sawy and Pavlou, 2008); (Pavlou and El Sawy, 2011).	Migration of applications to cloud computing will improve sensing, learning, integrating and coordinating capabilities.	(+) (+) (+) (+)	H10 H11 H12 H13

RESEARCH METHODOLOGY

The objective of the research is to help determine the relative strengths of each of the thirteen factors that influence application migration to cloud computing in government organizations. As an example, if all thirteen factors were equally considered, we would expect that each factor would contribute a weight of approximately 7.7% in the decision process. While prior studies on cloud computing identify several factors that influence the decision to migrate applications to the cloud environment, we are not aware of any studies that establish the relative importance of the various factors in this critical decision. Therefore, the primary objective of the study is to use the conjoint analysis approach to develop such an understanding. Specifically, by having the respondent consider thirteen factors together when making a decision, the conjoint methodology approach will help us uncover the importance of each of these factors.

VII.I Conjoint Technique

Conjoint research design has been widely used in many disciplines such as marketing since the early 1970's. However, it has been rarely applied in IT research, with a few notable exceptions (e.g., Money et al., 1988; Bajaj, 2000; Tiwana and Bush, 2007 and Schwarz *et al*, 2009). Conjoint analysis goes beyond simple surveys by providing a more realistic approach to understanding consumer attitudes, opinions, and behavior (Orme, 2010). Introduced as a fundamental measurement method more than forty years ago, conjoint analysis presents combinations of features or attributes in product profiles and asks people to rank or rate those profiles, or to make choices among product profiles (Orme, 2010). The technique requires participants to analyze a variety of different scenarios in which the independent variables are experimentally manipulated. The significant benefit of the conjoint approach is that is combines the control of a laboratory experiment with the external validity of a survey (Orme, 2010). The basic idea of a conjoint analysis is to present a subject with a profile of a product or service and ask the subject to rate its different attributes (factors). For example, in a consumer domain, one might ask an individual to rate several cars based on a variety of attributes of the car such as the color, make, horsepower, and other options. The respondent then rates each car based upon those attributes and the researcher uncovers which of the attributes is driving the decision to purchase (Schwarz et al, 2009).

Conjoint analysis is a multi-attribute judgment analysis technique based on information integration theory (Anderson, 1981), which involves a posteriori decomposition of the respondent's decision-making process (Louviere, 1988). The three elements that comprise a conjoint research design are 1) the attributes, 2) conjoint profiles, and, 3) part-worth and overall utilities. The attribute refers to a decision criterion that respondents might use to evaluate the dependent variables: -What is the likelihood of application migration to cloud computing? And, how attractive would it be for your government organization to migrate an application to cloud computing? In layman's terms, conjoint analysis (1 identifies the attributes important in a choice decision, (2 identifies the way the attributes are combined to make the decision, and, (3 determines the utility value for each of the levels of each of the attributes considered in the decision (Qualtrics, 2011).

VI.II Research Model

The constructs derived from the four theories (Transaction Cost, Resource-Based, Agency and Dynamic Capabilities) represent the conjoint attributes (factors) in this study (Figure 1). Different combinations of attribute levels are called conjoint profiles. The overall value assigned by the decision maker to the dependent variable is referred to as its overall utility and the contribution of each attribute its part-worth utility. Each respondent will be presented a series of conjoint application profiles with different combinations of attribute levels (application characteristics) and the respondent provides an assessment of the dependent variables (likelihood that you would recommend migrating an application to cloud computing, and how attractive would it be for your government organization to migrate an application to cloud computing?) for each profile (Figure 1). Each profile will describe an application in terms of the levels (i.e., "High" and "Low") of each of the attributes of the application and requires the respondent to assess its attractiveness for migrating to cloud computing and the likelihood that they would recommend migrating the application to cloud computing (Figure 2). Our study uses a sequential, multi-method data collection approach, where a theoretically guided conjoint survey is used to collect data from government stakeholders involved in the decision to migrate applications to cloud computing. In our study, the conjoint profiles will model different organizational scenarios that may impact the likelihood of application migration to cloud computing. Because organizational decision-makers are faced with different cloud computing migration choices, the responses to these profiles offer a level of insight not normally available from traditional questionnaire-based studies. Although conjoint analysis is widely used in marketing research, its use in evaluating factors related to IT decision making has been limited, with a few exceptions (e.g., Money *et al*., 1988; Bajaj, 2000; Tiwana and Bush, 2007, Schwarz *et al*, 2009). Further, a qualitative study is used to obtain additional insights on the results obtained from the conjoint study.

VII.III Development of the Conjoint Profiles

The first step in conjoint analysis is specifying the appropriate conjoint methodology and constructing the stimuli to be evaluated by the respondents under that methodology (Qualtrics, 2011). There are many different methodologies for conducting conjoint analysis (i.e., two attribute tradeoff analyses, full-profile, adaptive, choice-based and self-explicated). We use full-profile methodology since it is the most fundamental approach for measuring attribute utilities. Each profile was designed as part of a fractional factorial experimental design that evenly matches the occurrence of each attribute with all other attributes (Qualtrics, 2011). By controlling the actual pairings in the fractional factorial design, we are able to estimate the respondent's utility for each factor tested using a reduced set of profiles.

The conjoint profiles were generated using an orthogonal design feature included in IBM SPSS Conjoint 22 software. This is an add-on component software application to the SPSS software suite. The orthogonal factorial design is used to reduce the number of attribute combinations and make the task manageable (Green and Srinivasan, 1990). Being mindful of the demands on a government stakeholder's time, but still concerned with obtaining good quality data, I chose the orthogonal factorial design to reduce the number of profiles. Since I am using thirteen factors with this study, and each factor can have two possible values (high or low), the total number of profiles resulting from all possible combinations (conjoint profiles) of these application factors is 8,192 (2^{13}). The number of possible conjoint profiles therefore increases exponentially with each additional conjoint attribute (factor) or attribute level (Tiwana and Bush, 2007). It then becomes impractical for the respondent to evaluate every possible profile combination that can be generated. To solve this problem, the orthogonal design feature is used to select the minimum number of profiles needed, while still capturing the main effects for each factor level.

Each application migration factor (or attribute) was derived using definitions relating to the four theories (Table 1). The attributes were operationalized using definitions from IS theories and related literature reviews to our specific topic. Each respondent was given a respondent reference card (Appendix A) at the beginning of the survey to ensure that they were familiar with the definitions of each of the constructs. The two-level predictors with values of "high" and "low" were then entered into the orthogonal design along with the thirteen factors. The minimum number of cases necessary for the orthogonal plan is then automatically generated. For our study, a total of sixteen profiles were automatically generated by the conjoint algorithm implemented in SPSS software (Table 3), and each was evaluated by the respondents.

VII.IV Operationalization of Variables

For Transaction Cost Theory, *relative cost advantage* was operationalized as the expected cost savings from migrating an application to cloud computing instead of pursuing it internally (Tiwana and Bush, 2007). Similarly, *application complexity* was measured by the complexity of the application due to its size, scope, or technical novelty (Xi and Lee, 2004). *Application strategic importance* assessed how important the application is to the organization and the risk if something goes wrong (Tiwana and Bush, 2007).

For Resource-Based Theory, *resource gap* was measured as the extent to which there are internal people with technical skills to provide the application service (Schwarz, *et al*., 2009). *Resource heterogeneity* was operationalized as the extent to which the application differentiates the firm (Schwarz, *et al*., 2009). *Resource utilization* was measured as the extent to which resources are efficiently and effectively utilized (Schwarz, *et al*, 2009).

For Agency Theory, *application outcome measurability* was measured by the ability to measure the cost, schedules, risks and performance metrics of a given application (Harrison, 1988). *Vendor behavior observability* was defined as the extent to which vendor / employee behaviors can readily be monitored (Kirsch, 1996). *Trust in the vendor* was defined as the willingness of one person to increase their vulnerabilities to the actions of another person whose behavior they cannot control (Kim, *et al*., 2005).

The final set of factors was based on dynamic capabilities theory. *Sensing capabilities* were defined as the ability to spot, interpret, and pursue the need for changing the enterprise's operational capabilities by understanding market needs and identifying new internal and external opportunities (El Sawy and Pavlou, 2008). *Learning capabilities* were defined as the ability to acquire, assimilate and develop new knowledge needed to revamp operational capabilities and new knowledge and skills (El Sawy and Pavlou, 2008). *Integrating capabilities* was defined as the ability to combine individual knowledge into the unit's new operational capabilities (Pavlou and El Sawy, 2011). And finally, *coordinating capabilities* was defined as orchestrating and deploying discrete reconfigured tasks, resources, and activities embedded in the new operational capabilities (El Sawy and Pavlou, 2008).

The two dependent variables were measured on two items of a nine-point scale, were 1) what is the likelihood that you would recommend migrating an application to cloud computing based on the profile provided? and 2) how attractive would it be for your government organization to migrate an application to cloud computing based on the profile provided?

Table 3. Application Attribute Levels and Descriptive Statistics for the Sixteen Conjoint Profiles

	Conjoint Application Profile															
Conjoint attribute	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Relative Cost Advantage	Low	Low	High	High	High	Low	Low	High	High	Low	Low	High	Low	Low	High	High
Application Complexity	Low	Low	Low	Low	Low	High	High	High	High	Low	Low	High	High	High	Low	High
Application Importance	High	Low	High	Low	High	Low	Low	High	Low	High	Low	Low	High	High	Low	High
Resource Gap	High	Low	High	Low	Low	High	Low	High	High	Low	High	Low	Low	High	High	Low
Resource Heterogeneity	High	Low	Low	High	High	High	Low	Low	Low	Low	High	High	Low	High	Low	High
Resource Utilization	High	Low	Low	High	Low	Low	Low	Low	High	High	Low	High	High	High	High	Low
Outcome Measurability	Low	Low	Low	Low	High	High	Low	Low	High	High	High	Low	High	Low	High	High
Vendor Observability	Low	Low	Low	Low	High	Low	High	High	Low	High	High	High	Low	High	High	Low
Trust in Vendor	High	Low	Low	High	Low	High	High	High	Low	High	Low	Low	Low	Low	High	High
Sensing Capabilities	Low	Low	High	High	Low	High	Low	High	Low	High	High	High	High	Low	Low	Low
Learning Capabilities	Low	Low	High	High	Low	Low	High	Low	High	High	High	Low	Low	High	Low	High
Integrating Capabilities	Low	Low	High	High	High	High	High	Low	Low	Low	Low	Low	High	High	High	Low
Coordinating Capabilities	High	Low	High	Low	High	High	High	Low	High	High	Low	High	Low	Low	Low	Low
DV																
Mean	5.22	3.75	5.55	6.59	5.08	5.16	4.83	6.20	4.69	5.87	4.27	4.84	3.71	3.66	6.58	6.27
Standard deviation	2.13	2.43	1.99	1.75	2.00	2.05	1.95	1.94	1.9	1.86	1.94	1.72	1.80	1.87	1.91	1.96

VII.V Sample and Data Collection

The data collection approach included 1) conjoint survey instrument development, 2) conjoint survey administration, and, 3) follow-up interviews. The output from the SPSS Conjoint orthogonal plan displaying the 16 profiles with "High" and "Low" for each factor was then used to create the survey instrument. To ensure instrument validity and clarity of the definitions and the conjoint instrument, the materials were tested with three experts who were CIOs in government organizations. Feedback from these experts was used to refine the wording in the questionnaire, clarify definitions, ensure the profiles were realistic and demonstrate validity. The researcher elected to use Qualtrics, which is an online survey software tool, because of its ease of use, features for email and administration along with its strong security and privacy policy. The questionnaire was sent through Qualtrics to 355 civilian government professionals (excluding the Department of Defense) who hold positions ranging from CIO, CTO, IT Director Manager/ Supervisor, IT Specialist to Executive (non-IT). This sample represents key decision makers and stakeholders in application migration to cloud computing.

The researcher received a total of 81 usable responses for a response rate of 23%. The minimum recommended response rate level is 20% for organizational surveys (Grover, 1997; Yu and Cooper, 1983) and this response rate is comparable to those obtained in other information systems (IS) research studies (Pinsonneault and Kraemer, 1993; Tiwana and Bush, 2007; and Schwarz, *et. Al*, 2009). While there are no clear guidelines on minimum sample size for the conjoint approach (McCullough, 2002), a sample size of at least 75 is usually recommended (Schwarz, et. al., 2009). The sample size obtained in my study meets this threshold. Frequency tables showing the demographics of the respondents are shown in Table 4. Of the responses, several were discarded due to incomplete responses, leaving data on 1,296 (16 conjoint profiles x 81 stakeholders) responses from 81 federal government stakeholders.

Table 4: Frequency Tables

How many employees are in your IT organization (including contractors)?

Characteristic	Frequency	Percent
Less than 50 employees	6	7.4
50 - 100 employees	12	14.8
101 – 500 employees	23	28.4
501 – 1000 employees	14	17.3
Greater than 1000 employees	26	32.1
Total	81	100.0

What industry best describes your organization?

Characteristic	Frequency	Percent
General Services (i.e., buildings, construction, manufacturing)	4	4.9
Energy	8	9.9
Commerce	16	19.8
Financial Services	4	4.9
Agriculture	2	2.5
Homeland Security	19	23.5
Other	28	34.6
Total	81	100.0

What is your experience level working in the information technology area?

Characteristic	Frequency	Percent
Less than 1 year	1	1.2
2-5 years	3	3.7
5-10 years	2	2.5
10-15 years	7	8.6
15-20 years	20	24.7
Greater than 20 years	48	59.3
Total	81	100.0

VII.VI Control Variables and Demographics

Six demographic characteristics of the responding stakeholders were collected as important control variables to help divide the data into categories. These controls were guided primarily by theoretical considerations from the theories we selected and were independent of the application characteristics. They included: 1) number of employees in the respondent's IT organization (including contractors), 2) industry that best describes the respondent's organization within government, 3) the respondent's experience level working in the IT area, 4) the respondent's job title, 5) the respondent's prior experience in the number of applications that s/he has been involved in deploying to cloud computing, and, 6) the respondent's self-reported level of confidence in the evaluation of the application profiles. The participants in the survey were highly experienced with 59.3% having greater than 20 years of experience in the information technology area and with 24.7% having between 15-20 years of experience in the information technology area. Over 32% of the respondents were from government organizations with greater than 1,000 employees (including contractors) and with 28.4% of the respondents coming from government organizations with 101-500 employees (including contractors). Over 23% of the respondents came from the homeland security industry within government, 19.8% from Commerce and 34.6% from other industries within government. Of the respondents, 48.1% were either an IT Director/Manager or Supervisor and 29.6% were CIO's. Of the respondents, 45.7% had prior experience with migrating at least one to three applications in the number of applications that they have previously migrated and with 21% of the respondents having prior experience of migrating at least four to seven applications. Also, interestingly enough, over 17% have been involved in deploying greater than ten applications to cloud computing. Regarding the confidence level, 46.9% of the respondents stated that they were somewhat confident in rating the sixteen profiles and 39.5% said they were very confident. In view of the fact that cloud computing is still an emerging trend and standards and guidelines for cloud computing are still evolving, it is remarkable that only a small percentage of respondents (less than 10%) were not confident about their ratings.

VII.VII Follow-Up Interviews

The researcher conducted a total of twelve follow-up interviews, by selecting respondents randomly from the original pool of respondents. These semi structured interviews were conducted over the phone. Detailed notes were taken in each interview. The interview questions (Appendix F) were open-ended and were focused on gaining additional insights into the decision to migrate applications to cloud computing that are reported in the next section.

VII.VIII Data Analysis

In conjoint analysis, the direction of the relationship between each independent variable and the dependent variable is indicated by the Beta (regression coefficient) and its statistical significance by the corresponding z-statistic (Tiwana and Bush, 2007). The researcher used the SPSS software tool to measure the utility value or significance for each of the independent variables and the proportion of variance in the independent variables explained by the dependent variable to arrive at the importance of each factor. The researcher used a stepwise regression model to test the hypotheses on our sample. The purpose of stepwise regression is to reduce the set of independent variables down to the most important predictors (Stephens, 2004). The researcher created a stepwise regression model for each of the profiles to examine the effect of the factors on the dependent variable. The researcher created dummy variables for each attribute within each profile to compute an adjusted r^2 value for each of the independent variables. The predictors for each theory are then incrementally added to compare the contribution of each theory to help explain decisions in the migration of applications to cloud computing in government organizations.

We also ran a regression analysis against the 81 completed cases to compute the utility of importance for each of the factors along with the correlations for Pearson's R and Kendall's tau against our dependent variable (Appendix I). The Pearson's R and Kendall's tau are a measure of the correlation (linear dependence) between two variables X and Y, giving a value between +1 and −1 inclusive. These are widely used as a measure of the strength of linear dependence between two variables (Stephens, 2004).

RESULTS

VIII.I Stepwise Regression Results

A stepwise regression model of five-steps (control variables and four theories) was incrementally added to the model to produce the results from the conjoint analysis. The following five blocks of variables were incrementally introduced into the model: 1) Control variables, 2) Transaction Cost theory variables, 3) Resource-Based theory variables, 4) Agency theory variables, and, 5) Dynamic capabilities theory variables. The predictors for each of the theories were introduced incrementally in the stepwise procedure only for the purpose of comparing the incremental explanation provided by each theory on the decision to deploy applications to the cloud. The results from this analysis are presented in Table 5. Trust in vendor and relative cost advantage were both significant along with application complexity and sensing capabilities. It is surprising that trust in the vendor actually was more significant than relative cost advantage. It is also surprising that sensing capabilities under the dynamic capabilities theory was significant when introducing the other theories successively. Sensing is the ability to spot, interpret, and pursue the need for changing the enterprise's operational capabilities by understanding market needs and identifying new internal and external opportunities (El Sawy and Pavlou, 2008). The results possibly suggest that CIO's and other stakeholders need to be sensing both their internal and external environments by utilizing better planning for cloud migrations and anticipating later business and technology requirements. This would be true for whichever type of cloud implementation (i.e., public, private or hybrid) is being performed, although public and hybrid clouds may require more sensing of the environments from a privacy, security and compliance standpoint due to the data that is exposed via web facing servers and infrastructure that is hosted in a cloud environment. It is not surprising that relative cost advantage was significant since cost is often a major driver in IT application deployment project decisions (Tiwana and Bush, 2007). Although application strategic importance shows up as having relative importance, it is not significant. Experience level with the application as a control variable is significant for the dependent variable (See: Table 5). We empirically verified that the sequence in which the four theories were introduced did not alter the results.

VIII.II Hypothesis Test Results

Four factors were statistically significant in the hypothesized direction (See: Table 5) out of the total of thirteen proposed factors. The results of this analysis show that relative cost advantage (H1), application complexity (H2), the organization's trust in the vendor (H9), and the ability to sense new opportunities (H10) positively and significantly influence the decision makers' decision to deploy applications on the cloud computing platform in government organizations. It was surprising to see that no factors from the resource-based theory were significant. This could be related to the fact that resources are not as significant in a cloud computing environments due to the elasticity and requirements of using contractor resources as needed on demand. As cloud computing evolves, the resource issues both on the government side and contractor side will better mature and roles and responsibilities will be better defined. Also, it was surprising to see sensing capabilities under the dynamic capabilities theory as significant. This may be attributed to the fact that government organizations are becoming more agile and dynamic and must plan and sense their environments in advance of innovations such as migrating applications to cloud computing.

VIII.III Analysis of Application Strategic Importance

One of the hypothesized factors, strategic importance of the application, was not significant. To gain further insights into the non-significance of application strategic importance in migration of cloud computing applications in government organizations, we created two subgroups for high and low levels of strategic importance of the application and compared the models across these two groups. The results of this analysis are presented in Table 6. First, relative cost advantage is significant in both the high and low application strategic importance subgroups. Paradoxically, this implies that stakeholders are likely to migrate applications to the cloud motivated by cost savings whether the application is of high or low strategic importance. Second, application complexity is significant in both the high and low application strategic importance subgroups. Thus, regardless of the strategic importance, the perceived technical complexity of the application is significant in the decision making process. Third, for both high and low strategic important applications, trust in the cloud vendor has an effect on the likelihood of application migration to cloud computing. Thus, stakeholders are more likely to migrate applications to the cloud motivated by trust in the cloud computing vendor whether the application is of high or low strategic importance. Finally, sensing capabilities was positive and significant in applications of high strategic importance, suggesting that if an application is of high strategic importance and also provides sensing capabilities, stakeholders are more likely to migrate applications to cloud computing. However, sensing capabilities were not significant for applications with low strategic importance. The reader should note that our measure for strategic importance did not define low strategic importance from a tactical versus strategic standpoint, which may have influenced our results.

Table 5: Regression Results for Cloud DV

Table 5: Regression Results for Cloud DV

Variable		Expected Influence	Hypothesis	β	z-statistic	Step 2 TCE Variables β	Step 2 TCE Variables z- statistic	Step 3 RBT Variables β	Step 3 RBT Variables z-statistic	Step 4 AT Variables β	Step 4 AT Variables z- statistic	Step 5 DC Variables β	Step 5 DC Variables z- statistic	R Squared	Relative Importance
Constant				4.859	11.066*										
Number of Employees				-0.003	-0.054										
Industry Type				-0.002	-0.069									0.007	
Exp. Level in IT				0.027	0.444										
Job Title				-0.039	-0.87										
Exp. Level in Apps				-0.12	-2.301*										
Confidence Level				0.173	1.939										
Model	**Variables**														
	Relative Cost Advantage	(+)	H1			1.189	10.622*								2
Transaction Cost Theory (TCE)	Application Complexity	(+)	H2			-0.438	-3.908*							0.097	3
	Application Strategic Importance	(-)	H3			0.098	0.875								4
	Resource Gap	(+)	H4					0.052	0.461						
Resource-Based Theory (RBT)	Resource Heterogeneity	(-)	H5					-0.005	-0.048					0.097	
	Resource Utilization	(+)	H6					0.019	0.172						
	Application Outcome Measurability	(+)	H7							0.129	1.224			0.205	
Agency Theory (AT)	Vendor Behavior Observability	(+)	H8							0.059	0.564				
	Trust in Vendor	(+)	H9							1.376	13.063*				1
	Sensing Capabilities	(+)	H10									0.242	2.296*	0.209	
Dynamic Capabilities Theory (DC)	Learning Capabilities	(+)	H11									0.16	1.519		
	Integrating Capabilities	(+)	H12									-0.007	-0.066		
	Coordinating Capabilities	(+)	H13									0.004	0.037		

Note: * p ≤ 0.05

Table 6: Analysis for High and Low Application Strategic Importance

Attribute	High		Low	
	β	**z-statistic**	**β**	**z-statistic**
Relative Cost Advantage	0.282	**8.813***	0.28	**7.152***
Application Complexity	-0.118	**-3.695***	-0.083	**-2.127***
Resource Gap	0.006	0.198	0.02	0.518
Resource Heterogeneity	0.005	0.158	-0.01	-0.253
Resource Utilization	-0.011	-0.356	0.026	0.672
Application Outcome Measurability	0.016	0.514	0.05	1.267
Vendor Behavior Observability	0.035	1.087	-0.014	-0.364
Trust in Vendor	0.383	**11.955***	0.248	**6.314***
Sensing Capabilities	0.071	**2.213***	0.038	0.981
Learning Capabilities	0.036	1.126	0.04	1.025
Integrating Capabilities	0.004	0.138	-0.01	-0.253
Coordinating Capabilities	-0.006	-0.178	0.01	0.253

Note: $*p \leq 0.05$

VIII.IV Correlations between the Dependent Variable

To assess the statistical significance of the results for the stepwise regression methodology mentioned above, we examined the r^2 after running it for each of the four theories using SPSS Conjoint 22 add-on software and found the results for the r^2 to be .209 (Appendix H). The direction of the relationship between each independent variable and the dependent variable is indicated by its regression coefficient. We used the SPSS Conjoint 22 add-on software to compute Pearson's R and Kendall's tau, which were 0.998 and 0.954 respectively (Appendix I). The values measure the correlation between predicted (as per the model) and actual data.

We also used the SPSS Conjoint 22 software add-on to compute normal regression analysis against the 81 completed cases. The results show a surprising finding in that trust in the vendor was given a higher importance value than relative cost advantage when run against the dependent variable (see Table 7). The results also indicate that two other factors have minimal importance across all factors in the influence of application migration to cloud computing. Both resource heterogeneity and vendor behavior observability had the lowest average importance score when run against the dependent variable.

The values in Table 7 are the utility scores for each factor, which is computed using orthogonal design in conjoint analysis. The range of the scores (or utility values) from highest to lowest for each factor provides a measure of how important the factor was to overall preference. The factors with greater utility values play a more significant role than those with smaller values in the decision to migrate to cloud computing. The values in the tables provide a measure of the relative importance of each factor known as the importance score of factor. The values are computed by SPSS software by taking the utility range for each factor separately and dividing by the sum of the utility ranges for all factors. The values are thus percentages and have the property to sum to 100 (SPSS 22, 2013).

Table 7: Importance Values for Cloud DV

Averaged Importance Score	
Cost	**15.24**
Complexity	**7.417**
Strategic	**7.644**
Resources	**5.978**
Heterogeneity	**5.249**
Utilization	**5.79**
Measurability	**6.779**
Observability	**5.619**
Trust	**16.114**
Sensing	**5.693**
Learning	**6.053**
Coordinating	**6.674**
Integrating	**5.753**

The utility values above show that trust, cost, strategic importance and application complexity as the highest averaged importance scores. Note that two of the four theories have factors that are rated the highest from a utility standpoint. The utility values above for the dependent variable average show trust, cost, strategic importance and complexity as the highest averaged importance scores. The cost factor (transaction cost theory) and the trust factor (agency theory) are the most significant for the dependent variable analysis.

VIII.V Qualitative Feedback

As mentioned previously, twelve follow-up interviews were conducted to confirm our findings and to help provide explanations of our results. The respondents were asked to explain why trust in a vendor, relative cost advantage, application complexity and sensing capabilities came up statistically significant. Only one respondent was not surprised that trust in the vendor is significant. However, with the exception of one interviewee, none of the respondents was surprised that application complexity and sensing were significant. One interviewee responded, "*All four of these factors around trust, cost, application complexity and sensing are backbone concerns of any federal agency migrating to the cloud. I am not surprised by the outcome.*"

Reflecting on the finding that sensing capabilities was only significant for those applications with high strategic importance, most respondents suggested that they agreed with the results. One executive explained, "*Sensing is strategically important to us during application migration to cloud computing especially for those applications that have a high strategic importance.*" Elaborating on whether the respondents' decisions would have been different under different environmental circumstances (i.e., a normal environment without continuing resolution, sequestration, and shutdown, etc.) that were characteristic of the interviews' time frame , all but one respondent felt that no, their decisions would not have been different. Another executive explains as follows: "*This environment didn't really play a role when answering the questions and felt strongly in agreement with the three factors that came up significant.*" All respondents suggested that as more and more experience is gained, their confidence with deploying applications with cloud computing is likely to go up. One executive felt that, "*Experience is critical and that the combination of experience and confidence are huge success factors.* Another respondent suggested that, "*The confidence level played a big part in the trust. You have to have confidence in the vendor. Experience level is very important and when you are doing something new like cloud computing, you want someone with a high experience level.*"

Commenting on how their decision making may be influenced by the findings from the study, a senior technical executive stated, "*This will be a material contributor to the CTO for cloud solutions going forward with his cloud strategy and provide significant input for* *analysis."* Another executive replied that, "*This study has proven and validates my thoughts."* Thus, our follow-up study helped confirm the validity of our findings and provided additional insights on the relative importance of the various factors that influence application migration to cloud computing in government organizations.

VIII.VI Summary of Results

In summary, the results show that not only is relative cost advantage significant, but trust in the cloud computing vendor, sensing capabilities and application complexity are statistically significant. Further, consistent with prior studies, experience level in applications was also significant. The follow-up interviews provided confirmation that the stakeholders viewed trust in the cloud vendor, relative cost advantage, application complexity and sensing capabilities as critical in their decision to migrate to cloud computing. Further, as more experience is gained with cloud computing, their confidence level and trust with the cloud computing vendor will go up. Prior research on outsourcing examined the role of transaction cost, resource-based view, agency theory and knowledge-based theory (Schwarz, *et al.,* 2009 & Tiwana and Bush, 2007). Our study extends the literature by examining the role of dynamic capabilities in application migration to cloud computing.

DISCUSSION

IX.I Research Contributions

The relevance and practical importance of the study for evidence based management and engaged scholarship are significant. Cloud computing is still an emerging technology that has not been fully embraced in most government organizations; yet there are several indications that it will significantly change the landscape of IT application delivery. The literature on the factors that influence the migration of applications to cloud computing is very nascent. In the absence of clear guidelines, the decision to migrate applications is typically made by relevant stakeholders on the basis of the perceived risk associated with migration.

A primary contribution of our study is that it is the first attempt to compare the relative importance assigned by decision makers in governmental organizations to factors drawn from four complementary theories: Transaction Cost theory, Resource-Based theory, Agency theory and Dynamic Capabilities theory. While each of the theories has been used in isolation in prior research, our research is the first to provide a multitheoretical view of the decision to migrate applications to cloud computing. In fact, our study highlights how the consideration of multiple theories offers different results when compared to the use of each of the theories in isolation (Table 5 compared to Table 8).

The results for the relative importance of trust and cost provide critical insights for decision makers and cloud computing vendors involved in the migration of applications to cloud computing. Our results provide concrete evidence that trust in cloud computing vendors is a critical concern. It ranks higher when compared to relative cost advantage and all other dependent variables (Table 8). Our results show similarities with observations from a recent survey in the Edelman Trust Barometer (Edelman, 2013), that the importance of trust is on the rise in business, government, media and NGOs. Further, trust is considered to be most critical in technology related decisions. Since the migration of applications to cloud computing is a critical technology related decision, our results provide further evidence on the importance of trust in this context.

Our findings support other similar studies in the outsourcing area in which relative cost advantage has been found to have the highest level of importance. The most important attribute when making the decision to outsource to a domestic vendor is production costs (Schwarz, *et al*., 2009). Cloud computing has the same key attributes that are similar to those of the "standard" ASP outsourcing model, and exposes the user to similar risks (Brodkin, 2008; Gruman, 2008; Hayes, 2008). Therefore, the role of relative cost advantage as the second most important factor in the decision to migrate to cloud computing is consistent with the results from prior studies on outsourcing. However, the differences in the relative importance of trust and relative cost advantage merit further consideration. Our qualitative follow-up study suggests that in the context of outsourcing, when the vendor provides only application development in the context of migrating applications to the cloud, the client organization may retain very little control over not only the application but also organizational data that is being transacted through the application. As more and more organizations are recognizing the strategic importance of organizational data -- and hence the need to protect it -- decision makers are likely to weigh trust in the vendor as more important than relative cost advantage. Thus, our study highlights the need for more research to develop a nuanced understanding of the tradeoffs between relative cost advantage and trust when novel strategic alliances are developed through mechanisms like cloud computing.

The findings from our study align with the role of dynamic capabilities that have been observed in new product development (El Sawy and Pavlou 2008, Pavlou and El Sawy 2011). Specifically, the ability to create processes that help learn about customer needs which correspond to the ability to sense and learn was considered critical in the decision to migrate applications to the cloud. The cloud computing platform may provide opportunities for, " … enterprises to learn how to be prepared to respond to any novel situation." (El Sawy and Pavlou 2008). The development of such "improvisational capabilities" may be facilitated by the ability to reach beyond the boundaries of the organization and take advantage of capabilities provided by a cloud vendor to learn about the environment, customers and operations. Cloud computing enables rapid and continuous innovations by enabling sensing market opportunities and seizing them through dynamic commitment of resources which have been identified to be crucial in such environments (Eisenhardt 1989, Brown and Eisenhardt 1997). This may explain why sensing capabilities were considered significant by decision makers in their migration decision. Relative cost advantage (drawn from transaction cost theory) was shown to be significant in our study. The majority of the respondents in the qualitative study suggested that the expected savings from using cloud computing deployment will be high when compared to deploying the application internally. The resource-based view of the organization and transaction cost economics are viewed as complementary because the former is a theory of firm rents whereas the latter is a theory of the existence of the firm (Barney, 1991). Resources (of both government and contractor) were hypothesized to play a key role in cloud computing deployments. However, since governmental cloud computing implementations are still in their infancy, Resource Based theory factors were not found to be significant.

IX.II Practical Contributions

There currently exists no step-by-step methodology or framework for government CIOs when migrating applications to cloud computing. This research speaks to the need to develop such an approach which will help government decision makers weigh the factors that should influence their decision when migrating applications to cloud computing. Managers and cloud computing stakeholders can develop a simple tool based on the factors and results presented in this study, especially those that are significant, to help in the decision making process of migrating applications to cloud computing. This tool would list the necessary steps to follow and questions to answer when evaluating factors that influence the application migration to cloud computing in government organizations. In addition, the tool can also help government procurement managers when planning cloud computing procurements and service level agreements (SLA's) to ensure they address the key factors in contract solicitation. Cloud computing has been in serious consideration in government organizations only since approximately 2008 and cost savings has been reported to be the overarching factor driving most CIOs to its use. Other factors that drive decision makers to transition their applications to cloud computing have not been thoroughly examined. The results from this study are critically important currently because the government is now moving more and more applications to cloud computing. Our results will help decision makers to assess the appropriateness of migrating a candidate application to cloud computing. Specifically, this study will help decision makers in government organizations (i.e., federal, state, and local) appropriately weigh the various factors drawn from four complementary theories (Transaction Cost, Resource-Based, Agency and Dynamic Capabilities) while making the decision on the suitability of an application for migration to cloud computing. Thus, a contribution lies in evaluating the relative explanatory power of bringing these four complementary theories together in predicting cloud computing application migration decisions in government organizations.

Of importance during our data gathering phase was the current conditions of government at the time. A government sequester had just occurred which could have triggered spikes in the two significant factors of cost and trust, although our follow-up interviews suggested that a sequester did not affect their responses.

As IT managers plan and deploy cloud computing applications, trust, cost and experience are significant factors that need to be carefully considered. Planning a procurement strategy around these factors will help government organizations identify and migrate an appropriate portfolio of applications to the cloud. These factors should be given consideration while preparing a business case for migrating applications to cloud computing.

Since prior work experience was a significant factor, hiring personnel who have cloud computing skillsets (in both government and contractor organizations) is critical. These skills include networking, configuration management, project management and cyber security to name a few.

Security and privacy are a significant concern in government organizations. Use of the cloud increases the number of people with potential access to sensitive information due to the loss of control inherent with the architecture. Even though switching to the large and reliable cloud computing enables vendors to improve security for small organizations, data security over cloud computing is a major concern for organizations as their critical data is in the hands of the cloud provider. Therefore, as our results suggest, trust in a cloud vendor should be given serious consideration while making the decision to migrate applications to the cloud. Decision makers may also deploy their applications on private clouds as a way to maximize their decision rights and thereby trust in cloud migration.

LIMITATIONS AND FUTURE RESEARCH

The limitations of the study that relate to the use of the conjoint approach require careful consideration. Our study uses hypothetical applications that may not reflect actual applications which are familiar to the survey respondents. However, our pretest with industry experts confirmed that the scenarios were realistic and representative of applications that may be considered for cloud enablement. In addition, in spite of the validation of the scenarios by experts, the possibility that some of the conjoint profiles may not match real-life applications can’t be ruled out completely. Another concern relates to the use of the orthogonal design employed in our research. This technique does not account for interactions among the factors included in the study. The complexity of conjoint analysis also restricts the number of variables that may be included in a study. For example, organizational level factors that may influence cloud adoption that were not included in our study, which focused only on application level factors, require further study.

Additionally, the study was conducted when government organizations were going through budget sequestration. While uncertainty associated with such a scenario may influence the decisions made by government organizations, the relative frequency with which government organizations are operating under such budgetary pressures increases the applicability of the study results. This study excluded DoD organizations because of their unique needs. Similarly, private sector organizations were also not included in our sample. A comparison of the results with data drawn from these other organizations is likely to provide interesting insights.

CONCLUSIONS

This study uses a conjoint analysis approach by drawing from four theories – transaction cost, resource-based, agency and dynamic capabilities -- to examine the factors that influence application migration to cloud computing. We received a total of 81 usable survey responses from government stakeholders who were involved in cloud computing decision making. Both trust in the cloud computing vendor and relative cost advantage were the most significant factors when the theories were viewed individually. However, when the theories were run simultaneously, in addition to trust and cost being significant, sensing capabilities from the dynamic capabilities theory was significant as well. The control variables "experience level in applications" and "confidence level" were significant for one or both of the dependent variables. We also conducted a total of twelve follow-up interviews to confirm our findings and gain any additional insights into the decision to migrate applications to cloud computing in government organizations.

The results of this study contribute to the understanding of the relative importance of the factors that influence application migration to cloud computing. Further, this study examines how the results from the complementary use of these theories contradict the findings when they are used in isolation and how the relative explanatory power of these theories contributes to stakeholder decision making when migrating applications to cloud computing in government organizations.

Figure 2 Example of Conjoint Application Profiles

Profile 1		Profile 2	
Relative Cost Advantage	Low	Relative Cost Advantage	Low
Application Complexity	Low	Application Complexity	Low
Application Strategic Importance	High	Application Strategic Importance	Low
Resource Gap	High	Resource Gap	Low
Resource Heterogeneity	High	Resource Heterogeneity	Low
Resource Utilization	High	Resource Utilization	Low
Application Outcome Measurability	Low	Application Outcome Measurability	Low
Vendor Behavior Observability	Low	Vendor Behavior Observability	Low
Trust in Vendor	High	Trust in Vendor	Low
Sensing Capabilities	Low	Sensing Capabilities	Low
Learning Capabilities	Low	Learning Capabilities	Low
Integrating Capabilities	Low	Integrating Capabilities	Low
Coordinating Capabilities	High	Coordinating Capabilities	Low

Dependent Variable Items

What is the likelihood that you would recommend migrating an application with the above profile to cloud computing?

Very Low — Very High

1 2 3 4 5 6 7 8 9

How attractive would it be for your government organization to migrate an application with the above profile to cloud computing?

Very Unattractive — Very Attractive

1 2 3 4 5 6 7 8 9

REFERENCES

APPENDICES

Appendix A: Respondent Reference Card

Attribute	Definition of Attribute	Levels for Conjoint Analysis ("Low" and "High" Determinants)
Relative Cost Advantage	The expected overall cost savings from migrating an application to cloud computing instead of deploying it internally.	• Low: The expected savings from using cloud deployment will be low when compared to deploying the application internally. • High: The expected savings from using cloud deployment will be high when compared to deploying the application internally.
Application Complexity	The complexity of the application due to its size, scope, or technical novelty.	• Low: The perceived technical complexity of the application being migrated is low. • High: The perceived technical complexity of the application being migrated is high.
Application Strategic Importance	Importance of the application to the organization's mission.	• Low: The application has low strategic importance to the organization. • High: The application has high strategic importance to the organization.
Resource Gap	The availability of internal people with technical skills to deploy the applications in house.	• Low: The application being migrated to cloud computing requires internal people with technical skills that are relatively common. • High: the application being migrated to cloud computing requires internal people with technical skills that are relatively rare.
Resource Heterogeneity	The extent to which the application differentiates the organization.	• Low: The application does not serve as a differentiator for the organization. • High: The application does serve as a differentiator for the organization.
Resource Utilization	The extent to which the application is used.	• Low: A small number of users access the application. • High: A large number of users access the application.
Application Outcome Measurability	Extent to which the outcomes of the application can be precisely measured using predefined service level agreements (if applicable) on performance, trouble tickets, availability, security incidents, etc.	• Low: The outcomes of the application being migrated cannot be measured easily. • High: The outcomes of the application being migrated can be measured easily.
Vendor Behavior Observability	Extent to which vendor behaviors can readily be monitored during application deployment and integration through on-site staff or tracking software.	• Low: It will not be easy to monitor the behavior of the cloud computing vendor. • High: It will be easy to monitor the behavior of the cloud computing vendor.
Trust in Vendor	Willingness of one person to increase their vulnerabilities to the actions of another person whose behavior they cannot control.	• Low: Your trust in the cloud computing vendor is low. • High: Your trust in the cloud computing vendor is high.
Sensing Capabilities	The ability provided by the cloud deployment of the application to spot, interpret, and pursue the need for changing	• Low: The ability provided by the application to sense the environment to understand market needs and identify new internal and external opportunities is low.

	the organization's operational capabilities by understanding market needs and identifying new internal and external opportunities.	• High: The ability provided by the application to sense the environment to understand market needs and identify new internal and external opportunities is high.
Learning Capabilities	The ability provided by the cloud deployment of the application to acquire, assimilate, and develop new knowledge needed to revamp operational capabilities with new knowledge and skills.	• Low: The ability provided by the application being migrated to acquire additional knowledge and skills is low. • High: The ability provided by the application being migrated to acquire additional knowledge and skills is high.
Integrating Capabilities	The ability provided by the cloud deployment of the application to combine individual knowledge into the organizations new operational capabilities.	• Low: The ability provided by the application being migrated to help integrate new capabilities into a new reconfigured environment is low. • High: The ability provided by the application being migrated to help integrate new capabilities into a new reconfigured environment is high.
Coordinating Capabilities	The ability provided by the cloud deployment of the application to orchestrate and deploy discrete reconfigured tasks, resources, and activities embedded in the new operational capabilities.	• Low: The ability provided by the application being migrated to help coordinate activities that influence application migration to cloud computing is low. • High: The ability provided by the application being migrated to help coordinate activities that influence application migration to cloud computing is high.

Appendix B: Email Template for Cloud Computing Survey

As you may know, I am finishing up my executive doctorate degree in Business from Georgia State University and am currently in the data collection phase of my research. My topic is around cloud computing and I am specifically studying "What factors influence application migration to cloud computing." I would appreciate it if you could take a few minutes to complete the attached survey. Please read the attached Informed Consent Form and click the link at the end of the document to start the survey. I have also attached the link to the survey below but please read the Informed Consent Form first before starting the survey. If the link does not open, click and hold the ctrl key or copy the link into your web browser. I have also attached a Respondent Reference Card at the beginning of the survey to help provide definitions of the terms that I am using in the survey. Please refer to these definitions if you are unsure in what context I am using them in my study on application migration to cloud computing. I value your time and your feedback is critical to the final stages of my dissertation research. Please complete the survey in the next 3-5 days if at all possible.

Thanks,

Barry C. West
Executive Doctoral Student
Executive Doctorate in Business Program
J. Mack Robinson College of Business
Georgia State University

Informed Consent Form

Appendix C: Informed Consent Form

Georgia State University
Department of Computer Information Systems
Informed Consent

Title:	Factors that Influence Application Migration to Cloud Computing: A Conjoint Approach
Principal Investigator:	Dr. Balasubramaniam Ramesh
Student Investigator:	Barry C. West

I. Purpose:

You are invited to participate in a research study. The purpose of the study is to investigate the various factors that influence decision making around the suitability of an application for migration to cloud computing. You are invited to participate because you are currently using cloud computing in an organization and/or are involved in cloud computing technology adoption decisions. A total of 350+ participants will be recruited for this study. Participation should take less than 30 minutes of your time.

II. Procedures:

With your approved consent to proceed, you will have access to an on-line survey. Participants will select choices from different profiles along with several survey questions. There is no right or wrong answers to the choices or the survey questions. Please answer the choices and questions honestly. With your approved consent to proceed, you will be placed automatically into the on-line survey. This study involves no compensation to the participants.

III. Risks:

In this study, you will not have any more risks than you would in a normal day of life.

IV. Benefits:

Participation in this study may not benefit you personally. However, the researcher hopes to gain a better understanding of the factors that influence application migration to cloud computing. Overall, the researcher hopes to gain information about attitudes, opinions and behaviors when public sector stakeholders migrate applications to cloud computing. Therefore, potentially organizations and society will benefit from a deeper understanding of these behaviors.

V. Voluntary Participation and Withdrawal:

Participation in research is voluntary. You do not have to be in this study. If you decide to be in the study and change your mind, you have the right to drop out at any time. You may skip questions or stop participating at any time. Whatever you decide, you will not lose any benefits to which you are otherwise entitled.

VI. Confidentiality:

The researcher will keep your records private to the extent allowed by law. Data are collected for the sole purpose of this research. Only the principal investigator (Balasubramaniam Ramesh) and student investigator (Barry West) will have access to the information you provide. Information may also be shared with those who make sure the study is done correctly (GSU Institutional Review Board, the Office for Human Research Protection (OHRP). Each interview will be assigned a random identification number rather than your name on study records. The information you provide will be stored electronically in the Qualtrics software, which is a web platform for the creation and distribution of online surveys. Qualtrics uses password protection, backups and data replication and maintains a high level of security and privacy for the data that is collected. Your name and other facts that might point to you will not appear when the researcher presents this study or publishes its results. The findings will be summarized and reported in group form. You will not be identified personally.

VII. Contact Persons:

Contact Dr. Balasubramaniam Ramesh at (404) 413-7372 or bramesh@gsu.edu if you have questions, concerns, or complaints about this study. You can also call if think you have been harmed by the study. Call Susan Vogtner in the Georgia State University Office of Research Integrity at (404) 413-3513 or svogtner1@gsu.edu if you want to talk to someone who is not part of the study team. You can talk about questions, concerns, offer input, obtain information, or suggestions about the study. You can also call Susan Vogtner if you have questions or concerns about your rights in this study.

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VIII. Copy of Consent Form to Subject:

Please print a copy of this consent form for your records.

If you are willing to volunteer for this research, please click the link below to start.

Thank You.

Appendix D: Cloud Computing Survey

Q1   This survey is to help in the research on "Factors that Influence Application Migration to Cloud Computing: A Conjoint Approach."

INSTRUCTIONS: The purpose of this study is to understand the various factors that influence the decision to deploy applications on a cloud computing platform. You will be presented with a series of sixteen application scenarios. Please evaluate EACH application scenario independently by answering the TWO questions that follow. Also, please use the following definitions from the respondent reference card along with your own experience and knowledge to evaluate each scenario:

Respondent Reference Card

At the end, please answer the six questions centered around demographic information.

Q2 Based on the following 13 factors, please rank the question below for each of the 16 profiles:

Profile 1

Relative Cost Advantage – Low
Application Complexity – Low
Application Strategic Importance – High
Resource Gap – High
Resource Heterogeneity – High
Resource Utilization – High
Application Outcome Measurability – Low
Vendor Behavior Observability – Low
Trust in Vendor – High
Sensing Capabilities – Low
Learning Capabilities – Low
Integrating Capabilities – Low
Coordinating Capabilities – High

Q3 What is the likelihood that you would recommend migrating an application with the above profile to Cloud Computing?

❍ Very Low 1 (1)
❍ 2 (2)
❍ 3 (3)
❍ 4 (4)
❍ 5 (5)
❍ 6 (6)
❍ 7 (7)
❍ 8 (8)
❍ Very High 9 (9)

Q4 How attractive would it be for your government organization to migrate an application with the above profile to Cloud Computing?

❍ Very Unattractive 1 (1)
❍ 2 (2)
❍ 3 (3)
❍ 4 (4)
❍ 5 (5)
❍ 6 (6)
❍ 7 (7)
❍ 8 (8)
❍ Very Attractive 9 (9)

Q35 How many employees are in your IT organization (including contractors)?

- Less than 50 people (1)
- 50-100 employees (2)
- 101-500 employees (3)
- 501-1000 employees (4)
- Greater than 1000 employees (5)

Q36 What industry best describes your organization?

- General Services (i.e. buildings, construction, manufacturing) (1)
- Energy (2)
- Commerce (3)
- Financial Services (4)
- Transportation (5)
- Agriculture (6)
- Homeland Security (7)
- Other (8)

Q37 What is your experience level working in the information technology area:

- Less than 1 year (1)
- 2-5 years (2)
- 5-10 years (3)
- 10-15 years (4)
- 15-20 years (5)
- Greater than 20 years (6)

Q38 Which of the following best describes your job title?

- CIO (1)
- CTO (2)
- IT Director / Manager / Supervisor (3)
- IT Specialist (4)
- Executive (non-IT) (5)
- None specified (6)

Q39 What is your prior experience in the number of applications that you have been involved in deploying to cloud computing?

- No prior experience (1)
- 1-3 applications (2)
- 4-7 applications (3)
- 7-10 applications (4)
- Greater than 10 applications (5)

Q40 What was your level of confidence in rating the 16 profiles listed above?

- Not at all confident (1)
- Not very confident (2)
- Somewhat confident (3)
- Very confident (4)
- Extremely confident (5)

Q41 Thanks for your time in taking this survey.

Appendix E: Four Common Models for Setting Up and Managing Information Technology

1) Traditional Internal IT – all aspects that constitute an IT application or service are purchased and managed using internal resources.

2) Collocation – applications are within a third-party data center (collocation facility). The organization is still responsible for purchasing the server hardware and developing or purchasing the required software for running the applications.

3) Managed Service – outsourcing of core infrastructure. Managed service provider rents the hardware and software to the organization.

4) Cloud Computing – instead of dedicated hardware resources, the organization utilizes virtualized resources that are dynamically allocated only at the time of need.

These models were based on Rosenberg, J. and Mateos, A., 2011

Appendix F: Follow-Up Interview Questions (excerpt)

I have a few follow-up questions from my survey that was sent out earlier this year which focused on the following research question: "What factors influence application migration to cloud computing?"

During the analysis of my results it showed the following conclusions:

1) That the following factors came up statistically significant (trust in vendor, relative cost advantage and sensing capabilities). Do you agree with these conclusions?
2) Sensing capabilities was significant in applications of high strategic importance, which suggests that if an application is of high strategic importance and also provides sensing capabilities, stakeholders are more likely to migrate applications to cloud computing. Why?
3) Do you think your decisions would have been different under different environmental circumstances (i.e., normal environment without continuing resolution, sequestration, shutdown, etc.)?

Appendix G: Engaged Scholarship Component

Engaged Scholarship Component	Research Component
Area of Concern (A)	Understanding the decision making process when migrating applications to cloud computing in government organizations.
Real World Problem Setting (P)	Which factors are most significant to consider when migrating applications to cloud computing in government organizations?
Framing or Argument/Theoretical Framing (F) 1. F_A: Theory about Area of Concern	1. Transaction Cost 2. Resource-based 3. Agency 4. Dynamic Capabilities
Method (M) 1. Data Collection 2. Data Analysis	1. Survey (Qualtrics software) 2. A. Conjoint Analysis Technique B. SPSS 22 software
Contribution (C) to: 1. Area of Concern (A) 2. Theoretical Framing (F) 3. Method (M)	1. Understanding how the factors of Transaction Cost, Resource-based, Agency, and Dynamic Capabilities influence decisions to move applications to cloud computing in government organizations. 2. N/A 3. N/A
Research Question (RQ)	What factors influence application migration to cloud computing in government organizations?

Appendix H: Model Summary for DV

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.082[a]	.007	.002	2.11097
2	.312[b]	.097	.091	2.01488
3	.312[c]	.097	.089	2.01704
4	.452[d]	.205	.195	1.89573
5	.457[e]	.209	.197	1.89308

Appendix I: Correlations for DV

	Value	Sig.
Pearson's R	.998	.000
Kendall's tau	.954	.000

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