Influence of Cloud-Based Computing on User Productivity

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ABSTRACT

Cloud computing is a rapidly expanding IT paradigm for providing computational resources to enterprises and end-users. In recent research conducted by Garrison, he concludes that the key enablers of cloud deployment success are chiefly dependent upon relational (trust), technical, and managerial dependencies primarily borne by the firm contracting cloud computing services. In this document we expand upon their research to consider key metrics for the enterprise to consider in the successful adoption of cloud computing with a focus on the end-user. We reviewed applicable theories which were utilized during previous major IT shifts and well as investigate key user perspectives. The intent is to provide a model which will focus on cloud computing end-user success.

Keywords: cloud computing, resource based view of the firm, socio-technical

INTRODUCTION

Since the global economic crisis of 2008, organizations face the dilemma of maximizing expensive IT resources to sustain their competitiveness advantage in the marketplace, while working to substantially reduce their IT operational and maintenance costs (Dutta, Guo Chao Alex Peng, & Choudhary, 2013, p. 40). Many organizations are looking to leverage new computational technologies and services delivered by third party to help address these issues. What technologies are available to support their business operational model to provide a competitive advantage to win in the market place? Many enterprises are either wrestling with the idea of applying cloud-based computing within their organization or dealing with the after-effects of a cloud computing implementation.

The reasons CFOs cite in favor of cloud-based ERP services include the resource allocation flexibility. This allows CFOs to avoid large upfront investments in the early phases of an ERP deployment and provide the ability to avoid fixed capital investments during periods of corporate or economic uncertainty and timely access to the latest software capabilities (Miranda, 2013, p. 65). However, despite the overall benefits, organizations face obstacles adopting cloud services, including uncoordinated adoption by stakeholders, inadequate business and technical acumen, and data security (Garrison et al., 2012, p. 62). The majority of these enterprises have considered the end-user or consumer in this new IT service delivery model as an afterthought. With more competitive pressures directed toward the reduction of enterprise IT spending, drive for increased organizational productivity and corporate profits, what effect does cloud-based computing services have on the end-user? How does cloud computing negatively or positively enhance individual user performance, productivity, experience, and overall user acceptance? In spite of its attractive features and benefits, migrating internal IT resources and sensitive business data to a third-party cloud vendor is never an easy decision to be made by enterprises. In fact, the adoption of cloud computing is associated with a wide range of potential risks and challenges, which have not been sufficiently explored and studied by previous researchers (Dutta et al., 2013, p. 39).

In this paper, we will review literature specific to this particular area, where research has been conducted to frame the key driving forces in end-user cloud-computing issues. Since cloud computing is a new technological genre designed for widespread, mainstream consumption over the Internet, research in this subject area over the past five years will be the primary focus of review but earlier research in other similar areas will be also discussed (i.e. outsourcing). Other key articles from past research which support the subject matter will be taken into consideration. Key cloud-computing user areas to be investigated in this literature review are: availability; accessibility; functionality; and user security and privacy.

CLOUD COMPUTING OVERVIEW

With the advent of Internet technologies in the 1990s, and other technologies like Web 2.0, distributed computing, and high speed wireless in the 2000s, users have the ability to access remote applications, exchange information, and transact business anywhere. Coupled with the use of new end-user devices (e.g. laptops, smartphones, tablet computers), this provides the basis for today's cloud computing environment. There are many definitions of cloud computing. The most highly cited and referenced definition is provided by the National Institute of Standards and Technology (NIST) (http://www.nist.gov/). Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources. Cloud computing provides the ability for resources (networks, servers, storage, applications, and services) to be rapidly provisioned and released with minimal management effort or service-provider interaction (Mell & Grance, 2010).

> "A cloud is a type of parallel and distributed system consisting of a collection of inter-connected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resource(s) based on service-level agreements established through negotiation between the service provider and consumers (Buyya et al., 2009, p. 601)".

Cloud computing has evolved from computing services delivered in computing clusters or grids. This service can be provided by public and private entities. The cloud computing paradigm is being used to provide back-end computing platforms for large banking and financial institutions, as well as systems that support social media apps and games running on smartphones and tablet computers. Cloud computing is being transformed to a model consisting of services that are commoditized and delivered in a manner similar to traditional utilities such as water, electricity, gas, and telephony (Buyya et al., 2009, p. 599). With this computational utility model, users access services anytime and anywhere, based on their requirements without regard to where the services are hosted or how they are delivered. The emergence of cloud computing is transforming the way organizations purchase and manage computing resources. It provides a fundamentally different IT model in which a cloud provider might be responsible for a range of IT activities, including hardware and software installation, upgrades, maintenance, backup, data storage, and security (Garrison et al., 2012, p. 62).

Today's deployed cloud models vary in deployment models and have different variations within each model's scope, but each provides similar cloud computing enablement capabilities. Public or third party cloud computing's usage-based pricing model offers several advantages, including reduced capital expense, a low barrier to entry, and the ability to scale up as demand requires, as well as to support brief surges in capacity (Grossman, 2009, p. 25). The three major service models of cloud computing are: Software-as-a-Service (SaaS); Platform-as-a-Service (PaaS); and Infrastructure-as-a-Service (IaaS). The specific cloud service model which this literature review will focus is the Software-as-a-Service (SaaS) model.

Garrison focused on three IT relates capabilities that characterize a major potential source of competitive advantage in an enterprise adopting cloud computing. Those three areas are technical, managerial, and relational. Garrison defined technical capability to represent physical assets (such as computers, network equipment, and databases) or collective resources that give organization functionality and a flexible, scalable foundation. Managerial capability is defined as the business and technical skills, as well as organization-specific knowledge, required to recognize the potential of emerging technologies to influence the organization's overall performance. (Garrison et al., 2012). Relational capability reflects an ongoing positive association between the IT manager and the cloud vendor (Garrison et al., 2012). The cloud service vendor must have a clear understanding of how its cloud services benefit the client organization and is motivated to deliver them. Garrison's premise is since cloud computing services can so easily be duplicated, that an organization's unique IT capability in these three areas related directly to deployment success. The result of Garrison's mixed method study yielded significant results that confirmed relational, technical and managerial capabilities of an organization had a positive and significant relationship with cloud deployment success.

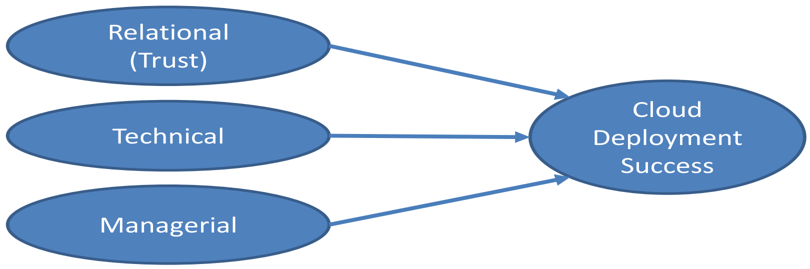

Figure 1: Success Factors for Deploying Cloud Computing (Garrison et al., 2012, p. 66)

END-USERS OF CLOUD BASED RESOURCES

What is the focus of other recent research in the area of cloud computing as it pertains to the end-user perspective? Most has been in the area of resource-based view of the firm (RBV). Resource-based theory of the firm emphasizes firm resources that it has rather than the products it makes (Srivastava et al., 2001). There are many sorts of resources which can variously be physical, intangible, financial, market-based, and so on. Resource-based theory views all organizations in terms of available resources and how to combine them to differentiate them to achieve competitive advantage (Srivastava et al., 2001). Cloud computing becomes an additional resource in the portfolio for the use of the firm to achieve a competitive advantage. Driving high usage of applications, sustained competitiveness, reduction of IT operation and maintenance costs (Dutta et al., 2013) are clearly RBV theoretical constructs, but what has been missed? Although research focused on technology acceptance model (TAM) (Kim and Kankanhalli, 2009), and the unified theory of acceptance and use of technology (UTAUT) (Katzan Jr., 2010) have been useful in expanding understanding of behavior, only recently has research examined user resistance (Kim and Kankanhalli, 2009). As it pertains to the applicability of dynamic capabilities theory, much research has been given to this space as it pertains to cloud computing. In dynamic capabilities theory all applications require a model of computation, a model of storage, a model of communication, and this especially true of cloud computing with it distinct models (Armbrust et al., 2010, p. 52). Dynamic capabilities theory is defined as 'the ability to integrate, build, and reconfigure internal and external competencies to address rapidly-changing environments' (Teece et al., 1997). When cloud services are procured from outside the enterprise, through a 'private' cloud (delivered by a 3rd party), 'shared' cloud, or 'public' cloud, the principal-agent theory is in effect. The principal-agent is a common theory used as a basis of research study in this space. Although not explicitly specified, the functionality incorporated into today's cloud computing models are to account and mitigate the risk by cloud provider (agent) for the enterprise and individual users (principals). This requires cloud providers to incorporate redundancy, reliability, and failover capabilities to make sure site and systems failures do not interrupt operations, and service level agreements (SLA) are kept. This also includes providing mechanisms to assure client data is protected and not compromised. Cloud providers must assure computational processing capabilities are guarded and performance is optimized when client need it. Later research in cloud computing is investigating a new model of brokered cloud-based services so that the cloud costs are optimized for the benefit of the consumer (enterprises; users; principals) and the providers (enterprises; agents) (Buyya et al., 2009, p. 603). With the advent of newer technologies to allow for shifting and moving cloud computational and data storage services to the operator with the lowest cost of delivery, this enables cloud-based computing to be more market driven and become more of a 'computing utility'. Although Garrison (2012) posited that cloud deployment success is based on three independent variables (See Figure 1), his perspective is clearly focused on the client organization and the provider, and not the end user.

RESEARCH GAPS

What are the research gaps in cloud computing? Although cloud computing risks is an emerging research area or 'gap' as it pertains to the enterprises or companies that adopt cloud computing, research on end-user or consumer risk (i.e. individual) has received less focus. Recent research identified a set of 39 cloud computing risks, which concentrated around diverse operational, organizational, technical, and legal areas (Dutta et al., 2013, p. 39). Dutta found that recent research focused mainly on security and privacy aspects, but failed to explore a more holistic picture that covers other socio-technical risks that are also important in the complicated cloud environment (Dutta et al., 2013, p. 40). The need to pay more attention to innovation and users has, in fact, already been identified by a range of scholars in innovation studies and evolutionary economics (Geels, 2004, p. 898). One area of research would be to adapt the Garrison (2012) model of success factors in deploying cloud computing to incorporate end-user centric factors. In this paper, we will discuss the inclusion of the following four constructs to address gaps in the research literature: availability, accessibility, functionality, and user security and privacy (See Figure 2).

AVAILABILITY

The availability of cloud-based computing services and its ability to adapt to demand is one of the greatest areas of research in this computing genre. For enterprises that require cloud-based computing, they run the risk of over or under provisioning service. Enterprises worry whether cloud computing services will have adequate availability to address demand, and this makes some wary of cloud computing. Under provisioning results in not enough resources being available when needed, and can result in lost revenue lost (i.e. missed orders, lack of responsiveness to clients). Overprovisioning results in the underutilization of resources, and a loss of money if an enterprise is paying for those resources regardless if they use them or not. The term used in this area of cloud-computing is called ‘elasticity’. Elasticity is cloud computing’s ability to add or remove resources at a fine grain (one server at a time) and with a lead time of minutes rather than weeks, allowing resources to be matched to workload much more closely (Armbrust et al., 2010, p. 53). Many cloud service provider have implemented tools to statistically calculate capacity needs and increase or reduce capacity to meet demand. The statistical multiplexing necessary to achieve elasticity and the appearance of infinite capacity available on demand requires automatic allocation and management (Armbrust et al., 2010, p. 52). According to Armbrust, if a cloud provider fails to adequately provide for the availability of a percentage of active users, the potential exist for those users to become defectors and be permanently lost. Over time the number of defectors will exceed active users, with the service reputation carried along with those disgruntled users. The ability to adapt automatically or rapidly respond to demand is critical for end user success and satisfaction. Some existing SaaS products have set a high standard in this regard. Google Search has a reputation for being highly available, to the point that even a small disruption is the exception (Armbrust et al., 2010, p. 54). To enable this cloud-as-a-utility model for an enterprise, implementation of a mix of cloud services, consisting of a ‘private’ cloud and distributed cloud service model (or a ‘hybrid cloud’), is essential.

ACCESSIBILITY

Infrastructure denoted as a “cloud” is one where businesses and users are able to access on-demand from anywhere in the world. The creation of the Internet was the greatest contribution to cloud computing. With the increase in the widely available broadband Internet services for the masses, cloud computing is now accessible and practical for all, through wired or wireless network connections. Included in this new cloud service model is the ability for users to access, use and pay only for the services they need verses investing in dedicated technology for limited use. Thus, the computing world is rapidly transforming towards developing software for millions to consume as a service, rather than to run on their individual computers (Buyya et al., 2009, p. 599). This broad degree of access and computational scalability enables certain enterprises the flexibility to allow their employees to work from anywhere, across public networks.

In addition, enterprise service consumers with global operations require faster response time, and thus save time by distributing workload requests to multiple clouds in various locations at the same time (Buyya et al., 2009, p. 600). Utility services, such as water, electricity, gas, and telephony are deemed necessary, essential and common for supporting life’s daily tasks. The reliability of utility services is taken for granted until they are unavailable for a brief span of time. In many locations in the United States and some other parts of the world, years go by without an outage of these core services. Even during certain natural (i.e. storms) or catastrophic events some of these services are still accessible and available. Utility services are accessed so frequently that they need to be available whenever the consumers require them. Cloud computing services are moving to the same utility direction. Consumers are now able to pay service providers based on their usage of these utility services (Buyya et al., 2009, p. 600), with the same levels of accessibility when they want it.

The challenge in area is there are still locations in the US where high-speed Internet access is absence. If it is available at all many times it is too costly for certain individuals to acquire depending on their level of income. For all end-users, broadband connectivity is essential for accessing and using cloud based services.

FUNCTIONALITY

Here is one of the key areas which socio-technical theory can be applied. When one intervenes in a work system, two potential improvements are possible. The first is an improvement in task accomplishment, i.e., improvement in productivity and/or quality of the product, reduced costs, etc.. The second is an improvement in the quality of working life (QWL) of the work system's members (Bostrom and Heinen, 1977, p. 18). Although this reflects the classic use of computing from 1977, its applicability in today's present consumer-based computing model requires some adjustment, with the advent of personal, handheld and smartphone-based computers. Earlier studies dealt with IS failure because they ignored or did not consider organization and individual behavior in the design. In the case of cloud based computing, many companies have failed in this area because they did not pick up on consumer shifts. Many did not properly assess market demand in the area of the functionality and needs of their users. A view of the companies that failed during the dot com days of the 90s is related to this view (i.e. Webvan, Pets.com, Kozmo, MySpace, etc). Many believe that the decision has yet to be made on the future of today's cloud computing companies and some predict more consolidation is forthcoming. Software practitioners are facing numerous and new challenges in creating software for millions of consumers to use as a service, rather than software to run (independently) on their individual computers (Buyya et al., 2009, p. 600). Consumers will be able to access applications and data from a "cloud" anywhere in the world on demand. With the ability of cloud provider to provide better functionality over competitors, consumers have less technological 'stickiness'. This provides for increased mobility to new platforms, if the data is not an issue (data portability).

What are the assurances for individual consumers that their cloud infrastructure is robust and will always be available at any time? One emerging question is: can users perform some level of functionality when their cloud is not available or not functioning properly? In some cases this implies some shared functionality to be enabled at the local device so that users can work in a 'disconnected mode' until functionality is restored (i.e. ability to create e-mails, create documents, etc.; store and forward functionality). For the end-user's benefit, cloud computing services need to be highly reliable, scalable, and autonomic to support ubiquitous access, dynamic discovery and composability. In particular, consumers indicate the required service level through Quality of Service (QoS) parameters, which are noted in SLAs established with providers (Buyya et al., 2009, p. 601). Many service providers have inflexible pricing, generally limited to flat rates or tariffs based on usage thresholds. Many consumers are restricted to offerings from a single provider at a time. Some providers have proprietary interfaces to their services thus restricting the ability of consumers to swap one provider for another. For cloud computing to mature, it is required that the services follow standard interfaces (Buyya et al., 2009, p. 604).

USER SECURITY AND PRIVACY

Enterprise and consumer security in cloud-based computing environments present special challenges. In the case of cloud service providers, the risk and responsibly as agent is to provide data security, access control, business continuity, recovery services and compliance for the principal. Despite companies today outsourcing ERP and using external email services to hold sensitive information, security is one of the most often-cited objections to cloud computing. Analysts and skeptical companies ask "who would trust their essential data out there, somewhere?" There are also requirements for auditability, in the case of Sarbanes-Oxley, Health Insurance Portability and Accountability Act (HIPAA) regulations, which must be provided for when data is moved to the cloud. (Armbrust et al., 2010, p. 55). On a positive side, because of economies of scale third party cloud service providers can provide these service in a cost effective way that smaller companies can afford (Grossman, 2009, p. 26).

One last security concern is protecting the cloud user against the provider. The provider will by definition control the "bottom layer" of the software stack, which effectively circumvents most known security techniques (Armbrust et al., 2010, p. 55). It is essential for data centers and clouds to implement strategies to design and provide personalized SLA-oriented resource management for customers. These strategies can also encourage trust and confidence with customers by emphasizing the security measures undertaken to mitigate risk and doubt, and assure the credibility of the provider (Buyya et al., 2009, p. 604).

CONCEPTUAL MODEL

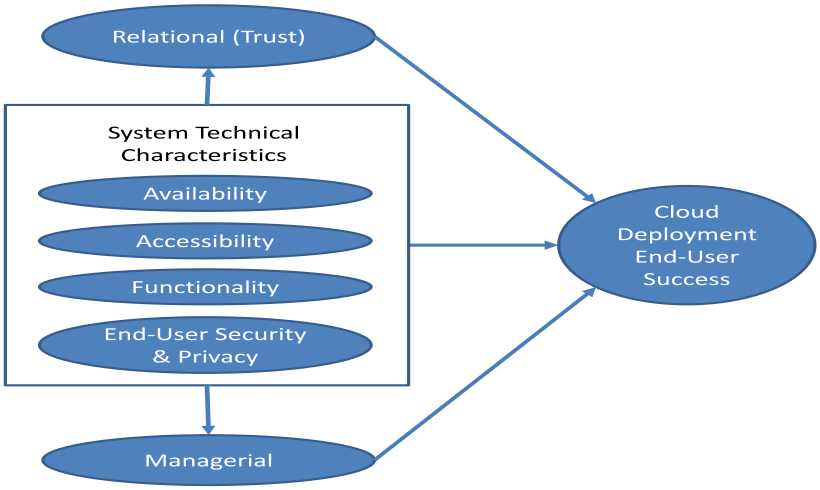

Figure 2: Cloud Computing End-User Success

CONCLUSION

The resulting cloud computing end-user success model would result in a clear focus placed on the end-user factors of availability, accessibility, functionality, and user security and privacy. Socio-technology theory has yet to be thoroughly applied in the cloud computing area, although in previous IS research it has been deemed a critical theory to determine the social impact to new technological innovations. Just as socio-technical theory has been applied to study the underlying effects of complex interconnected and interdependent systems such as transportation, electric power and telecommunication systems (Osorio et al., 2011, p. 365) and its social or human impact in the transition from one system to another, its applicability to cloud computing is deemed appropriate. Further research in the use of Delone and McLean IS success model (SM) is valid and appropriate. Combining D&M IS SM with Garrison's model for success factors in deploying cloud computing is rich area of future research.

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