# Challenges of Cloud Computing in Business: Towards New Organizational Competencies

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## Abstract

*Cloud computing is a nascent but fast growing innovation that has attracted increasing attention from both researchers and practitioners as a new Information Technology (IT) paradigm. Cloud computing cannot be sufficiently understood as a standalone phenomenon in the IT market, but rather as a core ingredient of a larger transformation of the IT industry that impacts the entire IT ecosystem. Due to the change from enterprise computing to cloud computing, organizations and individuals need to develop new skills and competencies. Extant literature in cloud computing has mainly focused on its affordances and challenges with scant attention given to organizational resources that enable efficient and effective adoption. This paper addresses how organizations can identify their own local cloud adoption challenges and how to overcome those challenges by developing new competencies. The paper draws on resource-based theory to propose new organizational competencies required for seamless migration from enterprise computing to cloud computing. This study was conducted through an extensive review of academic publications on cloud computing as well as professional literature such as industry white papers and technical reports.*

**Keywords:** Cloud computing; Resource based theory; Cloud competencies; Service models; Delivery Models; Cloud brokerage.

## *1. Introduction*

Cloud computing is arguably one of the most important technological shifts within the last decade (Wang, Rashid, & Chuang, 2011). Cloud computing represents a fundamental change in the way IT services are invented, developed, deployed, scaled, updated, maintained and paid for (Marston, Li, Bandyopadhyay, Zhang, & Ghalsasi, 2011). The promise of cloud computing expressed as cloud desires (Venters & Whitley, 2012) and cloud capabilities (Lyer & Henderson, 2010) seems to have attracted lofty expectations. Due to these expectations, cloud computing has attracted considerable interest in both commercial and academic spheres (Venters & Whitley, 2012). An international study on key information technology and management issues ranked cloud computing as 2nd and 3rd in terms of top application and technology developments in 2011 and 2012 respectively (Luftman & Zadeh, 2011; Luftman et al., 2012). Worldwide revenue from public IT cloud services exceeded $21.5 billion in 2010 and will reach $72.9 billion in 2015, representing a compound annual growth rate (CAGR) of 27.6% ("IDC Cloud," 2013). This rapid growth rate is over four times the projected growth for the worldwide IT market as a whole which stands at 6.7% ("IDC Cloud," 2013). For many companies (especially small and medium sized), the cloud computing model is overly attractive as it enables them to pass the demands of managing hardware and software to third party companies. According to AMI partners, small and medium businesses are expected to spend over $100 billion on cloud computing by 2014 (Marston et al., 2011). Cloud computing therefore makes a compelling business case on both technical and commercial aspects (KPMG, 2011).

Cloud computing cannot be sufficiently understood as a standalone phenomenon in the IT market, but rather as a core ingredient of a larger transformation of the IT industry that impacts the entire IT ecosystem. According to Voas and Zhang (2009), cloud computing has evolved from the previous computing paradigms like PCs, networked computing, the internet and grid computing.

While grid computing coalesces computing power from different machines, it lacks virtualization which is necessary for the abstraction of the underlying infrastructure. The vision behind grid computing and cloud computing is to provide computing as a utility in the same way that other public utilities such as gas and electricity are provided (Sriram & Khajeh-Hosseini, 2010). John McCarthy first exposed the idea of 'Utility Computing' in a MIT centennial and predicted that it would become the basis of a new and important industry (Cafaro & Aloisio, 2011). According to Lijun Mei et al (2008), the term cloud computing was first formulated in 1997 but its promotion and adoption has been slow until 2007. Some authors consider the birth of cloud computing to have been marked by the introduction of Amazon Elastic Compute Cloud (EC2) as a fee based commercial product (Weiss, 2007).

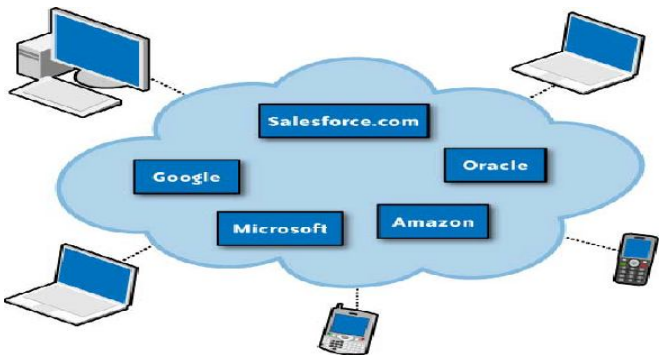
The concept of cloud computing and its disambiguation is still evolving. This is evident from the much discussion in industry as to what cloud computing actually means (Sriram & Khajeh-Hosseini, 2010). The term has been defined in different ways by analyst firms, academics, IT companies and standards bodies. The main reason for the existence of different perception of cloud computing is that cloud computing, unlike other technical terms, is not a new technology, but rather a new operations model that brings together a set of existing technologies to run business in a different way (Zhang, Cheng, & Boutaba, 2010). A summary of these definitions is given in table 1 below.

**Table 1: Cloud computing definitions**

| Category | Definition |
|---|---|
| **Standards Body** | Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. |
| **Industry Analysts** | Standardized IT capability (service, software or infrastructure) delivered via internet technologies in pay-per-use self service way. FORRESTER(Venters & Whitley, 2012). |
| | Style of computing in which scalable and elastic IT-enabled capabilities are delivered as a service to external customers using internet technologies. GARTNER *(Lecznar & Patig, 2011)* |
| | A model for enabling ubiquitous, convenient, on-demand access to a shared pool of configurable computing resources(e.g. networks, servers, storage, applications and services) that can be rapidly provisioned and released. KPMG(KPMG, 2011)**.** |
| **Academic** | A new computing paradigm that allows users to temporarily utilize computing infrastructure over the network, supplied as a service by a cloud provider at possibly one or more levels of abstraction (Venters & Whitley, 2012) |
| | A type of parallel and distributed systems consisting of collection of interconnected virtualized computers that are dynamically provisioned and presented as one or more unified computing resource based on service level agreements established through negotiation between provider and customer (Buyya, Yeo, Venugopal, Broberg, & Brandic, 2009)**.** |

In this study, we adopt the definition given by the US National Institute of Standards and Technology (NIST). The working definition of cloud computing provided by NIST covers commonly agreed aspects of the subject (Sriram & Khajeh-Hosseini, 2010). Figure 1 below is a depiction of cloud computing infrastructure.

**Figure 1: Cloud computing infrastructure**



Cloud computing represents a convergence of two major trends in IT – (a) IT efficiency, whereby the power of modern computers is utilized more efficiently through highly scalable hardware and software resources and (b) business agility, whereby IT can be used as a competitive tool through rapid deployment of applications that respond in real time to user requirements (Kim, 2009). In providing IT efficiency, cloud computing is commoditized and therefore provides competitive necessity and not a competitive advantage. While IT efficiency will deliver cost savings, the value of cloud computing should be increasingly viewed in terms of the competitive advantage that it can deliver (Marston et al., 2011). For cloud computing to provide a competitive advantage, it must provide a platform for innovation through business agility. To innovate means creating new knowledge about resources, goals, tasks, markets, products and processes (Ciborra, 2002, p. 45). As cloud computing desires (Venters & Whitley, 2012) begin to emerge, there are significant technical, operational and organizational issues which needs to be tackled. This issues have been addressed by Janssen and Joha (2011) as challenges of cloud adoption.

Research in cloud computing has been generally skewed toward technological issues such as performance, virtualization, network and data management (H. Yang & Tate, 2009); however a new theme regarding the social and organizational implications is beginning to emerge (S. Yang & Hsu, 2011). The adoption of cloud computing is still at an earlier stage in OECD countries (OECD, 2010) and by extension developing countries. Since cloud computing is still a new area, its research boundaries are still tenuous and researchers are still grappling with its demarcation. From research literature, there are different proposals of what should constitute germane research areas in the context of cloud computing. Some scholar have proposed a research agenda focusing on application domain, cloud migration standards, business models, pricing and the long tail in clouds (Weinhardt, Anandasivam, Blau, & Stoesser, 2009). Others have proposed a broad IS research agenda that includes: (1) cloud computing economics; (2) cloud computing and IT strategy/policy; (3) technology adoption and implementation issues; (4) cloud computing and green IT; (5) regulatory issues (Marston et al., 2011).

This paper contributes to the effort of the previous researchers by proposing new competencies that organizations should develop in order to gain competitive advantage from cloud adoption. As Ciborra (2002, p. 45) summarized, the skills and competencies available in a corporation represent at the same time the source of, and the constraint for innovation. This work relies on the resource based theory (RBT) as a theoretical lens to understand the relationship between a firm's resources and competitive advantage. In the next section, we discuss the various models of cloud computing. In sections 3, 4 and 5, we discuss the RBT, the proposed competencies and finally the conclusion.

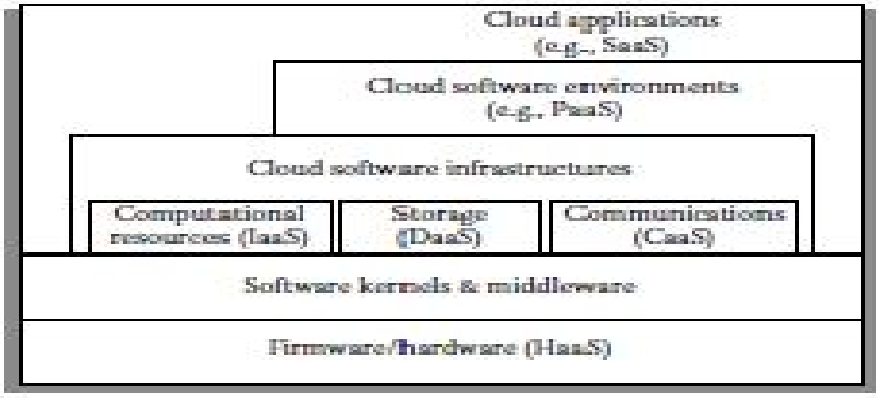
## *2. The Cloud Computing Taxonomies*

The role of taxonomies is to provide a structure and an organization to the knowledge of a field thus enabling researchers to study the relationships among concepts and, therefore, to hypothesize about these relationships (Nickerson, Varshney, & Muntermann, 2013). Taxonomic information is also essential for cloud service providers, enterprise firms, and border authorities to detect, manage, and control invasive alien components (Rimal, Choi, & Lumb, 2010). Three cloud computing taxonomies are considered; cloud service models, cloud deployment models, and cloud consumption models.

### 2.1 Cloud Service Models

In the course of cloud computing development, different classifications have been developed to capture its service layers. These layers have been referred to as cloud service models (Sriram & Khajeh-Hosseini, 2010), cloud business models (S. Yang & Hsu, 2011; Zhang et al., 2010) and cloud architectural layer (Stanoevska-Slabeva & Wozniak, 2010). The earliest classification known as the SPI model (Ahson & Ilyas, 2011) stratified cloud services into software as a service (SaaS), platform as a service (PaaS) and infrastructure as a service (IaaS)(S. Yang & Hsu, 2011; Zhang et al., 2010). The UCSB-IBM cloud ontology classified the cloud into five layers (Ahson & Ilyas, 2011, p. 5). The first three layers are similar to the SPI model and the rest of the two layers are software kernel layer and the hardware/firmware layer. The more r technical ontologies include Jackson's UCSB-IBM and Hoff's ontology (Ahson & Ilyas, 2011).

**Figure 2: UCSB-IBM Cloud Ontology**




The SaaS layer provides applications that run on the cloud eliminating the need to install and run the applications on the client computer (Marston et al., 2011). SaaS is a software that is owned, delivered and managed remotely by one or more providers and offered on a pay-per-use mode(Stanoevska-Slabeva & Wozniak, 2010). PaaS facilitates the development and deployment of applications by providing operating system support and software development frameworks. This eliminates the cost and complexity of managing the underlying hardware and software layers. PaaS is a cloud service targeting developers. IaaS comprise computing resources like computational power (processors) and data servers that can be virtualized and instances provided as a service. The table below (table 2) gives a summary of service models and some of the service providers and their products.

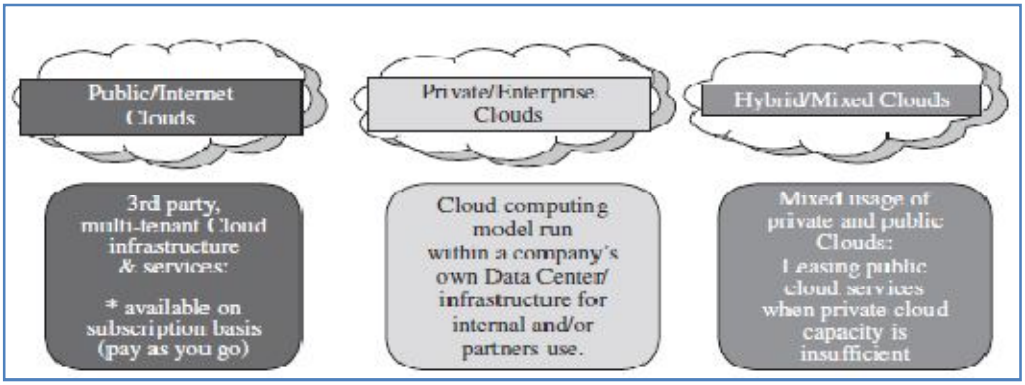
**Table 2: Cloud service providers and their products**

| Service model | Providers | Services |
|---|---|---|
| SaaS | SalesForce.Com | SalesForce.com |
| | Google | Google Apps |
| PaaS | Google | GoogleAppEngine |
| | Microsoft | Microsoft Azure |
| | SalesForce | Force.Com |
| IaaS | Amazon | Amazon EC2/S3 |
| | Zenith | Proud |

## 2.2 Cloud Deployment Models

The cloud computing deployment models can be classified based on three features. These are physical location and distribution (Buyya, Goscinski, & Broberg, 2011); and the owner of the cloud data centre (Ristol, 2010). In this sense, a cloud can be classified as private, public or hybrid (Buyya et al., 2011). Figure 3 below summarizes the various cloud deployment models.

**Figure 3: Cloud deployment models**




The cloud deployment models are service-agnostic, implying that each service model can be deployed as private and public or hybrid cloud.

### 2.3 Cloud Consumption Models

Cloud computing offers a unique way to consume computation, network, storage and software resources. At the most fundamental level, cloud computing provides flexible real time access to a shared pool of computing resources like networks, servers, storage, applications and services (Oltsik, 2010). The provision of ITaaS made available by cloud computing is possible due to some characteristics of cloud computing. Table 3 below provides a summary of the characteristics of cloud computing which is conceptualized as its consumption model (Oltsik, 2010).

**Table 3: Cloud consumption models (KPMG, 2011)**

| Characteristic | Explanation |
|---|---|
| On – demand self service | A consumer can unilaterally provision computing capabilities such as server time and network storage as needed. This provisioning is automated. |
| Broad Network access | Capabilities are available over the network and are accessed through the internet by use of different devices. |
| Resource pooling | The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand.. |
| Rapid elasticity | Capabilities can be rapidly and elastically provisioned, in some cases automatically, to quickly scale out and then rapidly released to quickly scale in. |
| Measured service | Resource usage can be monitored, controlled, and reported providing transparency for both the provider and consumer of the utilized service. |

Adapted from (Mell & Grance, 2011)

## *3. The Theoretical Framework and Related Literature*

### 3.1 Resource Based View

Resource-based view (RBV) theory has been discussed in strategic management and IS for many years. Using RBV theory in the IS literature emerged in the beginning of 1990s (Taher, 2012). RBV provides a theoretical lens for IS scholars to investigate how IS resources and capabilities can contribute to a firm's strategy and performance (Taher, 2012). RBV holds that a organization can be viewed as a collection of human and physical resources bound together in an administrative framework, the boundaries which are determined by the area of administrative coordination and authoritative communication (Peppard & Ward, 2004). This theory argues that firms posses resources, a subset of which enables them to achieve a competitive advantage and a further subset that leads to superior long term performance (Wade & Hulland, 2004). It is the later that gives the firm a sustainable competitive advantage. Resources that are valuable and rare provides a firm with a competitive advantage while those resources that are inimitable, non-substitutable and immobile provides a firm with a sustainable competitive advantage (Taher, 2012; Wade & Hulland, 2004).

Despite the fact that the term resource is a key concept in RBV, confusion reigns with regard to its meaning. RBV theorists have used a variety of different terms to talk about resources including competencies (Prahalad & Hamel, 1990), skills (Grant, 1991), strategic assets (Ross, Beath, & Goodhue, 1996), stocks (Amit & Schoemaker, 1993; Capron & Hulland, 1999) and a collection of assets, competencies, processes etc (Barney, 1991). In this paper we adopt the definition provided by (Wade & Hulland, 2004) - that resources are assets and capabilities that are available and useful in detecting and responding to market opportunities or threats. The terms 'capabilities' and 'competencies' are frequently used in RBV literature with no clear disambiguation. For example, (Peppard & Ward, 2004) treats competencies and capabilities as different concepts while (Wade & Hulland, 2004) considers competencies and capabilities as synonymous. We adopt the later since there is not yet a consensus in this matter.

### 3.2 RBV and Cloud Computing

Rooted in the strategic management literature, the RBV of the firm strives to understand and explain why firms are able to gain competitive advantage in the short run and sustainable competitive advantage in the long run through their resource endowments. Using RBV theory in the IS literature emerged in the 1990s following the call for a 'good conversation' amongst researchers from a variety of disciplines to use the RBV (Mahoney & Pandian, 1992).

Since then, a number of studies in IS including (Clemons & Row, 1991; Bharadwaj, Sambamurthy, & Zmud, 1999; Peppard & Ward, 2004; Holsapple & Wu, 2009) have used the RBV to examine the firm level strategic value of IS. The emergence of cloud computing, a form of outsourcing that uses the internet to deliver corporate applications to businesses (Gannon, 2013) shows all the characteristics of a disruptive technology (Marston et al., 2011). A disruptive technology is one that upsets the existing order of things in a particular industry (Christensen, 1997).

Cloud computing allows the reclassification from IT from an expensive 'capital expenditure' to a pay-as-you-go 'operating expenditure' (Venters & Whitley, 2012). This will potentially bring a large change in the corporate IT structure resulting in a host of intra-organizational issues that would need to be addressed (Marston et al., 2011). According to (Marston et al., 2011), the importance of cloud computing will be measured not only in terms of cost savings but increasingly in terms of the competitive advantages that it can deliver. Janssen and Joha (2011) further lists organization, performance, decision, contract and relationship as the challenges of cloud adoption. It is appreciated that cloud computing should provide a platform for more flexibility and a platform for more innovation (Venters & Whitley, 2012). Less clear is the extent to which enterprises have the skills and motivation to exploit such opportunities (Ciborra, 1996). We fill this research gap by proposing specific competencies that organizations need to develop in order to attain competitive advantage with cloud computing. The RBV theory is used to ground the study as it conceptualizes an organization or a firm as a collection of assets and competencies.

### 3.3 Organizational Competencies

According to van der Klink and Boon, competencies are a fuzzy concept. These authors underpin their statement by the lack of a universal definition and the confusion about the concept in the literature. According to von Krogh and Roos (1995), competence relates to craftsmanship, specialization, intelligence and problem solving. At the same time, terms such as 'distinctive competence', 'core competence, 'firm specific competence', and 'invisible assets' are used to convey what often seems to be a similar meaning (Peppard & Ward, 2004). In this study, we define competency as *"an underlying characteristic of an individual that is causally related to criterion-referenced effective and/or superior performance in a job or a situation"*, following Spencer and Spencer (1993, p. 9). The question that rises is which competencies employees need to develop to ensure an effective or superior performance in their current and future jobs

Three important types of competencies have been proposed by (Ans De Vos, De Hauw, & Willemase, 2011). First, functional competencies are defined as the knowledge and skills necessary for employees to successfully perform their jobs. These functional competencies are based upon the employees' tasks and roles and, hence, differ according to the industry and function. Second, learning competencies are defined as the individual characteristics of an employee that enable him/her to develop new functional competencies.

## *4. Organizational Competencies for Cloud Computing*

In recent times, more and more businesses have come to recognize the benefits of cloud computing and service orientation not only in cost, but scalability. What corporations don't have yet are the skills, organizational structure, and processes to realize this promise. Lin and Chen (2012) stress that IT professional's skills will be challenged by cloud computing. This is due to the fact that technology always advances faster than the ability of businesses to adopt it and use it in new ways. Organizations hoping to adopt cloud computing are looking for guidance in developing technology roadmaps, in order to decide (a) which applications are best positioned for moving to the cloud and (b) and how to implement the changes in the least disruptive manner (Marston et al., 2011). With the emergence of Information Technology as a Service (ITaaS), organizations will spend less time building technology assets but more on orchestrating services and enabling the business to consume them effectively in its operations, decisions and innovations (Elias & Mirchandani, 2012). In order to identify the new competencies, we identified various challenges of cloud computing as reported in research literature and proposed corresponding business processes that can address the challenges. The cloud competencies proposed are derived from these processes.

### 4.1 Cloud Challenges

There are several concerns users have with regard to the adoption of cloud computing. These challenges are seen as the main inhibitors to cloud adoption by organizations. Table 4 below provides a summary of cloud adoption challenges.

**Table 4: Cloud adoption challenges**

| Cloud Challenges | Explanation |
|---|---|
| **Availability/Reliability** (Kim, 2009), (Buyya et al., 2011), (ERNST & YOUNG, 2011) | It is expected that users will have certain expectations about the service level to be provided once their applications are moved to the cloud. These expectations include availability of the service, its overall performance, and what measures are to be taken when something goes wrong in the system or its components. |
| **Security and privacy** (Kim, 2009), (Buyya, Goscinski, & Broberg, 2011) | Security and privacy affect the entire cloud computing stack, since there is a massive use of third-party services and infrastructures that are used to host important data or to perform critical operations |
| **Vendor Lock-in/Portability/ Interoperability** (Kim, 2009; Mather, Kumaraswamy, & Latif, 2009, p. 228) | A major concern of cloud computing users is about having their data locked-in by a certain provider. |
| **Compliance/Regulatory ambiguity** (ERNST & YOUNG, 2011; Kim, 2009; KPMG, 2011) | Enterprise users must maintain business legal documents and assure their integrity in order to comply with various laws. Cloud computing vendors have to adopt technologies to ensure that their enterprise users' data satisfy their compliance requirements. |
| **Integration/ Componentization** (Mather et al., 2009, p. 230; Stanoevska-Slabeva & Wozniak, 2010) | Integration with the existing architecture. Availability of tools and standards that enable integration and componentization of applications. |
| **Limited scope for customization** (Stanoevska-Slabeva & Wozniak, 2010; KPMG, 2011) | Users want greater ability to "fit" cloud services more tightly into the context of their specific business. |
| **Vendor Management** (ERNST & YOUNG, 2011) | Cloud computing comes with a unique set of vendor management challenges and new criteria to evaluate when considering strategic sourcing models and analyses. |
| **Cultural Resistance** (KPMG, 2011) | Cloud users may face organizational inertia as shifting to a Cloud environment may change the role of IT departments in the organization. Organizations may not be prepared for this transition with many of them deciding to wait and watch. |
| **Transition and Execution** (KPMG, 2011) | Certain mission-critical applications may not be suitable to be used in the Cloud environments. |

In order for an organization to overcome these challenges and successfully migrate to the cloud, their IT teams must update their skills specially on cloud architecture, development, implementation and operation (KPMG, 2011). This can be done through competency development programs that encompasses all the activities carried out by the organization and the employee to maintain or enhance the employee's functional, learning and career competencies (A. De Vos, De Hauw, & Willemse, 2011). The table below (table 5) summarizes the proposed competencies required to address various cloud adoption challenges.

**Table 5: Proposed competencies and roles**

| Challenge | Competency | Emerging Role |
|---|---|---|
| **Availability/Reliability** | -The current disaster management processes would need to undergo changes to reflect the move to the Cloud. Further, while the Cloud promises to take care of disaster recovery planning for organizations, Cloud outages still point to the need to plan for disasters(KPMG, 2011)<br>-SLAs, which include QoS requirements must be ideally set up between customers and cloud providers to act as warranty. An SLA specifies the details of the service to be provided, including availability and performance guarantees (Buyya et al., 2011) | Provisioning Manager |
| **Security** | -Current cloud offerings are essentially public. For this reason there are potentially additional challenges to make cloud computing environments as secure as in-house IT systems (Buyya et al., 2011). | Security and Compliance Manager |
| **Portability/ Interoperability Integration/ Componentization /Customization** | -Bridge the technology domains, ensure the coherence of the computing<br>environment, and manage the evolution of the cloud platform for end-to-end business services (Elias & Mirchandani, 2012). | Cloud Architect |
| **Vendor Management/Lock-in** | -Manage relationships with cloud providers and cloud service brokers; and incorporate them as needed into the services management and delivery process (Elias & Mirchandani, 2012).<br>-IT shift from being an internal provider of services to a manager of external service providers (ERNST & YOUNG, 2011). | Vendor Manager |
| **Cultural Resistance** | -Manage the development functional, learning and career competencies(Ans De Vos et al., 2011)<br>-Change Management | Training Manager |
| **Transition and Execution** | -Manage the configuration, operation, and performance of cloud environments for specific business purposes and services (ERNST & YOUNG, 2011)<br>-Assess critical business drivers for cloud migration (KPMG, 2011). | Cloud Analyst |

## *5. Conclusion*

The Cloud computing engine is gathering steam, both within the industry and academia. Researchers and practitioners in computer software and hardware are already making large hops in addressing the technical challenges of cloud computing. The challenge now is that the business community, researchers and practitioners must also begin addressing the challenges of cloud computing from a business perspective. While there have been efforts in the recent past by researchers and practitioners to address business challenges of cloud computing, more research should address organizational issues. This study contributes to this effort by proposing competencies that business organizations need to develop so as to leverage cloud offerings. By drawing on the resource based view of the firm to ground and support the need for new competencies for cloud adoption, the study provides a new perspective of studying cloud computing.

The new competencies proposed in this study are theoretical. Empirical research is needed to for purposes of validation. Further research is needed to inform practitioners on the processes of competency development. This competency development research needs to be informed by reference disciplines like human resource management and organizational behavior.

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