Trusted Supply Chains: Surveying Competitive Value Of The Cloud

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ABSTRACT

Cloud computing has become a force multiplier for organizations as they realize the benefit from the shared computing platforms and services offered by cloud computing. Providers market shared computing platforms and services because of their convenience, dynamism, elasticity, and scalability to meet the growing demands of organizations, specifically in widespread supply chain networks. Yet, the issuance of trust has become a concern in the cloud web as cloud computing service technologies advance faster than measures to secure it. This research presents a framework to determine which specific supply chain functions can derive the most value from cloud capabilities and to understand how to leverage these technologies strategically to develop a competitive advantage. It proposes a strategic integration of cloud functionalities to create profitable supply chain network partnerships and to improve the processes, quality and innovation potential in the overall Supply Chain Management (SCM), while maintaining a trusted cloud environment.

Keywords: Cloud; Supply Chain; Value; Trust

INTRODUCTION

The dynamic environment of market conditions and increasing consumer demands force organizations to operate adjustable and flexible supply chains. Supply Chain Management (SCM) has become increasing challenged due to geographical dispersions in the supply chain networks along with an increased demand for sharing information across the chain. As SCM leaders face the challenges of global competition along with knowledge symmetries, they are considering implementing cloud computing for various business functions. Transitioning from traditional enterprise computing models to virtualized cloud-based models continues to be a challenge.

Accordingly, traditional Supply Chain Management's communication platform is quickly evolving in response to developments in collaborative technologies. Companies are seeking a competitive advantage in their supply chain solutions in order to achieve more efficient data synchronization, application integration and management of services between multiple agents in multiple companies. To this end, they are investing in software platforms that allow the most flexible and convenient mobile interfaces. Achieving optimal supply chain potential requires efficient collaboration, communication, and shared risk; the cloud computing environment provides such functionalities to the supply chain managers. Cloud computing facilitates a scalable, on-demand access to a shared pool of computing resources that can be scaled to meet the customers' computing needs and requirements.

Control and visibility are central tenets to building trust in cloud computing. Individuals trust a system less when they perceive to have less control over their assets, meaning that when customers have ownership and control the data consigned to the cloud, they trust the system more. A critical factor to cloud success is how the infrastructure and policies for control and visibility are managed and presented to the supply chain managers. The customer needs to be assured that they have control and ownership over their data, no matter where it is physically located. This assurance extends to security and prevention measures that facilitate the confidentiality, integrity and availability of the customer's data.

While the benefits of cloud computing have been predominately viewed as universal, the intent of this research is to develop a framework to determine how specific types of industries and company supply chains can derive value from cloud computing environments and to understand how to leverage these technologies strategically to develop a competitive advantage. This paper presents a strategic integration of cloud functionalities in order to create profitable supply chain network partnerships and to improve the processes, quality and innovation potential in the overall Supply Chain Management (SCM), while maintaining a trusted cloud environment.

BACKGROUND

Literature on cloud computing is nearly universal in its views on how competitive advantage and value are created with cloud computing. Dean (2009) describes the value of cloud computing on three levels: the utility level, the process transformation level, and the business model transformation level. At each level, the authors describe attributes, such as lower cost, improved processes and innovation, to name a few, whereby defining where the value is derived from in-cloud computing's capabilities. Marston et al. (2011), Schramm et al. (2012), and Shacklett (2010) further describe how supply chain management can benefit greatly from using cloud computing; it enables capabilities such as reducing the start-up costs, increasing the supply chain visibility, reducing lead time, enhancing the inter-firm collaboration and supply chain integration, and reducing response time to customers.

Cloud computing offers competitive advantage derived primarily from a firm's leverage of cloud computing's speed and agility, its promotion of innovation, and scalability. Butte et al. (2011) state, "The goal is business agility and efficiency." The ability to respond to changes in the business quickly, yet efficiently, is a key factor to sustainable competitive advantage. To the assertion that competitive advantage is also derived from cloud computing's ability to promote innovation, PricewaterhouseCoopers postulates that cloud computing lowers the financial barrier to trying new ideas while simultaneously speeding up their time to market PWC (2011). In the same instance, once again, the benefit of speed is referenced as facilitating competitive advantage. Scalability becomes a competitive advantage with cloud computing's ability to grow and shrink with demand as described by Harris et al. (2010). Furthermore, cloud computing can provide on-demand computing services with high reliability, scalability, and availability in a distributed environment, as stated by Xun (2012).

This growth and continued interest in cloud computing warrants a greater interest in defining and establishing trust within the cloud between all the interacting entities, including appropriate procedural and technical protections. Trust in the context of cloud computing is a complex process which requires all participants to disclose volumes of information about themselves. Vast types of entities interact and share with each other within the cloud, yet forgo assurances that these entities can be trusted. For a trusting environment to exist, the participants are "universally required to accept the underlying premise of trust." Kramer (2010). The collaborative nature in which these entities interact with each other "is only productive if all participants operate in an honest manner." (Abawajy, J., 2009)

APPROACH

As noted previously, the cloud provides an elastic computing power environment which is highly scalable and is a pay-per-use model for software, infrastructure, and platforms. It also provides the ubiquitous on-demand services that are always on anywhere, anytime and anyplace. In order to evaluate the value of operating cloud-based supply chain networks for specific types of industries, an in-depth analysis and synthesis of research finding from across disciplines was performed. The approach was to review the existing research and identify various terms which represent positive attributes of the value of the cloud. These attributes could be described in different, yet similar meaning terminology, such as "beneficial" or "valuable", or any such term representing a degree of the positive impact of cloud computing on business. A list of attributes was comprised in this manner. Then a cross-reference of these terms was conducted across multiple sources; this indicated reasons as to why an organization would opt to shift their business functions to the cloud. Table 1 exemplifies how the list was developed:

Table 1: Sources Indicating Value Of Cloud

Source	Cost Savings	Speed	Flexibility	Scalability	Distance	On-demand	Company-wide Integration
[2]	X	X	X	X	X	X	X
[3]	X	X	X	X		X	
[10]	X	X	X	X	X	X	
[4]	X	X	X	X	X	X	X
[5]	X	X	X	X		X	X
[6]	X	X	X	X	X		X

Further mining the sources produced specific explanations of how an attribute derived value for a specific type of business. By using Dean et al. (2009) categorization of cloud computing's attributes into various levels of value categories as a guide, a mapping of the value attributes stated in Table 1 into each of the value categories was conducted. This was based on the description of how the value was determined at each level.

Finally, in determining what specific industries and companies derive the most value from cloud computing, the author used the industries with highest rates of cloud computing adoption as an initialization to the process. Mining the sources for any mention of these industries and any explanation of what specific cloud attributes lead to the value being realized, a list of industries was created. The same process was used for determining what company or industry experienced a discernible competitive advantage from cloud computing. This revealed how cloud technology was incorporated by the Zynga Company to derive profit results; this exemplified one industry type that leveraged cloud to deploy a competitive advantage in the supply chain system (Harris et al., 2010).

RECOMMENDATIONS

Findings

Table 2 presents the results of analysis which indicates the industry types in which cloud computing reveals the most value.

Table 2: SCM Characteristics/ Industries Deriving Cloud Value

Characteristic	Industry	Examples
Operations are fragmented or span several industries or organizations.	Healthcare industry Travel & Hospitality	Centralizing Electronic Medical Records (EMRs)
Supply Chains spanning large Geographic areas	Manufacturing/supply chain-based industries	Centralized order fulfillment, logistics, replenishment - Continuous availability of resource
Legal Policies/Procedures across jurisdictions (wide network)	Education industry	Transparency; Increased collaborations
Cost concerns (lack of capitol/resources) and uncertainty	Small- to medium-sized businesses	Commoditized - Pay as needed, scalability

By further analyzing the characteristics, the added value to supply chain networks derived from the cloud environment can be demonstrated by mapping the specific attributes of cloud computing to the unique attributes and functionalities of each industry. The following details the characteristics and examples of the value realized from cloud computing as listed in Table 2:

1. Industries whose operations were fragmented or spanned several industries or organizations.
    a. Healthcare industry: Management of a single patient record encompasses the coordination of doctors, hospitals, insurance companies, laborites, etc. Cloud computing facilitates the collecting and maintaining of high quality patient data by providing a platform which allows multiple entities to seamlessly share their internal capabilities with trusted partners (Cloud Computing Forum, 2012). Where each component in the healthcare value chain assembles their own fragmented information on one patient, cloud computing rectifies the issues that arise with this practice by allowing all contributing parties a single entry point to all information pertinent to patient care.

For example, centralizing Electronic Medical Records (EMRs) in the cloud provides patients with consistent, comprehensive, and current data to patients and providers.

b. Travel and Hospitality industry: Similar to the fragmented nature of healthcare operations, travel plans can encompass reservation activities across hotels, airlines, and rental car companies. Where the internet displaced travel agents with providing all necessary resources for travel booking and coordination online, cloud computing takes it one step further by consolidating interactions with each party involved into one transaction.

2. Cloud computing's value is realized in industries requiring instant business/transactions across long distances because of the ability to negate large spans of geographic distance.
   a. Global Manufacturing/supply chain-based industries require continuous availability of resources. Such industries benefit from accessibility to the up-to-date real time information and from a collaboration platform enabling timely secure transactions.
3. Cloud platform provides a centralized environment for wide networks across jurisdictions to collaborate, share, and discuss Legal Policies/Procedures.
   a. Education industry: The education system is subject to federal mandates, as well as state, and, in many cases, even county. The cloud environment allows the education system to leverage efficiency across these various networks. Furthermore, the cloud enables collaboration among various teams and departments, facilitating efficiency and process transformation.
4. Cloud service value is realized by those organizations lacking investment capital and resources, thus requiring low cost implementation and maintenance of enterprise software.
   a. Small- to medium-sized businesses: Cloud computing eliminates the requirement of large, upfront capital investments for IT infrastructure, something small- or medium-sized businesses might not have at their disposal. Additionally, the speed and timeliness aspects of cloud computing emerged as prime value adds to small- and medium-sized businesses. Being able to quickly access and deploy computing capabilities, in many ways, closes the gap between large and small companies in getting products and services to the public in a timely manner.

With the increased flexibility of the cloud, which allows all levels of the data to be processed in one location, heightened visibility is also a benefit the cloud offers. The single platform allows the entire supply chain, including forecasting, order fulfillment, logistics, replenishment, etc., to be reviewed in real-time from any mobile or stationary device that can connect. Not only has cloud computing widened the pathways to greater computing power and functioning; in many ways, it has forged brand new paths. The survey results identify precise industry attributes for which various functions of cloud computing can offer specific value or competitive advantage:

1. Cost Savings: Cloud computing is billed as either a utility or a subscription service and is based on services used.
2. Speed and timeliness: Cloud services are up and running in days instead of the weeks or months it might take to deploy a traditional in-house software and hardware system. This reduces the lag between realizing a business need and satisfying the need.
3. Flexibility is the ability to change without disruption to the business.
4. Scalability is the ability to shrink and expand as business needs dictate.
5. Distance lessens impact of geographic distance in a global market.
6. On-demand self-service means that computing capabilities can be rapidly scaled – storage, server time, and applications – up or down based on need.
7. Company-wide integration: The integrative nature of the cloud platform means that everyone will be able to see the same real-time information whenever they need it.

The business values on the utility level are cost savings, flexibility, and speed and convenience. At the process transformation level, the company-wide integration capability is where the value is derived. On the business-model innovation level, the value is realized in the scalability aspect of cloud computing.

Based on the above findings, the following recommendations should be taken into consideration when deciding to employ cloud computing:

1. When a business encompasses several industries, such as the health care industry, the cloud should be used to defragment interactions among the various groups.
2. Cloud computing should be the main consideration for small start-up businesses due to the lack of up-front capital expenditures and the flexibility of cloud applications.
3. Cloud vendors should communicate the reliability and stability of their services to overcome threats to adoption.

Validating this recommendation for using cloud computing to gain a competitive advantage is the social media gaming company - Zynga. Zynga heralds its unique cloud infrastructure as one of its core strengths (Harris, 2012). Zynga's IT infrastructure is composed of a mixture of their own data centers and public cloud data centers, linked with high-speed networking. Their approach to hybrid cloud computing is contrary to the conventional approach; while other companies anticipate using private clouds as a stepping stone to public clouds, Zynga uses Amazon EC2 "…as a staging ground before ultimately moving games onto private cloud resources." (Harris, 2012) By using public cloud computing in this way, it allows Zynga to "…scale elasticity and determine average traffic loads and other metrics so that it can optimize its internal infrastructure for each game's specific needs" (Harris, 2012). In their S-1 statement filing with the SEC, Zynga describes a scenario where "…our automatic provisioning tools enabled us to add up to 1,000 servers in a 24-hour period in response to game demand" (Harris, 2012). The speed, scalability, and real time, on-demand nature of cloud computing is at the core of Zynga's competitive advantage.

While cloud computing's benefits are enticing, there are some considerable barriers in place that thwart adoption on a larger scale. These barriers are data security concerns, data privacy concerns, the cloud's dependency on Internet access, confidence in the reliability of vendors, and physical location of data. When these obstacles are satisfactorily diminished or eliminated, cloud computing's true benefits have the potential to be realized.

Trust

Kramer (2010) notes that there are three distinct aspects that determine the concept of trust in a system:

1. Trust relations - the interaction between two entities in which they believe or know that the other entity is operating in an honest manner.
2. Trust domains - a community of mutually trusting entities in which there is a universal belief and a sharing of knowledge among all entities within the community.
3. Trust management – the organization of trust relations into trust domains and assurance of the flow of trust negotiation between all participating entities.

Apparent from these three distinct aspects is that trust is very much based on the establishment of building a reputation amongst all participating entities. Trust relations can be further broken down to incorporate potential trustees since each trust relation will begin with the two entities not knowing each other. Hence, reputation management can have an important role in establishing the cooperative trust relations between entities. Reputation schemes basically reach out to other peers of a particular entity to infer trust toward this potential trustee. More than likely what occurs is an aggregation of the inferences, which are, in turn, used to build a trusted entity. This newly trusted entity would then become part of a larger community of trusted entities forming a trusted domain. As these trusted domains interact with each other, they effectively build a web of trust.

A trust model must take into account all entities that make up the cloud computing environment to support the chain of trust which in turn creates a web of trust. In supply chains, these networks of entities expand and require transparency along with privacy. More importantly, because establishing trust is reputation-based, the supply chain manager must validate implementation of processes which prevent tampering with the reputation information that is shared between peers. Incorporation of policies and credentialing into the trust model, or adding time-stamp hashing capabilities, are potential solutions that the cloud provider may have embedded in the

environment. The result is a tamper-proof trust negotiation environment that will lead to greater assurances of the cloud computing environment.

CONCLUSIONS

The value cloud computing offers to supply chains can be realized through specific aspects of its capabilities, though the supply chain managers must maintain caution regarding trust among the entities. Value at various levels is derived via cost savings, flexibility, speed, convenience, integration capability, and the scalability aspect of cloud computing. These cloud value propositions are realized predominantly in the healthcare industry, the hotel and hospitality industry, manufacturing/supply-chain-based industries, and education. The use of existing trust and reputation management systems remains critical to realizing this value. Hence, cloud computing offers the supply chain managers an option for a highly scalable, elastic and dynamic environment for companies of all sizes to use.

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AUTHOR INFORMATION

Rajni Goel, PhD, originally trained as a mathematician and earned her Ph.D. in Information Technology from George Mason University, concentrating on Information Security. Since joining the HU Business School's Department of Information Systems & Decision Sciences in 2003, she has conducted research on information security, railway security, privacy, and data mining. She has published and presented numerous papers on topics ranging from how to secure trains and supply chains to how to secure online bidding and purchasing. Rajni has also garnered more than $1 million in grants from the federal government to develop secure wireless communication systems for U.S. railways. Email: Rgoel@Howard.Edu.

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NOTES