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The Prospects of Cloud Computing in Supply Chain Management

(A Theoretical Perspective)

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Abstract

Today's world organizations are searching for ways to minimize the cost and maximize the efficiency of each cycle of their supply chain, such as procurement, manufacturing, and distribution, particularly for those that handle multiple supply chains. Cloud computing technology emerges as an effective tool that, according to some researches, contributes to firms' effectiveness and competiveness by providing the right infrastructure and business solutions for the entire supply chain via the Internet.

This study aims to shed more light on the prospects of cloud computing in supply chain management. More specifically, with focus on cloud computing's suitability and benefits by offering a thorough review and analysis to previous and current research, including all types of published materials that lead to an adequate answer for the main research problem, as follows:

What are the prospects and benefits of cloud computing technology in the supply chain of business organizations?

This research method relies solely on secondary data, such as research papers, reference materials, conference proceedings, and all types of reliable data that serve the purpose of this paper.

The major conclusion of this study is that; Organizations that work in a more turbulent environment are the ones that feel the effect of the cloud computing technology on their supply chain performance compared to those that work in a more stable business environment.

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Therefore, the degree of importance of cloud computing adoption varies from one sector to another, therefore, cloud computing—if adopted properly—can improve the supply chain performance in terms of cost, quality, speed, and flexibility.

Keywords: cloud computing, supply chain management, supply chain collaboration, information sharing

1. Introduction

In light of today's technological turmoil, organizations are trying shift to new business models, changing their strategic plans and reorganizing their structures to be able to survive and continue to offer products and services to consumers.

On the other hand, the shift of organizational strategic orientations from competition to collaboration forced companies to look in to new ways in managing their operations, which calls for a strong connection among three major production activities: procurement, manufacturing, and distribution, paving the way to a new management concept known as the supply chain management (SCM).

One of the major developments in the information and communications technology that may contribute to the efficiency and effectiveness of the SCM is the evolution of the concept of cloud computing which is a kind of Internet-based computing that offers shared processing solutions, resources, and data to computers and other devices on demand (Hassan, 2011). It is an IT service model where computing services that include both hardware and software are delivered on-demand to customers over a self-service fashion, independent of device and location (Marston et al., 2011). Therefore, having local servers or personal devices to handle applications are no longer needed.

The technology of cloud computing is still somewhat surrounded by ambiguity and uncertainty in terms of how useful and effective it is for business organizations that have already adopted it or are still undecided. Thus, this paper tries to offer a theoretical review on that matter.

2. Statement of the Problem

Businesses across the globe are always looking for ways to cut down on cost and at the same time maximize the efficiency of each cycle in a supply chain. Businesses that handle multiple supply chains in particular are eager to find ways of achieving maximum efficiency at minimum cost. By providing the right infrastructure and business solutions for a company's entire supply chain via the Internet, cloud computing is beginning to be credited for firms' effectiveness and competitiveness.

Casey et al. (2012) stressed that the concept of cloud-based SCM is still new, and theoretical frameworks are still in its infancy stage. Hence, one way of adding extra knowledge and understanding of cloud computing and its relationship with the SCM is to enrich the theory through qualitative approach, such as grounded theory.

Despite recent studies, there still exists a significant hole regarding the level of usefulness and success of cloud computing as utilized in a supply chain. A number of questions still remain, which prompts this paper's research into the prospects of cloud computing in application to SCM, with regard to cloud computing's suitability and benefits. This research is powered by an offering of literature review and an analysis of both past and present studies, including all types of published materials that should lead to an acceptable answer for the main research problem:

What are the prospects and benefits of the cloud computing technology in the supply chain of business organizations?

3. Research Significance

Cloud computing is a technology that is in need for more studies as it is still relatively new. Additional research into this system can only contribute to its growth and development, thus enabling supply chains to benefit from the knowledge and understanding gained.

Furthermore, many organizations are still in doubt regarding the gains and risks associated with adopting cloud computing, and are still waiting for the science and the practice to prove its use and reliability. Hence, the researcher hopes this study can arrive at a convincing answer for business organizations all over.

The researcher's interest lies in exploring topics related to the supply chain development and optimization, particularly at this point in time when competition is based on cost, speed, flexibility, and delivery, and not just end result results alone.

4. Research Methodology

This research relies solely on secondary data, such as research papers, reference materials, conference proceedings, including all types of reliable data that serve the purpose of this paper. Therefore, this paper consists of an introduction, a brief overview on the concept of SCM and cloud computing, the relationship between cloud computing and the supply chain performance, the results discussion, conclusions, and recommendations.

5. Literature Review

5.1 The concept of cloud computing

Computing services are getting to be commoditized in a nature similar to ones currently being supplied in the same manner such as water, electricity, and communications services. Users can have access to such service according to their computing needs, regardless of where the services are hosted or how they are delivered. Several computing models have promised to deliver this utility computing vision, and these include Cluster Computing, Grid Computing, and more recently, Cloud Computing (Buyya, et al., 2009). Internet service providers (ISPs) came up with the idea of cloud computing in order to support the maximum number of users and elastic service with minimum resource (Qian, et al., 2009).

Cloud computing began to gain popularity in 2007 as a resource optimization tool that provides services to geographically separated clients on demand (Etro, 2011; Ruan, Baggili, Carthy, and Kechadi, 2011). According to Armburst et al. (2010), cloud computing may also be referred to as follows:

"refers to both the applications delivered as services over the Internet and the hardware and systems software in the datacenters that provide those services, when a Cloud is made available in a pay-as-you-go manner to the general public, we call it a Public Cloud; the service being sold is Utility Computing. We use the term Private Cloud to refer to internal datacenters of a business or other organization, not made available to the general public"

(Armburst, et al., 2010).

Therefore, according to Foster et al. (2008), cloud computing or grid computing can be seen as a specialized, distributed computer paradigm that is different from the traditional ones because of its ability to be distributed massively, and perform under an increased or expanding workload. It is able to offer a wide variety of services that can meet different clients' needs, and it is driven by the economy of scale (Foster et al., 2008).

Cloud computing is getting to be a key strategy for information technology vendors, Internet service providers (ISP), and telecommunications service providers. Even further, the United States of America and Japan have made cloud computing a national strategy and a concern (Qian, et al., 2009).

Taking into consideration the business model (Figure 1) of cloud computing, said technology offers services that can be divided into three types: software as a service (SaaS), platform as a service (PaaS), and infrastructure as a service (IaaS) (Zhang, et al., 2010).

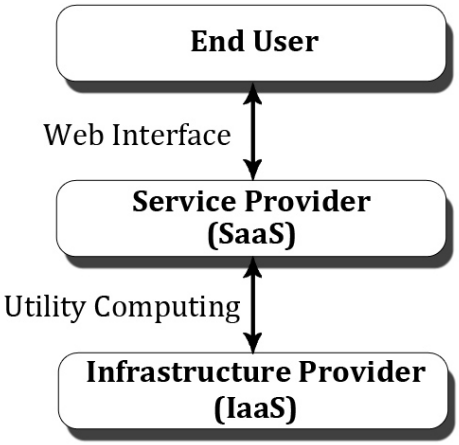

Figure 1. Business model of cloud computing

1. **Infrastructure as a Service:** IaaS refers to on-demand provisioning of infrastructural resources, usually in terms of virtual machines or VMs. The cloud owner who offers IaaS is called an IaaS provider. Examples of IaaS providers include Amazon EC2, Go Grid, and Flexiscale.

2. **Platform as a Service:** PaaS refers to providing platform layer resources, such as operating system support and software development frameworks. An example of a PaaS provider is the Google App Engine.

3. **Software as a Service:** SaaS refers to providing on-demand applications over the Internet. Examples of SaaS providers include Salesforce.com, Rackspace, and SAP Business By Design.

5.2 The concept of the supply chain management

As a term, "supply chain management" (SCM) was coined during the early 1980s. Later,

SCM became a very popular term and concept, as well as an attractive topic for researchers. Such is the case to the extent that it is quite impossible to see a journal on manufacturing, operations, marketing, customer management, inventory management, and others more without seeing a research paper about SCM and topics related to it. SCM represents a paradigm shift that extends one's appreciation for the concepts of cooperation and competition. Cooperation is no longer seen as a process between one set of trading partners but along the entire supply chain (Spekman, et al., 2008).

Stock and Boyer (2009) view SCM as

"The management of a network of relationships within a firm and between interdependent organizations and business units consisting of material suppliers, purchasing, production facilities, logistics, marketing, and related systems that facilitate the forward and reverse flow of materials, services, finances and information from the original producer to final customer with the benefits of adding value, maximizing profitability through efficiencies, and achieving customer satisfaction" (p. 706).

A supply chain is a network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services delivered to the ultimate consumer (Christopher, 1992). SCM, on the other hand, is "an integrative philosophy to manage the total flow of a distribution channel from supplier to the ultimate user" (Cooper et al. 1997). SCM concept enforces the system's approach by viewing the organization and its partners as a system with different parts that must work together in a collaborative manner in order to reach the organization strategic goals (Ellram and Cooper, 1990).

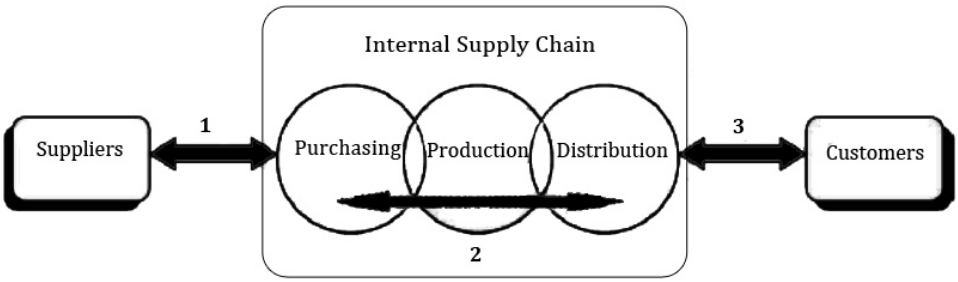

Figure 2. A company's supply chain source (Chen and Paulraj, 2004)

Mentzet et al. (2001) identified three levels of supply chain: a direct supply chain, an extended supply chain, and an ultimate supply chain. A direct supply chain is made up of a company, a supplier, and a customer having a part in the upstream and or downstream flows of products, services, finances, and /or information. An extended supply chain consists of suppliers of the direct supplier and customers of the direct customer, all actively participating in the upstream and/or downstream movements of products, services, finances, and/or information. An ultimate supply chain contains all the organizations participating in all the upstream and downstream flows of products, services, finances, and information from the ultimate supplier to the ultimate customer.

Naturally, another reason for the increased interest is the potential benefits of SCM. Benefits

include improvement in returns on investments (ROI) and returns on assets (ROA). "Ultimately, the goal of SCM is to achieve greater profitability by adding value and creating efficiencies, thereby increasing customer satisfaction" (Stock and Boyer 2009, p. 703). Ideally, improvement of the supply chain translates to how the SCM is gaining popularity due to the perceived benefits that organizations can get as a result of SCM adoption, such as improvement in ROIs and ROAs. In the end, the purpose of SCM is to increase profit by adding value and maximizing efficiency, which would lead to a higher level of customer satisfaction (Stock and Boyer 2009, p.703). Other benefits may include decrease in cost due to the reduction of redundancies, lower level of inventory, shorter lead time, and less uncertainty in demand, (Fisher 1997; Lambert et al., 2005; Lee et al., 1997).

To sum it up, the SCM is no longer considered a new concept, but a concept that requires continuous development and improvement to maintain its validity and suitability for the current production and manufacturing trends. Therefore, the evolution of cloud computing can be treated as a new method for improving SCM.

5.3 The supply chain management (SCM) and cloud computing

IBM conducted a study which revealed that the use of cloud computing will more than double until 2014. The very same research also found that many companies are considering the adoption of cloud computing, and that some have already piloted and implemented the technology (Berman et al., 2012). Cloud services bring flexibility, configurability, cost effectiveness, low implementation cost to IT, and— by extension—SCM.

The Internet and web technologies can support the entire supply chain's operations. Internet-based supply chain operations are fast and inexpensive. Moreover, customers can instantly check the status of their orders by simply clicking their computer mouse. Corporate executives and managers can conduct real-time access to firm's inventory level, and so can their suppliers and distributors (Chou et al., 2004).

Cloud computing is a new and promising paradigm delivering IT services as computing utilities. As Clouds are designed to provide services to external users, providers need to be compensated for sharing their resources and capabilities (Buya et al., 2009). The synergy gained through shared expertise and resources and the business advantages (i.e. lower product costs, reduced time to market, improved quality, advanced technology, or improved service/delivery) gained from the relationships among organizations have prioritized the management of relationships (Daugherty, 2011).

Cloud computing technology carries with it flexibility, cost efficiency and effectiveness, and configurability, which, if adopted by organizations, can lead to better supply chain performance (Durowoju et al., 2011). McCrea (2012) conducted a study on supply chain technology, specifically cloud computing breakthroughs:

- the adoption of cloud computing rates are highest in areas of collaborative sourcing and procurement, demand planning, global trade management, and transportation management systems; and

- cloud computing will lead to new forms of collaboration that cannot be developed with traditional solutions in traditional architecture

Therefore, different business processes can be performed and managed efficiently when applying said technology (McCrea, 2012).

Cloud computing is becoming an opportunity for small organizations to share the same services as larger firms. This opportunity includes the benefits of being able to openly interact and manage processes outside the organization, which results in the reduction of the cost of ownership of supply chain collaboration (Aviles, 2015). To reach the expected success, cloud computing requires the mediating support of supply chain integration. However, there is no concluding evidence that cloud computing has a positive effect on either supply chain integration or operational performance. A positive significant relationship was found between supply chain integration and operational performance in all of the models used (Camara et al., 2015).

The Internet enhances SCM's performance, which is an essential part of e-Commerce. As the SCM evolves in the information age, the network supports coordination among business partners to ensure all information, transactions, and decisions flow through the network. As a successful SCM model, Dell Computers has established competitive advantages with the advancement of the networked economy (Chou et al., 2004).

Of organizations that currently use cloud-based solutions, the benefit mentioned most frequently is that it can be rapidly deployed and upgraded, as indicated by 50% of all organizations. However, the second most common benefit of cloud is that it reduces the risk of IT disruptions from external factors such as natural disasters.

This is increasingly becoming recognized as a major benefit of cloud-based solutions, particularly given the impact on business operations of natural disasters, and the ability of cloud-based solutions to reduce this risk (Frost and Sullivan, 2012). Further details are shown in the table below:

Table 1. Benefits of SaaS cloud solutions versus on-premises solutions

Can be rapidly deployed and upgraded	50%
Reduced risk of IT disruptions from external factors such as natural disasters	45%
Enables accessibility via mobile devices (smartphone, tablet)	42%
Can easily set up multiple subsidiaries in different locations and currencies	40%
Seamless integration with in-house infrastructure	38%
Can more easily keep up with regulatory changes	37%
More predictable monthly expenditure	31%
Enables better support of a decentralized business spanning multiple locations	30%
Can reallocate IT budget from maintenance to enable innovation	29%
Single integrated suite, doing away with the need to integrate disparate systems	28%
Enables better collaboration with suppliers, customers, and channels	24%
Source: Frost & Sullivan, APAC survey of 167 companies, in Logistics, Distribution and Manufacturing verticals	

Schniederjans and Özpolat (2013) conducted a study on an empirical examination of cloud computing in humanitarian logistics and found a positive association between cloud computing use and collaboration among humanitarian organizations and their suppliers, as well as the ultimate positive impact on agility. Cloud computing offers its users massive scalable services and pricing options that allow humanitarian organizations to scale according to their own needs, as well as the needs of their supply chain's partners (Marston et al., 2011). Humanitarian supply chains often require the use of several transport modes, as well as the involvement of several government and independent non-governmental organizations (Oloruntoba and Gray, 2006).

Research by Gartner predicts that the total public cloud services' market size will expand to $206.6 billion by 2016. The assertion is that the adoption rates are highest in the areas of collaborative sourcing and procurement, demand planning, Global Trade Management (GTM), and transportation management systems. As manifested by that big investment in cloud services, we may conclude that companies are already convinced with the benefits attained by the implementation of cloud computing in their operations (Srivastava, 2012).

Cloud-based procurement enables companies to manage different suppliers in one integrated database, and provides tracking in forward and reverse logistics in one closed-loop supply chain model (Aivazidou et al., 2012). Enterprises that fail to integrate the capabilities of business partners and exploit the new functionalities and favorable economies of cloud services risk competitive disadvantage (Stamas, 2013).

We also found that all of the cases implied that cloud computing greatly enhanced information sharing among supply chain partners. Cloud computing provided firms the ability to share information internally and externally throughout their companies and supply chains. That being said, it was only through the alignment with the business strategy that cloud computing provided a basis for secure, efficient, and effective information sharing. Moreover,

the positive impact that cloud computing has on information sharing ultimately leads to greater supply chain performance. Various researches have outlined that, although security is important in the use of cloud computing technology, measures to address these issues are being taken, including private cloud use (Cao et al., 2012).

Lindner et al. (2010) reported a comparison of cloud supply chain concepts that counters those of the traditional supply chain concepts.

- Supply demand at the lowest level of costs and respond quickly to demand.
- Create modularity to allow individual setting while maximizing the performance of services at the same time.
- Lower margins, as high competition on comparable products.
- High utilization while flexible reaction on demand.
- Optimization of buyer for unpredicted demand and best utilization.
- Strong service level agreement (SLA) for *ad hoc* provision.
- Select on complex optimum speed, cost, and flexibility.
- Implement highly responsive and low-cost modes.

The real-time demand of information and inventory visibility problem in demand management (DeM) and distribution management (DiM will be resolved by having cloud computing. Real-time information travels immediately backwards by cloud and inventory flows swiftly forward. Most importantly, goods and services are delivered quickly and reliably when and where they are needed. Therefore, the more integrated the flow of data between customers and suppliers are, the easier it becomes to balance supply and demand across the entire network. Eventually, it reduces lead time and helps in defeating the bullwhip effect in the industry and contributes to higher performance in supply chain (Ali, 2012).

Organizations using cloud computing showed significant differences in their collaborative relationships, in trust, and in terms of communication. The results showed remarkable result for large organizations using cloud computing in the association between collaborative relationships and relational outcomes. According to the aforementioned result, logistics managers from large organizations perceived that organizations using cloud computing were generating higher relational outcomes (Aviles, 2015).

6. Summary of Literature Review

1. Researchers such as Berman et al. (2012) agreed on the ability of cloud computing to bring flexibility, configurability, cost effectiveness, low implementation to SCM, and its ability to make Internet-based supply chain operations fast and inexpensive.

2. Synergy can also be gained through shared expertise and resources and business advantages such as lower product costs, reduced time to market, improved quality, and improved service/delivery (Daugherty, 2011).

3. The synergy can lead to new forms of collaboration that cannot be developed with traditional solutions in traditional architecture. Therefore, different business processes can be performed and managed efficiently when applying this technology (McCrea, 2012).

4. Another significant relationship was found between supply chain integration and operational performance in all the models used (Camara et al., 2015), which may be due to the reason that cloud services' corporate executives and managers can conduct real-time access to firm's inventory level, and so do their suppliers and distributors (Chou et al., 2004).

5. Cloud computing has been considered as an opportunity for small organizations to share the same services as larger firms, as well as share in the benefits garnered from their ability to openly interact and manage processes outside the organization. At the same time, this also allows organizations to reduce the cost of ownership of supply chain collaboration (Aviles, 2015).

6. Another benefit mentioned most frequently is that it can be rapidly deployed and upgraded, thus reducing the risk of IT disruptions from external factors such as natural disasters (Frost and Sullivan, 2012).

7. Cloud-based procurement enables companies to manage different suppliers in one integrated database. It provides tracking in forward and reverse logistics in one closed-loop supply chain model (Aivazidou et al., 2012).

8. It provided firms the ability to share information internally and externally throughout their companies. For supply chains, the positive impact that cloud computing has on information sharing ultimately leads to greater supply chain performance (Cao et al., 2012). Therefore, the more integrated the flow of data between customers and suppliers, the easier it becomes to balance supply and demand across the entire network (Ali Sayed, 2012).

9. Gartner predicts that the total public cloud services' market size will expand to $206.6 billion by 2016. He asserts that adoption rates of the technology are highest in the areas of collaborative sourcing and procurement, and demand planning (Srivastava, 2012).

7. Conclusion

The previous literature review made it clear that cloud computing implementation is not just a strategic option, but also a great opportunity for business firms to excel at all aspects of their operations. As a matter of fact, what was once considered as a tool that consumes much in terms of money, effort, and time, apparently is already available and for a very low cost.

The reasons behind the convergence of collaboration between competing companies, rather than stiff competition, can be traced to the cloud computing technology capability in making sharing of information and resources a lot easier compared to decades ago.

The shift in the industries structure from fragmentation to consolidation is what previous literature indicates, and that is because business firms which work at the same industrial or service sector can unify their sources to reap the benefit of the economy of scale, increase the quality of their purchased materials, and have a high negotiating power.

Organizations that work in a more turbulent environment are the ones that feel the effect of the cloud computing technology on their supply chain performance compared to those that work in a more stable business environment. Therefore, the degree of importance of cloud computing adoption varies from one sector to another.

To sum it all up, cloud computing—if adopted properly—can improve the supply chain performance in terms of cost, quality, speed, and flexibility.

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