Modeling Cloud Computing Integration with E-Supply Chain Management

Ahsan Chaudhri, Anita Ajmiri, and Jaishree Asarpota
Business Department, Higher Colleges of Technology, Dubai, United Arab Emirates
Email: {achaudhri, aajmiri, jasarpota}@hct.ac.ae

***Abstract*—This paper proposes a conceptual framework model for integration of cloud computing with the e-supply chain network. This integration can potentially allow firms to leverage the benefits inherent in a cloud computing environment and thus, enable organizations to optimize their cost and operational efficiency of management of their electronic supply chain. A cloud based environment can greatly enhance e-SCM success by creating information visibility along the entire supply chain; improving speed, cost, quality, customer service, and amalgamation of all e-SCM activities into a unified, accessible and virtualized platform. The e-SCM activities can be modeled after the cyclic view in order to improve the conceptualization of integration of e-SCM with cloud computing**

***Index Terms*—e-Supply Chain Management (eSCM), cloud computing, Information and Communication Technology (ICT)**

I. Introduction

Supply Chain Management (SCM) is the '*design, planning, execution, control and monitoring of supply chain activities with the intention of creating value, building a competitive infrastructure, leveraging world-wide logistics, synchronizing supply with demand and measuring performance globally'* [1]. By extension, e-SCM involves managing all supply chain electronically. The e-SCM processes can be identified as activities associated with the flow of materials, information and services from suppliers of raw materials to the end customer via product and service processing and warehousing [2] managed electronically. In order to effectively manage the complexity of supply chain, many firms have adopted a strategy of utilizing sophisticated IT for the purpose of facilitating large information flow and thus, creating greater competitive advantage [3]. This development has led to the era of e-SCM.

Cloud computing is estimated to become a $150 billion business by 2014 end, projects Gartner Research, and will potentially grow to more than $24 billion by 2020. Cloud computing is defined as '*a type of parallel and distributed system of… interconnected and virtualized computers that are dynamically presented as one or more unified computing resources'* [4]. A cloud consists of several components such as clients, data centres, and distributed servers with a high capacity for fault-tolerance, availability, accessibility, scalability, and reduced over-heads [5].

Manuscript received July 25, 2014; revised July 12, 2015.

II. Cycle View of E-SCM

Cycle view of SCM proposes a series of cycles: customer, replenishment, manufacturing and procurement cycles, wherein, activities are performed at the interface of two successive stages of each cycle [6], [2]. Fig. 1 illustrates the stages in electronic supply chain management (e-SCM) as conceptualized in this paper. Activities like collaborative product design and development (both inter and intra-firm), scheduling, service options and contacts could be placed in a cloud based environment and managed electronically. Furthermore, all stages of the product development process can be shared over a secured cloud-based network including product specific information, marketing information, test results and customers feedback etc. This allows for real-time online access to these data for all supply chain partners. We have thus extended the cycle view of SCM to the management of electronic supply chain management (e-SCM). Various stages of e-SCM have been described below.

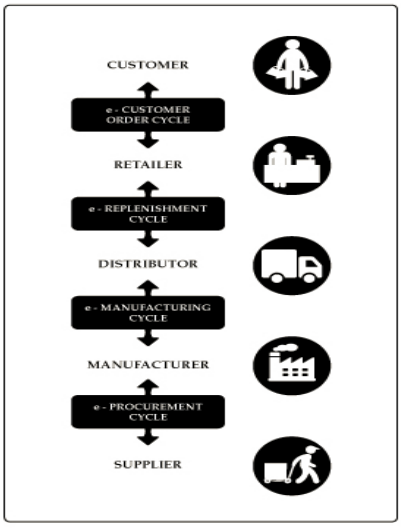

Figure 1. Stages of e-supply chain cycles (adapted from Gibson, & Edwards, 2004) [2]

A. E-Customer Order Cycle

The customer order cycle sits at the interface between the customer and the retailer. This is the first stage in e-

doi: 10.18178/lnit.3.1.56-59

SCM in Fig. 1. The activities performed during this cycle may include customer arrival, inventory checking, order entry, fulfillment, and issuing receipt, electronically. Ubiquitous and anytime-anywhere nature of cloud computing implies that customers can potentially benefit from online, real-time access to product/service information using their computing and mobile devices from anywhere. This is especially beneficial within a B2B environment.

B. E-Replenishment Cycle

Replenishment cycle occurs between the retailer and the distributer or the wholesaler and includes all processes for replenishing retail inventory including order entry, fulfillment and receipt. Refer to the second cycle in Fig. 1. Placing activities like demand forecasting, planning and inventory management within a cloud based environment that support complex databases containing information from multiple suppliers will allow supply chain partners real-time access to all related information and thereby speed up their product comparison, selection, and decision-making process. Cloud-based tools can enable companies and customers to mutually develop contracts and enhance contract management as well.

C. E-Manufacturing Cycle

Manufacturing cycle is located between the manufacturer and the next downstream supply chain partner. Activities like collaborative product design and development (both inter and intra-firm), scheduling, service options and contacts could be placed in a cloud based environment. This is illustrated as cycle 3 in Fig. 1. All stages of the product development process can be shared over a secured cloud-based network including product specific information, marketing information, test results and customers feedback etc. This allows for real-time access to these data for all supply chain partners to avail.

D. E-Procurement Cycle

Procurement cycle occurs between the manufacturer and supplier. The activities involved during this cycle include: materials sourcing; warehousing and transportation; logistics and information management systems etc. Application areas where cloud-based solutions can assist are e-procurement, distribution, inventory, warehousing, and transportation. Vendors like IBM, JDA, and Ariba are among the early deployers of cloud technology [7]. This stage is shown as the final stage in Fig. 1. Furthermore, a cloud-based logistics management system offers the added benefits of on-demand and online self-service, multi-vendor resource pooling, elasticity and scalability of systems in order to avoid the bullwhip effect within a traditional supply chain.

III. Conceptualizing Integration of Cloud Computing into E-SCM

Cloud computing's contribution to e-SCM includes providing firms with infrastructure, platform, and software solutions for its entire supply chain over the internet. Using a cloud-enabled, non-proprietary digital platform can potentially enable all players of e-supply chain management to communicate and work collaboratively.

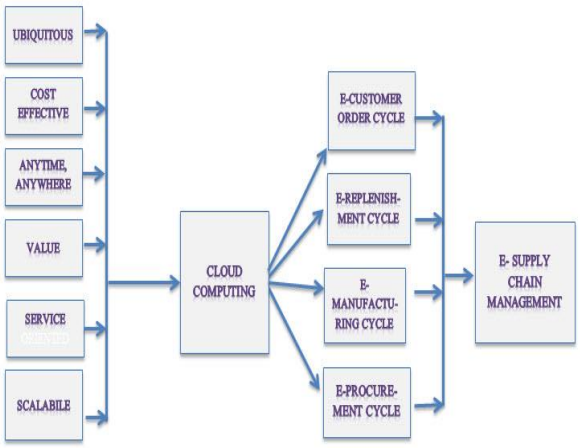

Figure 2. Modeling integration of cloud computing into e-SCM

E-supply chain management performance can be enhanced by exploring adoption of novel technologies like cloud computing. The main advantages of integration with cloud computing is the simplication of interfaces thus eliminating the compatibility issue arising from using multiple platforms for various players within the e-supply chain [4]. By integrating their e-SMC with cloud computing, smaller firms can also benefit from significant reduction in entry cost and access to business analytics previously inaccessible to them due to cost constraints.

It is thus advisable to consider the integration of cloud computing within e-supply chain management [8]. Cycle view is one way of outlining the processes performed within a firm's supply chain [6]. As previously discussed, within e-SCM, the four process cycles will comprise: e-customer order cycle, e-replenishment cycle, e-manufacturing cycle and e-procurement cycle. The cycles specify the roles and responsibilities of each member of the supply chain and the desired outcome of each of the processes and can be integrated into cloud computing to enhance the benefits offered by e-supply chain management. Synthesized from various sources, the key characteristics of cloud computing are: ubiquitous, cost-effective, anytime-anywhere, scalability, value and service-focus. These have been illustrated in Fig. 2.

Ubiquitous: Cloud Computing offers ubiquitous services wherein computing facilities are made available wirelessly through digital devices like smartphones, tablets, laptops etc. from multi-cloud sources. Cloud computing, when integrated with e-SCM, will accommodate n-consumer devices in the front-end with multiple cloud services at the back-end. The proposed framework promises high scalability and agility by accommodating an increasing number of supply-chain partners.

Cost effective: Provision of IT services on the cloud can prove to be cost effective for the service provider and the customer. For the customer, there is no up-front investment cost since cloud computing uses a pay-as-you-

go model; and for the provider, services are run from their virtualized infrastructures which can accommodate multiple tenants [9].

Anytime, anywhere: The complexity resulting from the inter - connectedness of various players within an organization's supply chain is partly due to their geographical dispersion and partly due to the sheer volume of information that needs to be managed and acted upon in real-time. Cloud computing delivers services such as software, platform and infrastructure through next-generation data centers which are built on compute-and-storage virtualization technologies [10]. This enables consumers to access data from a 'cloud' anywhere in the world on demand. All application data are stored in remotely located servers and data centres from where data can be shared and accessed virtually [11].

Value: Cloud computing is attractive to business owners because it eliminates the requirement to own IT infrastructure and allows organizations to start from small and increase in scale only when the demand mandates [12]. Both the service provider and the service user gain from an economical single application software that serves a multiple clients. Resources in a cloud environment can be quickly allocated and de-allocated on demand; the process tends to be cost-effective for the service provider and the user [13].

Service oriented: Cloud computing offers three major types of services: infrastructure as a service (IAAS); platform as a service (PAAS); and software as a service (SAAS). Cloud computing makes resources like hardware, software and platform available as general utilities that can be leased and re-leased by many users simultaneously over the internet on an on-demand basis [13], thereby making computing resources highly service oriented. A combination of these services have the potential to integrate shippers, service providers, distributors, logistics providers, customers, sellers etc. in a global supply chain and thus create a supply chain community of stakeholders similar to a social network environment. E-supply chain management can be improved by integrating supply chain practices with efficient information sharing [14]. Within this environment, information on prices, inventory, schedules, order status, online payment system, shipping and delivery updates, service options, contacts, announcements etc. could be placed in the virtual cloud. This will result in timely information updates from all stakeholders and result in companies becoming demand driven rather than reactive [15].

Scaling: In a cloud computing environment, infrastructure providers are able to pool large amounts of resources from data centres and make them easily accessible to users [13]. If the service demand increases the service provider could expand the services to a larger scale [16].

A combination of these services have the potential to integrate shippers, service providers, distributors, logistics providers, customers, sellers etc. in a global supply chain and thus create a supply chain community of stakeholders similar to a social network environment. E-supply chain management can be improved by integrating supply chain practices with efficient information sharing [14]. Within this environment, information on prices, inventory, schedules, order status, online payment system, shipping and delivery updates, service options, contacts, announcements etc. could be placed in the virtual cloud. This will result in timely information updates from all stakeholders and result in companies becoming demand driven rather than reactive [15].

Thus Fig. 2 gives a visual representation of the postulate that the inherent characteristics of Cloud Computing further support the various cycles of the electronic supply chain management.

IV. Discussion/Management Implications/Directions for Further Research

In today's complex, highly integrated and globalized world, as companies are embracing e-SCM in order to improve their costs and operational efficiency while trying to maintain competitive advantage, cloud computing offers a viable solution by offering platform, service and software services for businesses that are affordable, scalable, cost-effective and customer-focused. Success of e-SCM depends upon complete visibility of and access to information at every cycle of the e-supply chain, in order to facilitate decision-making and action-taking. A cloud-based eSCM system has the potential to create this visibility and accessibility of information in real-time on an anytime-anywhere basis thereby enabling firms to improve the speed, cost, quality and the level of customer service at every cycle of its e-supply chain, thereby integrating all activities within the e-supply chain more tightly. For example, cloud computing provides a logistics infrastructure – platform as a service (Paas) for all partners of an e-supply chain. The common platform of cloud computing also helps satisfy the need to coordinate multiple activities within internal units of the organization as well as with external supply chain partners. The ability to scale up the down the e-SCM infrastructure helps mitigate the bullwhip effect created by erratic demand fluctuations within various levels of traditional supply chain as well.

References

[1] J. Leukel, S. Kim, and T. Sechgel, "Supply chain as a service: A cloud perspective on supply chain systems," *IEEE Systems Journal*, vol. 5, no. 1, pp. 16-27, 2011.

[2] P. R. Gibson and J. Edwards, *The Strategic Importance of E-Commerce in Modern Supply Chains*, Hershey, Pennsylvania, U.S.A.: Idea Group Inc., 2005, pp. 265-286.

[3] T. Hult, D. Ketchen, and M. Arrfelt, "Strategic supply chain management: Improving performance through a culture of competitiveness and knowledge development," *Strategic Management Journal*, vol. 28, no. 10, pp. 1035-1052, 2007.

[4] R. Buyya, C. Yeo, and S. Venugopal, "Market oriented cloud computing: Vision, hype, and reality for delivering IT services as computing utilities," *IEEE Computer Society*, Washington DC., 2008, pp. 5-13.

[5] A. Tiwari and M. Jain, 'Analysis of supply chain management in cloud computing," *International Journal of Innovative Technology and Exploring Engineering*, vol. 3, no. 5, pp. 152-155, 2013.

[6] S. Chopra and P. Meindl, *Supply Chain Management: Strategy, Planning and Operations*, New York, U.S.A.: Prentice Hall, 2007.

[7] B. McCrea. (2012). Supply chain technology: Cloud computing breakthrough. *Logistics Management Online Magazine*. [Online]. Available: http://www.logisticsmanagement.com/article/supply_chain_technology_cloud_breakthrough
[8] C. G. Cegielski, L. A. Jones-Farmer, Y. Wu, and B. T. Hazen, "Adoption of cloud computing technologies in supply chains: An organizational informaiton processing theory approach," *The International Journal of Logistics Management*, vol. 23, no. 2, pp. 184-211, 2012.
[9] S. Marston, S. Bandyopadhyay, and A. Ghalsasi, "Cloud computing-the business perspective," *Decision Support Systems*, vol. 51, no. 1, pp. 176-189, 2011.
[10] A. Weiss, "Computing in the clouds," *NetWorker*, vol. 11, no. 4, pp. 16-25, 2007.
[11] P. Nair, "High performance and cloud computing interventions," *Technical Trends*, pp. 14-15, 2013.
[12] A. Chaudhri and I. Bajwa, "Services based management of business processes using cloud computing," *European Journal of Scientific Research*, vol. 80, no. 3, pp. 303-310, 2012.
[13] Q. Zhang, L. Cheng, and R. Boutaba, "Cloud computing –State of the art and research challenges," *The Brazilian Computer Society*, vol. 1, no. 1, pp. 16-27, 2010.
[14] H. Zhou and W. C. Benton, "Supply chain practice and information sharing," *Journal of Operations Management*, vol. 25, pp. 1348-1365, 2007.
[15] M. Christopher, "The agile supply chain management: Competing in volatile marketplace," *Industrial Marketing Management*, vol. 29, no. 1, pp. 37-44, 2000.
[16] M. Armburst. Above the clouds: A Berkley view of cloud computing' UC Berkley. *Cloud Computing Journal*. [Online]. Available: http://cloudcomputingsystems.com/read/612375_p.htm

Ahsan Chaudhri holds BB (IT) from Curtin University, Australia and PGC, MBA, MBUS (IT), Master of Education & Leadership, from Auckland University of Technology, New Zealand. His previous positions include Director of Academic Programs in New Zealand. Ahsan holds more than 14 years of combined experience in academia and industry. He has published in many leading journals and attended conferences in Australia, New Zealand, Malaysia, Thailand, and UAE. His research interest includes domains of business and information systems. Recently, he got the Best Paper' award in the MAG scholar 2013 conference held in Dubai. He presently works as Business Faculty in Higher Colleges of Technology.

Anita Ajmiri obtained her Bachelor of Arts Degree from Central Connecticut State University, USA, and later completed her Bachelors n Education Degree from University of Toronto, Canada. In addition to this she holds an MBA from the University of Wollongong, Australia. Anita's research interests are focused on technology, innovation, business strategy and entrepreneurship. Anita now works as Business Faculty in the Higher Colleges of Technology, Dubai, United Arab Emirates. Anita has over 20 years' combined experience in teaching and managing at institutions of higher learning in Australia, U.S.A and Canada.

Jaishree Asarpota holds an MBA from the Edinburgh Business School in addition to being a Chartered Marketer from the Chartered Institute of Marketing, both completed in 1997. She has since then completed a Masters in Strategic Planning. Jaishree works as Business Faculty in the Higher Colleges of Technology, United Arab Emirates. She has over 18 years' experience in teaching at graduate level, and over 10 years 'of industry experience working in an International Airline. Jaishree's research interests are focused on marketing, consumer behavior and the retail environment. Jaishree has won the "Best Paper" Award at the ACBSP conference in November 2012 in Geneva, Switzerland. In addition to this she was a finalist for Outstanding contribution in education award for the Gulf Education Forum. Jaishree also won the Teaching Excellence Award for Region 8 at the ACBSP International Conference in Chicago in June 2014.