Intelligent Agent Technology in Supply Chains

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INTRODUCTION

Firms are seeking competitive advantages through supply chain management (SCM) to stay competitive in today's global market. An inevitable endeavor of SCM is to promote information transparency that enables firms to coordinate supply chain activities efficiently to better meet ever-changing customer demand. Effective SCM requires that the underlying information technology infrastructure of the supply chains be intelligent and flexible enough to adapt to market changes quickly. Recent development in agent technology provides new and interesting potentials of innovative SCM. In this chapter, we first review inter-organizational systems that support SCM and the major challenges faced with supply chains. Then we review the agent technology and its potential applications in SCM based on three major dimensions of the intelligent supply chain: Autonomy, Intelligence and Coordination. Finally, we propose an infrastructure necessary to achieve intelligent SCM and point out future research to intelligent SCM.

BACKGROUND

Today's global market is electronically linked and dynamic in nature. In order to survive in the global market, many companies are trying their best to be flexible and responsive to customer demand. For instance, companies decentralize their value-adding activities by outsourcing and developing virtual enterprise. Companies are trying to establish partnership with wholesalers or retailers in other countries to promote their products or services. Nowadays, there is no single firm can effectively satisfy customer demand by managing all the business processes from the raw materials to end customer products. In fact, these individual firms depend on each other to succeed by working together to deliver the right product at the right time and right price at the right location. The interdependence among trading partners calls for close cooperation and tight integration of different functions along the supply chain, which is quite different from the discrete, independent, and isolated activities across the supply chain (Dyer, 2000). Naturally, Supply chain coordination evolves as the management of the interdependent activities among chain members. Modern SCM heavily relies on information technology (IT) to improve inter-organizational coordination which significantly affects the firm's performance (Sanders, 2008). Studies have found that adopting technological innovations is the most important weapon for firms to keep their competitive advantages (Kimberly & Evanisko, 1981). For example, Electronic Data Interchange (EDI) systems have improved both operational and strategic efficiencies by an IT innovation (Subramani, 2004). With the development of Internet technology, Internet-enabled systems such as Enterprise Resource Planning (ERP), E-procurement Applications, Customer Relationship Management (CRM) and Supplier Relationship Management (SRM) have been adopted in vari-

ous supply chains. These systems have already become a critical part of supply chain strategies for most industries (Frohlich & Westbook, 2001; Frohlich, 2002).

Nowadays, supply chains face great challenges such as cost containment, supply chain visibility, risk management, increasing customer demand and globalization (IBM, 2010). More and more companies turn to newly developed IT technologies for solutions. For example, investments on radio frequency identification (RFID) technology have improved the coordination and the visibility of various supply chains by leveraging reliable and timely RFID data. More importantly, the improved supply chain visibility enables chain members to adapt to market changes effectively and efficiently (Attaran, 2007). Despite these achievements, supply chain managers still need to deal with the emerging challenges as reported by IBM (2010). Today's supply chains are swamped with more data and information, it is difficult for supply chain professionals to identify and act on the right information. How companies in supply chains could make use of big data and make real-time analytics available for better decision making is critical to the success of the supply chain. Moreover, new trading partners and new products call for structural changes which transform the topology of supply chains (Li & Chan, 2013). How supply chain members could adapt to such structural changes is another key issue in SCM.

To better deal with the emerging challenges of the supply chain, an intelligent supply chain, which is capable of learning and automatically adapting to market changes, is required. An intelligent supply chain will have certain levels of intelligence to learn, adapt and respond to market change automatically. Recent technologies (such as intelligent agent technology, data mining, and could computing) may provide new and interesting possibilities to SCM. Interestingly, these technologies share something in common: Intelligence. Among them, intelligent technology may provide the potential of transforming the landscape of the

SCM. The concept of intelligent agent is being considered in several disciplines such as information technology, human computer interaction, mobile systems and distributed and concurrent systems (Tarokh & Soroor, 2005). Agent technology has been used in SCM in the past, it is considered as one of the promising technologies which enable effective management of supply chains with high level uncertainty (Lou et al., 2004). Dias et al. (2009) further argue that the use of techniques such as distributed artificial intelligence could be a good alternative to aid complex decision making by tapping real-time RFID data.

Researchers have studied the use of intelligent software agent in different areas of the supply chain such as procurement, production, scheduling and risk management (Caridi & Cavalieri, 2004; Giannakis & Louis, 2011). The findings of these studies are encouraging. However, most of these studies demonstrated the effect of the agent technology on certain functions of the supply chain instead of the whole supply chain. Little research has been done to investigate the possibility of designing and implementing an intelligent supply chain from system perspective. The traditional information systems (such as legacy systems and ERP) and IT infrastructures are limited to provide sustainable solutions for collaborative SCM since they lack real-time adaptability and fail to support multiple collaborations among trading partners(Giannakis & Louis, 2011). In order to deal with the emerging challenges, a supply chain must possess certain levels of intelligence to learn, adapt and respond to market changes automatically. Intelligent agent technology is expected to play a key role in making an intelligent supply chain.

In this chapter, we first review agent technology and justify why it is suitable to effective SCM. Then, we identify the key components of the intelligent supply chain: Autonomy, Intelligence and Collaboration. Furthermore, we propose an integrated IT infrastructure, which provides an indispensable foundation to run an intelligent supply chain.

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