A Survey of Information Technologies in Logistics Management

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ABSTRACT

This paper analyzes the impact of information technologies (IT) on logistics by conducting a survey of literatures on academic logistics journals and practitioner journals. The literature survey and practice find that third party logistic providers have better opportunity to leverage IT since they need to have interoperable IT systems with their customers. The business philosophy of Just-In-Time (JIT) has also contributed to the impact of IT in logistics. Further, information technologies are identified that has benefited the logistics. Future directions of logistics are discussed.

INTRODUCTION

The proliferation of information technologies (IT) and the internet technologies have provided impetus and challenges to the logistics. New technologies present new means to manage the flow of information. IT as a productivity tool can be utilized to both increase the capability and decrease the cost at the same time (Closs et al., 1997). It has been widely accepted that firms can achieve competitive advantage by cost reduction or differentiation with the proper implementation of IT (Porter & Millar, 1985). Enabled by IT the logistics has become a source of competitive advantage for many firms.

Two streams of research are identified that highlights the role of IT in logistics. First stream relates to just-in-time logistics information system (Anderson & Quinn, 1986; Bookbinder & Dilts, 1989; Das & Handfield, 1997; Gomes & Mentzer, 1988; Perry, 1988; Schwarz & Weng, 2000; Spencer, M. S. et al., 1994; Spencer, M. S. et al., 1996; Takahashi & Nakamura, 2000; Titone, 1996; Wafa & Yasin, 1996). The other stream is the third party logistics (Lewis & Talalayevsky, 2000; Peters et al., 1998; Sauvage, 2003; Sink & Langley, 1997; Vaidyanathan, 2005). Importance of IT in logistics has grown to some extent by business philosophy of Just-In-Time (JIT) by firms. With the emphasis of firms on JIT, the impact of logistics has grown as it is increasingly recognized as a source of consistent, low lead time, damage free deliveries (Bardi et al., 1994). In pursuit of competitive advantages, firms outsource their functions which are non-core competencies so that they can focus on their core competencies. A recent survey found that 83 percent of the surveyed Fortune 500 companies reported having at least one contract with a third-party logistics provider (Lieb & Bentz, 2004). Over the years, the use of third-party logistics has been increasing. Similar survey of Fortune 500 companies taken in 1991 had only 38 percent of the respondents reporting the use of third-party logistics provider (Lieb, 1992). The

third party logistic operators attempt to harness the capability of information technology to provide superior services to their customers.

The objective of this paper is to study how IT has impacted logistics. To this end, literature review of both leading academic and practitioner logistic journals is conducted. The next section will report the framework of logistics. The following section will analyze the IT enablers in logistics. Then, the implications of ecommerce are discussed followed by a section on future directions for logistics.

REVIEW OF THE LITERATURE

A classification scheme logistics functions provides a meaningful way to study how IT has impacted the various functions of logistics. Previous research in logistics have categorized the use of information systems in logistics in different ways. A system of logistics functions can be divided into following five broad areas (Bowersox, 1974): facility location, transportation, inventory, communication and material movement. Based on the problem areas that application addresses, seven areas of logistics has been identified as facility location, inventory control, order entry, vehicle scheduling, warehouse layout planning, freight rate retrieval, and product and shipment tracing (Ballou, 1976). Another survey identified five categories as facility location, inventory control, transportation, production scheduling, and total physical distribution (House, 1978). These categories treated each category as individual entities rather than a whole system. Noting this shortcoming, Stenger (1986) proposed another classification consisting of transaction systems, short-term scheduling and inventory replenishment systems, flow planning systems, and network planning and design systems. Expanding on the framework developed by Bowersox, Novack et al (1992) divided logistics function into two categories. The first category refers to physical activities that are required various utilities of customer need. These will include inventory, transportation and customer service operations. The second category refers to flow of information or transaction activities that follow or initiate the physical activities. The physical and information flows in logistics function is well-depicted in Figure 1 that shows the categorization of logistics functions as described by Vaidyanathan (2005). As shown in the figure, information flows between logistics function are managed, coordinated and supported by various logistics technologies.

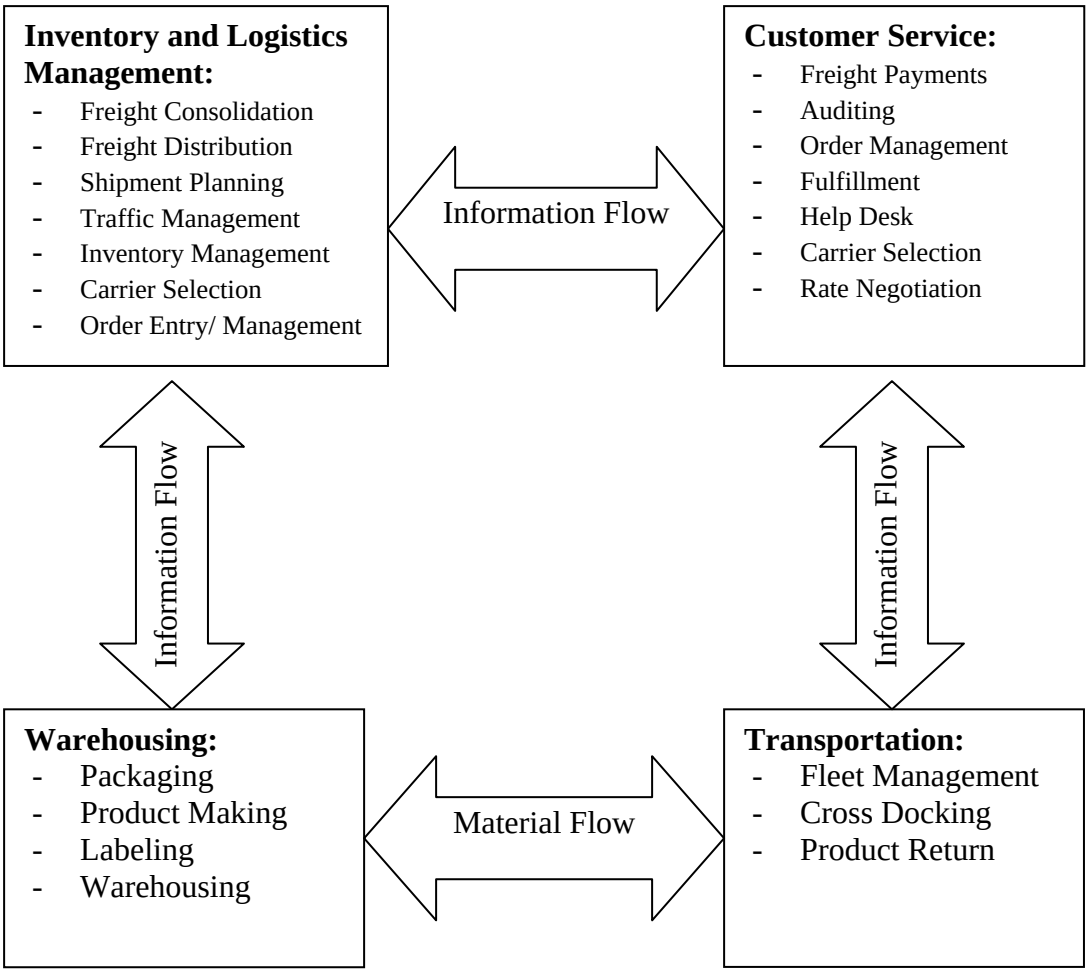

Figure 1: Categorization of Logistics Functions (adapted from Vaidyanathan 2005)

IT enablers in Logistics

The literature in logistics is full of instances where information technology has been touted as a means to enhance logistics competitiveness (Bowersox, 1974; Closs et al., 1997; Rabinovich et al., 1999; Stenger, 1986). Yet there has been few empirical studies that relates logistics information capabilities to logistics competence (Closs et al., 1997). A popular framework in information systems discipline put forward by Gorry & Morton (1989) place logistics decisions as structured and varying from operational to strategic. The role of logistics information systems as operational and strategic enablers in different areas of the firm's supply chain has been stated in the literature (Langley et al., 1988). There has been a shift of IT from being an enabler of operational and material handling functions to being an enabler of decision-making and activity-planning functions within the supply chain (La Londe & Auker, 1973).

Logistics Information System

Logistics Information System (LIS) is the application component of logistics information technology. An effective LIS facilitates the proper information flow between inventory,

warehousing and transportation to realize the high level of customer service. The ability to optimize the logistics cost and service levels is affected by the LIS of the firm and its partners. Firms that provide better logistics services at a lower cost can have competitive advantage over its competitors (Bardi et al., 1994). Two classes of LIS has been recognized in the literature (Closs et al., 1997). Logistics operating systems (LOS) refer to transactional applications such as order entry, order processing, warehousing, and transportation. Logistics planning systems (LPS) refer to coordinating applications such as forecasting, inventory management, and distribution requirements planning.

EDI

Electronic Data Interchange (EDI) has successfully enhanced the communication between firms which is essential for logistics. This technology requires firms to have common data formatting and transmission standards or protocols. Such technologies have been employed by companies to coordinate their value chain activities including logistics. Early applications of EDI has been on transmitting vehicle location information by railways to their customers. Other types of logistics information carried by EDI are purchase orders/releases and changes, advanced shipping notices, bills of lading, and invoices. Timely and accurate information is crucial in decision making about complex logistics problems. Japan Airlines (JAL) adopted EDI to manage their complex value chain logistics required for their operations, including procurement and just-in-time delivery of aircraft fuel, repair and maintenance aircraft parts, food catering and other customer requirements (Chatfield & Bjorn-Andersen, 1997). The competitive advantage gained by companies employing EDI is cited in the literature. Firms utilizing EDI were better able to fulfill greater number of services to their customers (Rogers et al., 1992).

Bar coding

Bar coding is one of the most IT enablers to date and has made significant impact in the practice. Starting in 1960's some of the earliest implementation of bar codes were in rail road cars. Nowadays it is rampant in anything that needs to be identified and tracked. The different type of bar codes are available, known as symbologies, for different purposes. In practice, most firms prefer to use industry standards rather than proprietary standards for most of their bar codes on their products. By following industry standards, bar codes reduce the complications inherent in the use of multiple standards and thus provides a strong foundation for integrating the corporate logistics and the supply chain (Closs & Kefeng, 2000).

Real-time communications capability

The logistics IT capability of real-time communications is essential for maintaining the flow of information. As noted by Dudley & Lasserre (1989), one of the important roles of logistics IT is to substitute information for inventory. To make real-time tracking of goods, logistic information systems of business partners should have real-time communications capability. The business partners require an integrated messaging architecture which exchanges business data while customizing business flows and format transformation. Real-time communications also allows for schedule plans to change in dynamic routing and scheduling system when the vehicles are

already out on the road. Any last minute changes in routing and scheduling system or constant tracking has been possible only with real-time communications ability of the respective systems.

RFID

RFID helps to identify, track and locate items automatically. The use of Radio Frequency Identification (RFID) is expected to increase rapidly in coming years. Often referred to as the next step in the evolution of bar-coding, RFID is growing rapidly in the automatic data capture and identification market (Srivastava, 2004). RFID is not a new technology, in fact, its use dates back to 1940's but only now it is starting to make a significant impact within the supply chain. The growth in use of RFID will be enhanced to some extent by mandates from large retailers such as Wal-Mart and Target, and the US Department of Defense, who require their suppliers to adopt this technology within the next few years (Asif & Mandviwalla, 2005). Among the companies that are piloting RFID in their supply chain management prominent ones are Wal-Mart, Procter & Gamble, Coca-cola and Gillette. Although the biggest driver in the popularity of RFID has been supply chain, companies are experimenting in other applications as well. Other applications are theft detection, asset tracking, mobile payments, in-process inventory tracking and luggage tracking. Dell, Seagate, Boeing and Ford are among other companies that are using RFID to track their in-process inventory in manufacturing. An RFID system includes transponders or tags that can identify items ; antennas that allows tags to be interrogated and to respond; and software that controls the RFID equipment, manages the data and interfaces with enterprise applications. RFID has lots of potential to improve the efficiency in the supply chain and reduce waste. For example, efficiency would result from automatic update of inventory system when products with RFID tags are unloaded from trucks into stores.

The advantages of RFID over bar coding are as follows: RFID tags can provide longer read distances; store more data; require no direct line of sight between tag and reader; and can collect data from multiple sources simultaneously (Asif & Mandviwalla, 2005). There are some technical and business challenges to overcome before RFID can be ubiquitous. Technical issues include problems of interference, security and accuracy while business issues relate to costs and lack of standards. Another significant business challenge in adopting RFID faced by managers is to work out a business case for the executive board. Early adopters of these technologies are marred by problems such as possible adverse consumer outbursts to perceived invasion of privacy, reliability of the RFID system, and issues related to health, safety and IT integration.

IMPLICATION OF ECOMMERCE ON LOGISTICS

The growth of ecommerce pose opportunities and challenges for logistics. As internet retailing increases the companies are accepting orders from their clientele across the borders. In many instances the location of clients are not covered by any existing distribution system of the companies. On such occasions the companies have no resort but to turn towards third party logistics operators for physical flow of goods. As for the information flow, the companies need to have capabilities for ecommerce applications. The group of technologies and processes for coordinating logistics information flow has been named e-logistics. An important web

technology that facilitates the exchange of business data among logistics business partners across different platforms is extra markup language (XML). For example, UPS is exploiting the power of the web services to streamline its information flows for logistics activities such as RFQ, shipping and tracking.

Changing Trends in Logistics

Consultants are beginning to take an active part in helping out the shippers select third party logistics operators. Shippers hire consultants to help them align business processes with supply chain strategies. The newly coined term "4PL" for consultants stands for dominant role that consultants will be taking in managing the resources, the technology and the processes in the supply chain. It is yet to be seen whether the shippers will let the consultants manage all the logistics processes. Instead of handing over the authority to manage the logistics processes to the consulting firms, shippers may choose to develop alliance with the third party logistics operators and maintain the supply chain themselves. The key thing that will allow coordination between shipper firms and the third party logistics will be information technology and management skills to run the supply chain effectively. This implies that firms should also have proper logistic technologies in place to enjoy the full benefits of use of third party logistics.

FUTURE RESEARCH DIRECTIONS

The research directions that are available for researchers in logistics are numerous. Before companies implement new logistic information technologies such as RFID it is important to assess the viability of adopting the technology. What would be the expected benefits? What is the ROI? Researchers can come up with various econometric models to predict the outcomes of adopting logistics technologies. Modeling techniques can be used to assess the scenarios that would be beneficial for adopting new technologies.

As companies are entering into ecommerce, better coordinating techniques are required to streamline logistics activities for transactions taking place on the internet. Collaborative technologies for supporting e-logistics would greatly enhance the future logistics. Multi-agent systems (MAS) provide an interesting avenue of research that is applicable for supporting logistics technologies on the internet. Intelligent software agents can be used to assess the bids offered by multiple third-party logistics operators.

To support global ecommerce the companies need to have different options for global logistics. The best way to traverse the geographical distribution is through technology. What are the communication channels and technologies that would benefit the company in terms of monitoring and coordination logistics functions?

More empirical evidence will be preferred to establish the direct link between organizational performance and logistics information systems. Researchers can seek to examine the complex relationships between logistics technologies and performance from different paradigms and theories. The perspective of organizational learning can be used to evaluate the performance gained by employing logistics information systems.

CONCLUSION

The objective of this paper was to observe the impact of information technology on the logistics functions. A literature review of the academic and practitioners journals was conducted. The information technologies that have been used to support logistics functions were discussed.

It is evident that academic researchers are aware of new technologies in practice such as RFID. Development in technologies offer sources of competitive advantage for companies. Adoption of new technologies provide challenge and opportunities for the companies. Proper business case and calculation of ROI needs to be done to assess the expected benefits from new technologies.

Changing trends in business in terms of ecommerce open new markets for firms for all sizes to expand their market share. Strategic use of information resource would bear results of competitive advantage and thus leading to success stories. The best practices in logistic information technologies need to be adopted by firms in alignment of their strategic goals.

Future trends in logistics may prompt companies to rethink their logistics strategies. Firms may choose to use third party logistics in order to focus on their core competencies. However, firms need to have logistics information systems in place that is compatible with the third party operators in order to fully benefit from their services.

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