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Synergy of Supply Chain Management and Information Technology in JIT

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Abstract—*A global recession has created tremendous financial pressures on companies and their supply chains. Companies are being forced to remain competitive and innovative while cutting or maintaining costs. Making supply chain efficient is the need of time so as to reduce costs and improve quality and customer service, thereby improving competitiveness. Late deliveries of supplies or delivery of poor-quality products and services badly affect the performance of supply chains. Smooth information flow among the supply chain partners helps in meeting the objectives of just-in-time (JIT) by delivering the right products to customers at right time. Tools of information technology (IT) play an important role in the unobstructed flow of information in the supply chain. Managers need relevant and timely information to make decisions that are facilitated by the tools of information technology. The Internet is an important tool of information technology, which has become a common and economical way to conduct business operations in the supply chain. An increasing number of customers are directly connected to firms through Internet. In the present paper, a model is proposed to show the relationship between SCM and IT that is needed in JIT implementation. The synergy of SCM and IT is found to facilitate JIT and also tends to accelerate its implementation.*

Keywords*: Information technology (IT), Internet, Just-in-time (JIT), Supply chain, Supply chain management (SCM).*

1. INTRODUCTION

The development and management of an organization's supply chains is critical for its smooth functioning. A supply chain is much bigger than procurement and logistics. It is an important determinant of improved cash flow since it affects order cycle time to customers. Supply chain management (SCM) is connected to design and management of flows of products, information, and funds in the supply chain (Sanders, 2015), and links all the entities involved in the supply chain in an integrated two-way communication system. SCM fulfils twin goals of cost reduction and service enhancement through better utilization of resources. Supply chain management largely relies on information technology that facilitates better communication among the supply chain partners. Various tools of information technology such as the Internet, bar codes, and RFID technology enhance the speed and accuracy of information shared. JIT aims at producing and delivering only what is immediately needed through improved supply chain. The use of information technology has widened the business area to include global markets for a company. It has also eliminated many associated problems in the supply chain. It has made supply chain networks more effective that has resulted in reduced lead time, making on-time delivery more reliable and predictable; thus paving the way for effective implementation of JIT.

2. SUPPLY CHAIN MANAGEMENT: AN INVENTORY MANAGEMENT APPROACH

Inventory typically represents the second largest component of logistics cost next to transportation. Organizations need inventory to reduce the gap between supply and demand, and to safeguard against uncertainties in the supply chain. There is a need to have the right inventory on hand at the right time. The right amount of inventory supports the business operations, but its excess or deficient amount tends to adversely affect the performance of an organization. Hence, inventory must be managed closely. It is equally important to consider the quality of inventory as the flow of defective items can obstruct the movement of materials in the supply chain because of their possibility of repair or replacement. Supply chain management (SCM) is the most important aspect of inventory management and is closely linked to it. The success of a company largely depends upon how well it manages its supply chain and related components. An effective supply chain promotes smooth flow of materials and reduces or eliminates the buffer of inventory existing in the supply chain. It reduces the overall production costs along with maintaining the inventory at the most desired level.Poor inventory management is the result of poor supply chain management. High level of inventories, uncoordinated schedules, and poor services that result in dissatisfied customers indicate towards poor supply chain management. An efficient and integrated supply chain ensures continuous replenishment flow of materials with zero or minimum storage of inventory at any distribution stage. Wal-Mart, the largest discount retailer in

the world, is the best example of integrated supply chain. Supply chain integration results in smooth flow of materials within the system, and hence facilitates JIT implementation. Many researchers have discussed different mechanisms for integrating supply chains (Lee et al., 1997; Vereecke and Muylle, 2006).

3. SUPPLY CHAIN RELATIONSHIPS: A STRATEGIC ISSUE

Operating successfully today requires organizations to become much more involved with their suppliers and customers. One of the important characteristics of an effective supply chain network is the focus on relationships among the supply chain partners. The development of long-term collaborative partnerships is gaining wide acceptance, as it tends to give competitive advantages to the organization. Lower total costs are the common result of collaborative and alliance relationships. It is also easier to implement and design operational improvements in such cases as all parties have a common goal of earning more profits. Another significant advantage is that duplication of efforts among partners is eliminated. For example, a good quality supply from the suppliers eliminates the need of manufacturing firms to inspect the quality of incoming materials. It results in huge cost savings.

Supplier relations in American industries tend to be based on arms-length negotiations that are often unstable from the supplier's viewpoint. On the other hand, Japanese industries have long-term stable relationships with their suppliers. It is the part of operations strategy of Japanese industries to include their suppliers in their efforts of optimizing cost, ensuring quality and making product availability at right time. This closely fulfills the objectives of JIT. The competitive advantage of Japanese auto companies like Toyota and Honda over their competitors is because of their collaborative relationships with their suppliers. World-class companies are forming partnerships with suppliers to quickly produce defect-free products when needed with little inventory (Gaither and Frazier, 2010). In order to attain maximum manufacturing and distribution efficiency, Wal-Mart and P&G reached an unprecedented partnership that drastically changed the way purchasing had traditionally operated with suppliers. Dynamic, collaborative and trusting alliance relationships and networks are the keys to survival and success in the 21st century.

Lasting relationship through collaborative partnership can only be achieved by reducing the number of suppliers, as the relationship management is simpler with a few suppliers. Companies tend to be substantially benefitted from a long-term sole-supplier (sole-sourcing) relationship as it will ensure reliable delivery, high quality and stable or decreasing prices because of consolidation of orders from the same supplier. A number of companies such as Xerox, Motorola, Ford and General Motors have reduced the number of their suppliers by 50-90% or more (Martinich, 2005) to significantly obtain the benefits of fewer suppliers.

4. SUPPLY CHAIN MANAGEMENT: SOME OTHER CONSIDERATIONS

Supply chain management is greatly affected by some other parameters; prominently among them include quality, automation, and organizational set-up.

Quality acts as a driving force to speed up the supply chain. It accelerates the flow of products in the supply chain and reduces the level of in-process inventory. It can be used as a competing tool to survive in the most challenging dynamic environment. A few companies that are well-known for competing on quality include Toyota, Mercedes, General Electric, and Motorola. Quality must be continuously improved through total quality management (TQM) and six sigma approach to reduce the operational costs of the supply chains and to ensure total customer satisfaction. Companies must work with, and extend TQM programme to their suppliers to obtain quality raw materials and other components. A firm that is considering the adoption of JIT manufacturing must focus on its suppliers' ability and willingness to meet the stringent quality and schedule demands imposed by the system (Burt et al., 2016).

Automation involves use of specialized machines and equipment with little or no human intervention. It greatly improves material handling besides making manufacturing operations more accurate and delivering defect-free products. Efficient material handling saves cost, cuts down on time and minimizes product damages during its movement. It is extremely important that products are delivered to each supply chain member on time. Automation increases the speed, accuracy and reliability of supply chain processes thus facilitating JIT implementation. It also facilitates in quick movement of products through inbound and outbound warehouses and distribution centres in the supply chain. It may range from automated barcode scanning system to automated storage and retrieval system (ASRS). Today many warehouses are completely automated and they are using very sophisticated ASRS.

An organization's informal and flexible structure, where formality and hierarchy are missing, ensures frankness and openness in the organization, which in turn, facilitates smooth sharing of information in the supply chain at all levels. The traditional management set-up, on the other hand, creates hindrances in terms of ego clash, rivalry, jealousy and similar negative effects, which adversely affect the efficiency of supply chain. Cordial organizational atmosphere based on mutual trust and co-operation is extremely useful in making supply chain stronger, which tends to accelerate JIT implementation.

5. SUPPLY CHAIN MANAGEMENT: INFORMATION SHARING AND INFORMATION SYSTEM

Information sharing is a key enabler of effective supply chain management(Burt et al., 2016). Information sharing and collaboration with trading partners is considered as a company's top logistic challenge (Electronic Newsletter, 2005), and forms an important part of supply chain management (Chen and Paulraj, 2004; Carr and Kaynak, 2007). Such information pertains to status of orders, product availabilities, delivery schedules and other such supply chain data (Meredith and Shafer, 2015). The efficacy and productivity of the supply chain network can be significantly improved through effective sharing of information in the supply chain. Information needs to be transparent and easily accessible. Information sharing is easier and simpler in case of close relationships among members in the supply chain.

An information system is like a nerve system for supply chain management. It facilitates information sharing among trading partners in the supply chain. The supply chain information system consists of computer hardware, communication technology and software that are designed to handle information related to business operations, managerial decision making and strategic advantage (Russel and Taylor, 2006). They are no longer regarded as tools for mere automation of manual operations. Information technology (IT) is widely used in manufacturing operations to increase the speed and accuracy, and improve the product quality (Mazda, 2000); by doing so it increases the speed of materials flow in the supply chain. It is extensively used as a strategic tool by many companies to better disseminate information within the supply chains and to get more competitive advantage than those without doing it. E-business, the Internet and advances in information technology are enabling supply chain collaboration and coordination. A number of industries have made it essential to connect electronically to become a supply chain partner (Spekman and Davis, 2004). Customer service, operations, product and marketing strategies and distribution are heavily or sometimes even entirely dependent on it. Sanders (2015)has described the supply chain management of Wal-Mart. The company operates about 8400 stores worldwide involving more than two million employees and handles over 200 million transactions every week. It effectively manages inventory using an IT system called Retail Link, which enables its suppliers to see the exact number of their products on every shelf of every store at a particular moment.

Strategic advantages from information systems are usually short-lived as new and latest technologies are emerging rapidly to make older version obsolete. Hence, companies need to continuously improve on their information systems and technology to outperform their competitors. A supply chain network can fail in the absence of effective information system. The 'bullwhip effect' is the common negative effect caused due to poor design of information system that causes mismatch between supply and demand, and leads to uncertainty in the supply chain management.

6. INFORMATION SYSTEMS AND TECHNOLOGY: DESIGN CONSIDERATION IN A SUPPLY CHAIN

Paper has long been used as the primary means of communication between supply chain partners. However, this means is associated with some demerits. It is slow, often unreliable and prone to errors. Verity (1996) reported about 60 percent errors received through fax and phone orders by Campbell Soup Company. In today's highly competitive world, the effective use of information technology has not only eliminated the inherent demerits of paper-based transactions, but has also helped an organization to drastically reduce cycle times and operating costs.Information technology has broken down the barrier of distance between companies and geographic regions (Sanders, 2015). IT tools are being extensively used for increasing efficiency, problem solutions and decision-making in businesses today.

Design of information systems and related technologies enables data sharing, communication and process synchronization in a faster and much simpler way. Designing the information systems for an organization is an important element of SCM. It is of strategic importance as it involves issues such as who must communicate with whom, how and when. The information system should be designed in a manner to ensure information visibility along the supply chain. An integrated IT-based system is extremely helpful in achieving the objectives of make-to-order environment that is replacing make-to-forecast, where various functions within the organization share a common data of information, and effective link exists with customers and suppliers (Mazda, 2000). Things are changing so fast and to have connectivity to all partners is just critical (Biederman, 2010). When there is a high degree of trust, information systems can be customized to serve each other more effectively. However, confidentiality of sensitive financial, product and process information must be maintained. An SCM information system is designed in a manner so as to provide information and information processing capability to support the strategy, operations, management analysis, and decision-making functions in an organization's supply network. It provides high quality, relevant and timely information flow that effectively supports decision-making for inventory replenishment as is required in JIT inventory management.

Summarily, the IT-based supply chain management effectively results in the following benefits:

- Reduced manufacturing costs
- Improved products quality
- Reduced lead time
- Increased on-time delivery

- Increased level of customer satisfaction
- Improved business environment
- Increased productivity level
- Increased market share
- Enhanced reputation for a company

A JIT model involving supply chain management (SCM) and information technology (IT) is shown in Figure 1. JIT implementation gets accelerated in presence of IT [YIT] through improved supply chain capabilities, as compared to its absence [NIT]. NIT and YIT respectively stand for No and Yes conditions for IT. The increased circle size of JIT is indicative of its more effectiveness in presence of IT.

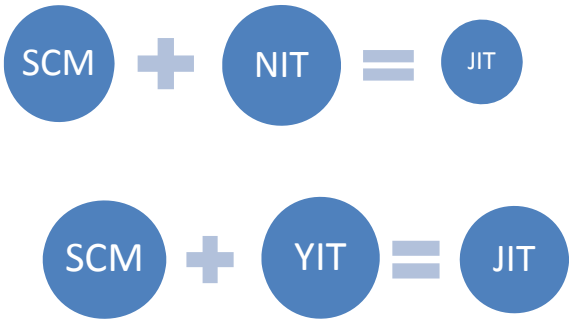

Fig. 1: IT facilitates SCM to help JIT.

7. IMPORTANT IT TOOLS IN SUPPLY CHAIN MANAGEMENT

Many types of information technologies are available that enable SCM. Some important information technologies with their specific features are briefly discussed below.

1. *Electronic Data Interchange*, in short called EDI, involves the electronic exchange of business transaction documents pertaining to purchase orders, invoices, requests for quotations and shipping notices, etc. among trading partners in the supply chain over computer networks. It is sometimes called *paperless transaction*. It is extremely useful in reducing operational costs and improving operational efficiency of the supply chain. Its major benefits include substantial reduction in paper work, postage and labour costs, faster access to information, reductions in errors, increase in productivity, improved customer service and reduction in inventory levels (O'Brien, 2003), which is a basic requirement for a JIT system. EDI provides competitive advantage to a company by effectively operating the JIT system. With EDI, orders can go directly from the customers into the supplier's manufacturing system. The big US auto makers such as General Electric, Ford and Chrysler make extensive use of EDI to obtain lower-cost parts, cut costs and thus improve their competitive positions in the global markets.
2. *Internet* is the most significant tool of information technology (IT) for the efficient supply chain management is the Internet. It allows supply chain members to manage their supply chains collaboratively and to synchronize their operations (Martinich, 2005). It has become an essential part of business operations and a common and economical way to complete business-to-business (B2B) transactions. It facilitates communication among members in the supply chain and results in reduced cost, better time management, improved competitiveness and profitability for all members of the chain. More and more companies are turning to Internet technologies like World Wide Web (WWW or simply called Web) and their networks such as Intranets and Extranets to integrate the flow of information among members in the supply chain. The Web offers a big platform for sharing information. Intranets allow all employees of a firm to intercommunicate, whereas extranets which form a firm's supply chain information system are private networks that allow the organization to securely interact with external parties like suppliers, dealers, customers, and so on (Meredith and Shafer, 2015).
3. *Enterprise resource planning*, in short commonly called ERP, has been a software-based one of the significant and powerful IT tools used to effectively manage inventory in the supply chain. It is an enterprise-wide information system that aims to integrate most of a company's IT-based business processes. It is the foundation of any firm's supply chain information system. It enables the supply, manufacturing and logistics processes to flow smoothly and helps in making on-time deliveries of end-products to customers, thus reducing supply chain inventories (Wisner *et al*., 2015) and helping in JIT implementation. Due to improved supply chain visibility, the bullwhip effect is also reduced. It has the advantage of incorporating customization in its software according to the needs of the enterprise because of its module that imparts greater flexibility. Firms continue to place a strong emphasis on ERP system implementation to achieve information consistency, economies of scale and integration (Bowersox *et al*., 2016).
4. *Radio frequency identification*, in short RFID, is one of the latest and emerging information technologies which has huge potential to improve the operational efficiency of the supply chain. It is a wireless (Wi-Fi) technology that has largely replaced barcode system for tracking products in real time. It has facilitated supply chain management in accessing real-time inventory information by a firm and making it promptly react to replenish the depleted inventory (Wisner *et al*., 2015). RFID uses a coded electronic chip (microchip) which is attached to a

product or its container through a RFID tag. It continuously emits radio signal waves containing information on the product's whereabouts as it moves through the supply chain (Bowersox *et al*., 2016). These signals can be received by receivers at different locations, hence making it known to all trading partners the locations of the product or container as it moves through different facilities in the supply chain. Unlike bar codes, RFID tags do not need line of sight to read, and many tags can be read simultaneously over a long distance. RFID is one of the latest developments in inventory management and major retailers of the world such as Marks & Spencer and Tesco of the U.K., Metro Group of Germany and Wal-Mart of the U.S. and their suppliers are using RFID technology to manage their inventory effectively and efficiently (Wisner *et al*., 2015).

8. ELECTRONIC BUSINESS AND SUPPLY CHAIN MANAGEMENT

Electronic business, in short *e-business*, is also called electronic commerce or *e-commerce*. It uses electronic means to conduct businesses over interconnected computer networks using web-based technologies such as Internet, intranet and extranet (O'Brien, 2003). These electronic means include electronic data interchange (EDI), e-mail, electronic funds transfer (EFT), bar coding, fax, radio frequency identification (RFID), etc. One of the most important impacts of the Internet and *e-business* in supply chain management is the availability of instantaneous information (Gaither and Frazier, 2010) that allows all supply chain members to immediately react to changes in demand and supply. The revolution in business caused by the Internet and its related technologies demonstrates that information systems and information technology are essential ingredients for the success of today's internetworked business enterprise. Firms like General Electric, Wal-Mart and Procter & Gamble use *e-commerce* to communicate directly with suppliers and retailers. Government agencies tend to use *e-commerce* to provide better services for citizens, control waste and fraud, and minimize costs. Filing of income tax returns electronically and direct benefit transfer of LPG subsidy into bank accounts of beneficiaries are the examples of use of *e-commerce* by the government agencies. Major *e-commerce* relationships include B2B (business-to-business), B2C (business-to-customer), C2C (customer-to-customer), G2C (government-to-customer), G2G (government-to-government) and G2B (government-to-business). B2B *e-commerce* has a significant impact on inventory management in the supply chain. Rocks (2000) has reported about the drastic reduction in inventory by Dell through its e-*commerce* business with its suppliers. Dell completed 90% of its purchasing online during June to September 2000, which was virtually zero just a few months earlier. As a result, Dell maintains only two hours of inventory for most parts.

9. CONCLUSION

Supply chain management (SCM) and information technology (IT) are closely interrelated. Information technology is the backbone of supply chain management. The efficiency and effectiveness of the supply chains greatly depend on the use of information technology. However, it requires the development of a comprehensive database which can provide timely and accurate input to supply chain management. An effective supply chain network facilitates in JIT implementation by reducing the level of in-process inventory. The IT-based supply chain management accelerates the speed of JIT implementation and helps in achieving the goals of world class manufacturing through enhanced organizational capabilities.

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