Information systems development within supply chain management

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Abstract

In order to improve effectiveness of supply chain management and compete in today’s dynamic global markets, it is not sufficient to have effective integrated processes within a business; synchronized operations of all partners in the supply chain is required. In the past, this has been achieved by one company owning or having control over all businesses in the chain. Now, it is more likely that this integration is carried out by using interorganisational information systems. This paper analyses the development and role of interorganisational information systems within supply chain management. The Internet has improved interorganisational information systems capability and therefore is being adopted as a routine platform for information systems development. An evaluation of its use is carried out.

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Keywords: Supply chain management; Interorganisational information systems; Internet

1. Introduction

Companies have consistently tried to enhance their business efficiency and effectiveness by reassessing their internal business operations such as purchasing, warehousing, materials management and distribution. These processes commit huge time and financial resources and therefore companies are continually striving to make them more effective in order to improve their financial standing and market positions. This has involved manufacturers using techniques such as Manufacturing Resource Planning (MRPII) and Just-In-Time (JIT) (Tan, 2001). However, businesses in today’s highly competitive global market place require to reassess their business operations and examine both internal processes and external linkages with business

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partners to satisfy the changing needs of their customers, react to the actions and new business models of their competitors and opportunities afforded by new technologies (Chaffey, 2002). They must offer products, which fully satisfy customer demands as well as trying to anticipate future demands. Therefore supply chain management (SCM) is coming under increasing scrutiny in trying to achieve this competitive advantage as it provides many opportunities for reducing operating costs and improving customer service and satisfaction.

“Supply chain management is the management of the interconnection of organisations which relate to each other through upstream and downstream linkages between the different processes that produce value in the form of products and services to the ultimate consumer”

(Slack, Chambers, & Johnston, 2001)

Using techniques such as MRPII and JIT within SCM are not sufficient. These systems focus on discrete functions within the supply chain. Re-engineering the whole supply chain and examining the linkages between internal and external functions is required. This now usually involves implementing an information system, which facilitates information sharing and coordination between internal and external partners in the chain. An interorganisational information system (IOS) is a collection of IT resources, including communications networks, hardware IT applications, standards for data transmission, and human skills and experiences. It provides a framework for electronic cooperation between businesses by allowing the processing, sharing and communication of information (Haiwook, 2001). Thus IOS are increasingly being used within SCM as the costs of acquiring and exchanging information by participating firms are decreased and process or transaction costs are minimized (Ayers, 2002). They have also led to businesses in the supply chain forming partnerships and alliances. Therefore the development of IOS has increased rapidly in recent years and has meant a shift in the role of IT, from a competition weapon to a cooperation enabler (Hong, 2002).

2. Inteorganisational information systems

The development of IOS has taken place over the past 40 years and can be categorized into four phases (Shore, 2001). The current state of IOS development within a business depends on a number of variables, as discussed below.

Phase one: This includes paper copies of purchase orders, bills and invoices and represents most of the information flows. Information technology and telecommunications do not contribute significantly to the information system. Therefore information sharing between businesses in the supply chain and within the business is limited. This phase of IOS development is still in use in some industries and in many small businesses where restricted resources such as finance and IT knowledge, may limit its development.

Phase two: This phase saw the development of EDI that had a dramatic effect on the automation of information flows and the elimination of many labour intensive processes and procedures in partner businesses. Purchase orders, invoices as well as order status, pricing enquiries and scheduling transactions can be processed using EDI. Traditional EDI uses a value added network (VAN), which can be expensive for smaller firms to implement. Also, research by Golden and Powell (1999) showed that EDI limits the flexibility of suppliers who are connected to
more than one customer since they are required to support specific technologies for each. Therefore this resulted in an explosion of different EDI software, VANS and EDI standards, which made it difficult to integrate the technologies. Other factors have also been shown to affect the use of EDI within businesses. For example, Angeles and Nath (2001) studied 152 companies and identified EDI ‘readiness’ of the partner as one significant factor in the use of EDI, to achieve effective SCM business partnering. This means that the partner should have the hardware, software and technical expertise to run the EDI systems. The partner should also be ready to reply to important EDI-related projects such as JIT, Total Quality Management (TQM) and continuous improvement programmes to meet high levels of customer service, as well as being able to meet performance expectations in terms of information exchange. Therefore infrastructure mismatch can occur when partners are at different stages of IT development. However, it has been the main technology used by large companies to initially pass information between departments and then among partners in a supply chain. Now universal standards allow many companies to share information between their computer systems (Krishnamurthy, 2003).

The development of Internet EDI with its lower initial costs, allows more medium and smaller sized firms entry to the EDI network. It allows small and medium sized companies to engage in automatic data sharing and brings them lower cost and increased business benefits. It also reduces trading partner switching costs. Thus businesses will initiate Internet EDI quicker, and the importance of the ‘readiness for EDI’ factor will increase.

Phase three: This phase describes a more integrated approach. Enterprise-wide systems and databases are integrated and coordination of IT operations takes place. These systems, characterized by Enterprise Resource Planning (ERP) systems, have developed from MRP II applications and now allow integration of businesses, such as suppliers and customers, through an integrated database environment. This is a phase in which the limited focus of EDI is being subsumed in a much larger view of data transfer and data sharing. An ERP system can potentially improve transparency across the supply chain by removing information distortions and increasing the speed of information by reducing information delays (Akkerman, Bogerd, Yucesan, & van Wassenhove, 2003). For example, the retailer Londis has re-engineered its inventory management function and implemented E3Trim, one of the UK’s first collaborative supply chain systems, to allow joint inventory management with a number of its main suppliers such as Coca Cola Enterprises, Cussons and Carlsberg Tetley (Conspectus, July 2003). Each supplier has access to his own products’ information in Londis’s stock database, such as stock level, promotions, returns, lost sales and handling costs. This information sharing has allowed Londis and the suppliers to improve operational efficiency and has resulted in substantial benefits. Londis has reduced stock holding costs by about £20million and improved stock management. Suppliers have benefited by increasing service levels and thereby increasing sales by up to £2million per annum.

ERP systems, such as SAP’s R3, have been implemented across the globe. Worldwide sales of ERP packages, combined with implementation support, exceeded $15billion in 1999 with annual growth rates of over 30%. However, ERP systems were designed to integrate the various functions of an individual business rather than support one or more functions or operations across a large number of businesses (Akkerman et al., 2003). They also have a closed and non-modular system architecture and today’s scenario of a network of businesses, requires open and flexible IT solutions (Akkerman et al., 2003).
Phase four: Here, the supply chain is defined by strategic supplier partnerships with extensive two-way information flows. The integration of information resources has therefore been enabled by the use of web development technologies such as XML and Java, which enable business partners to integrate their information resources and therefore to accelerate the decision-making on SCM processes. These systems also provide platforms for fast and reliable communications between trading partners, regardless of physical barriers (Shore, 2001). SCM here also requires the development of new interfaces, such as portals, allowing partners access to a company’s databases. This information may be used in operational or planning functions. For example, information on a retailer’s sales may be picked up by the supplier, who alters his purchasing plan, production schedule and distribution schedule accordingly. Also, the use of the Internet, giving real time information across the supply chain to ultimately satisfy more demanding customers, requires integration of computer systems. This involves examining existing legacy systems and software and developing integrated solutions.

This linking of systems may not require a complete redevelopment of existing systems as developed standards such as XML mean that a business and its suppliers can exchange information without requiring the use of the same software. Similarly, Microsoft’s Data Warehousing Alliance assists customers to build, use and manage data warehousing solutions that are fully integrated with SQL Server 2000, Microsoft Office and Windows 2000 systems (Krizner, 2001). These types of systems improve information flows and cut time out of the supply chain, bringing about increases in customer satisfaction.

For example, the First American Financial Corporation uses IBM’s MQSeries integration and messaging software in its database product division, which sells information about properties to mortgage lenders. MQSeries lets First American connect large business customers directly into its systems. If a mortgage lender requires appraisal details for a property, the integration technology receives the request from the customer’s applications over the network. It then sends the request to the systems needed to answer it, receives the replies, and feeds them back into the customers system—all in a few seconds (Sweat, 1999).

However, a survey of 33,000 companies worldwide by IBM shows that most businesses are still in the initial stages of e-business with 80% of them using the Internet to extend their markets and provide information. They also found that fewer than 5% of businesses were at the stage of integrating their information systems with external partners. The key difficulty was integrating work processes, such as purchasing and customer relations, across disparate computing platforms, applications and operating systems (Mills, 2001). Other types of problems also exist. For example, results from a survey carried out by Arthur Anderson show that of the top 10 problems experienced by Amazon.com on on-line purchasing, six of them were concerned with logistics mal-performance. Thus Amazon have failed to develop adequate back office systems and management solutions to cope with on-line purchasing and underestimated the complexities of the virtual supply chain (Van Hoek, 2001). Hence, before considering implementing new inter-business processes and applications, managers should evaluate their IT infrastructure capabilities.

There are a variety of information mechanisms available for use by managers in SCM, such as auctions, purchasing groups and electronic agents, which provide this linkage. Developments also include trading exchanges or market places. These are online supply chains, which allow the sharing of real-time synchronized information by using XML on features such as prices and delivery information. Examples include NonstopRX.com for the pharmaceutical industry and
Retail.com for apparel manufacturers and buyers (Messmer, 2000). These mechanisms may be used to conduct a business transaction, to purchase something at a given price or to share information to coordinate the flow of the item after the purchase has taken place. Managers are required to choose the appropriate level of integration for particular relationships in the supply chain and the appropriate degree of information sharing, as shown in Table 1 (Garcia-Dastugue & Lambert, 2003).

Therefore managers within companies have to capitalize on the state of the art IT to improve the performance of their business. Choosing the coordination mechanism that best fits each type of relationship in the supply chain is part of this challenge. Managers need to choose the form of coordination that is most appropriate for their business needs. They also need to choose the appropriate level of integration for particular relationships in the supply chain and the appropriate degree of information sharing (Garcia-Dastugue & Lambert, 2003). This decision may also require businesses to move from one phase to another in order to experience greater operational effectiveness. However, changing corporate information systems, such as implementing ERP systems or information portals, brings about a number of managerial challenges. Any changes require to be managed successfully if benefits are to be realized and factors such as security and risk aspects of opening up internal systems to external parties, the financial and time resources required to carry out systems integration, businesses may define processes and data differently from their supply chain partners and legacy systems of partners may use different platforms, should be considered (Krizner, 2001).

3. Internet IOS applications

As part of phase four identified previously, the Internet is now being used as one of the main networking platforms in the upstream, downstream and internal supply chains by both large and relatively small companies and has presented many opportunities for cost reduction, service improvements and greater speed agility in the supply chain.
BAA plc has implemented a complete reorganization of its supply chain management function (Whitehead, 2001). It has been radically transformed and has experienced significant savings and benefits, which includes:

- A saving of £47 million on the £1.2 billion spending budget.
- A reduction in the number of suppliers from 26,000 to 1500.
- A reduction in the number of purchasing personnel, from 139 to 63.
- Direct access to the system by all employees.
- Closer integration with suppliers.

Therefore it has impacted on all functions of SCM by bringing about a number of benefits, such as increased productivity, increased profits and it also allowed firms to customize services for their customers, which enhanced their overall value and competitive position. It has also brought about cost reduction by integrated forecasting of demand, reducing stock-outs and the costs of order tracking and logistics (Briant, 2000).

The Department of Marketing at Temple University, USA carried out research on the most popular use of the Internet in American companies that belong to the Council of Logistics Management to determine the usage of the Internet in their supply chains (Lancioni, Smith, & Oliva, 2000). Results from the study show that companies have moved away from an indiscriminate use of Internet-related processes toward more focused, strategic applications, and the development of precise and measurable goals. Table 2 shows the growth in the use of the Internet and the application areas in which it is used the most. This was purchasing/procurement, followed by transportation. The use of the Internet in these functions has risen dramatically over this 2-year period, with an increase in both of at least 50%.

The use of the Internet in the upstream supply chain, between suppliers and manufacturers, is impacting greatly on purchasing as well as on the coordination, communication and movement of goods and information from suppliers. It is a very effective medium, which is improving information flows. For example, Tesco has developed Tesco Information Exchange (TIE), which allows Tesco and its suppliers to exchange trading information by using the Internet, virtually on a real time basis. This closer collaboration has brought about a number of benefits for both Tesco and the suppliers in terms of reduced lead times, improved customer service levels and reduced costs (Chaffey, 2002).

Table 2
Internet applications by logistics decision area application (Lancioni et al., 2000)

<table>
<thead>
<tr>
<th>Application</th>
<th>1999% Using</th>
<th>2001% Using</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchasing/procurement</td>
<td>45.2</td>
<td>86.7</td>
</tr>
<tr>
<td>Inventory Management</td>
<td>30.1</td>
<td>48.5</td>
</tr>
<tr>
<td>Transportation</td>
<td>56.2</td>
<td>84.3</td>
</tr>
<tr>
<td>Order Processing</td>
<td>50.7</td>
<td>63.4</td>
</tr>
<tr>
<td>Customer Service</td>
<td>52.5</td>
<td>67.1</td>
</tr>
<tr>
<td>Production Scheduling</td>
<td>12.3</td>
<td>19.5</td>
</tr>
<tr>
<td>Relations with suppliers</td>
<td>45.3</td>
<td>57.2</td>
</tr>
</tbody>
</table>
The Internet is used in the downstream supply chain in areas such as transport scheduling, vehicle tracking and customer service. Lancioni et al. (2000) suggest that the Internet brings the following opportunities:

- direct selling to all customers, including international customers,
- ability to monitor all transportation systems,
- better communications with all partners in the chain,
- 24 h/7 day worldwide customer service,
- more efficient internal processes, such as order and payment processing,
- improved customer service.

For example, General Electric uses the Internet to schedule shipments out of centrally located warehouses to allow the company to realise savings of time and money (Lancioni et al., 2000). Fisher Scientific is using the Internet to allow its customers to order personalised products (Lancioni et al., 2000). It also allows information to be more readily available along the distribution chain and has also impacted on the distribution strategy. Many companies are now selling direct to customers, as well as through traditional distribution channels. This has caused disintermediation and reintermediation (Chaffey, 2002), which can be defined as:

**Disintermediation:** The removal of intermediaries such as distributors or brokers that formerly linked a company to its customers.

**Reintermediation:** The creation of new intermediaries between customers and suppliers providing services such as supplier search and product evaluation.

Major retailers such as Dell (www.dell.co.uk, 2002) and Tesco (www.tesco.co.uk, 2002) sell online as well as through their traditional distribution networks of warehouses and stores. New online companies such as Amazon and Ebay sell online from their own web sites.

### 4. Information sharing and communication improvements

The use of the Internet has also shown businesses that all partners, both upstream and downstream, gain from sharing information in the supply chain. One of the most popular uses of the Internet in SCM is in distribution, which is a costly function for companies. A study of North American transport companies (Lancioni et al., 2000) has shown that carriers can use the Internet in the monitoring of deliveries. This is especially important for a company, since tracking deliveries provides the company with data on the reliability performance of the carriers. It also provides managers with the information they require to inform carriers of delays as they occur, and not have to wait for several days before the information becomes available for corrective measures to be taken.

Buyers and suppliers can have extended reach into partners’ systems and are able to view operational information. Smaller partners in a supply chain are now in a position to ‘shop around’ for better price and service. Available to promise (ATP) systems, which allow suppliers to reach into their partners’ systems, provide real-time integrated checks throughout the entire supply chain.
The Internet has improved the speed of information transmission. For example, customers can quickly notify suppliers of stock emergencies. Lancioni et al. (2000) have shown that the information available to inventory managers is becoming more readily available due to the reporting systems that can be used through the Internet. This includes finished goods inventory levels at manufacturing and regional depots along with raw material levels at central and regional locations. Orders can also be processed much quicker. The reduction in order cycle time has been reduced by as much as 50%.

5. Supplier relations

The use of the Internet can also improve supplier relations by improving communications and data flows between suppliers and businesses. Table 2 shows the increased use of the Internet in this area. The use of the Internet in monitoring supplier raw material stock levels has increased dramatically, more than 400%.

The benefits of the use of the Internet can therefore equate to "real" savings by reducing SCM costs. Roberts (2000) reports that digital technologies can bring about 8–35% reductions in supply chain costs, 22–85% reductions in inventory, 12–24% delivery improvements and 17–68% cycle time improvement.

6. Customer service improvements

Providing customers with their requirements in terms of products, services and information is of paramount importance to businesses today. Research by Lancioni et al. (2000) has shown that the Internet can be used to improve communications with customers by receiving their complaints, emergency notifications and 24-h access to company information. The overall effect has led to reduced response times to customer service problems and increased customer loyalty.

The improved quality of information due to the use of the Internet has also benefited SCM. Pricing accuracy is very important in order processing and the Internet provides companies with the ability to check processes on-line before an order is placed. It also gives them access to latest prices.

However, the above evaluation concerns the use of the Internet in SCM at the operational level. The Internet can also be used to provide information, which can be used for strategic advantage, as opposed to operational purposes. For example, on-line ordering of the Smartcar, or the engineering of a customized car using multi-media tools in the showroom, is directly and electronically linked to production planning. The production plan is shared with suppliers who receive orders in real-time from the manufacturer, using the supply chain wide information infrastructure. As a result, the entire supply chain is involved in the concept. Also, information is not only used for operational ordering purposes but also as a strategic, long term resource for competitiveness and further innovation in the supply chain (Van Hoek, 2001). Customer preference information can be mined and used to inform future product developments and innovation. Also, communications are not sequential but multi-directional which overcomes the Forrester 'bull-whip' effect (Forrester, 1961).
7. Conclusion

This paper analysed the development of interorganisational information systems within SCM, and their impact on the effectiveness of the supply chain. The development of IOS, although taking place over the last 40 years, has increased rapidly in recent years and has meant a shift in the role of IT, from a competition weapon to a cooperation enabler (Hong, 2002). The development can be categorized into four phases, from paper-based documentation, through development of EDI, and integration of information systems to strategic partnerships.

The Internet has improved interorganisational information systems capability and therefore is being adopted as a routine platform for information systems development within supply chain management. An investigation of its influence and impact in the various internal business functions, such as purchasing, inventory management, order processing and transportation, as well as how they were made more effective and efficient due to the use of the Internet was carried out (Lancioni et al., 2000). This shows that although the Internet improves information flows and allows better communication between parties, organizational and systems factors such as process definitions and legacy systems are also important. The use of the Internet in information flow in the supply chain can bring operational benefits as well as strategic advantage, such as product innovation by providing market research information (Van Hoek, 2001). Research (Lancioni et al., 2000) also shows that 57.2% of American companies use the Internet to improve relations with suppliers. The more integrated the effort and the more virtual the supply chain, then the larger the potential benefits. However, the further upstream and the more integrated the supply chain focus, the more time consuming and complex it is to achieve.

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**Further reading**


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