E-volution of a supply chain: cases and best practices

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Keywords

Supply chain management, Case studies, Electronic commerce

Abstract

Supply chain management (SCM) is an integrating philosophy to manage the total flow of materials, information and finance from supplier to ultimate customer. The goal of SCM is to meet the needs of the final consumer by supplying the right product at the right place, time and price. Companies use SCM as a way to meet the competitive challenges of today's business environment. The focus of SCM has shifted from engineering efficient functional processes to the co-ordination of activities in a supply chain network. The aim of this paper is to examine the stages in the evolution of the supply chain to an electronic supply chain. To illustrate and support the types of evolutionary progress involved, best practices and case studies are provided and analysed.

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Introduction

Supply chain management (SCM) in the new business era is considered as a medium for achieving short-term economic benefits and gaining long-term competitive advantages. SCM can be considered as an aggregation of approaches and efforts supporting the efficient consolidation of producers, suppliers and distributors, in effect a co-ordination of the value chain so that products are produced and distributed in the right quantity, at the right quality, at the right time and at the right place to ultimately achieve consumer satisfaction (Simchi-Levi *et al.*, 2000). Current advances in information and communication technology (ICT) have revolutionised SCM to make it a mechanism that enables diverse and geographically disperse companies to create alliances to meet a new form of Internet-oriented consumer demand (De Man *et al.*, 2002). These alliances represent advanced and dynamically changing networks that aim to become competitive by focusing their resources on bringing elements of e-business to specific market segments. In other words, the focus of SCM has shifted from the engineering and improvement of individual functional processes to the co-ordination of the activities of a dynamic supply chain network. The tremendous transformations fostered by e-business have called for SCM research (Grieger, 2002).

This paper aims to develop a framework for identifying and analysing the various types of SCM ranging from the initial efforts towards optimising main and isolated business functions to the creation of virtual enterprise networks, which by adapting several e-business models and practices are totally dependent on the Internet. Five parameters are used for identifying the various types of SCM:

(1) the business strategy;
(2) co-operative relationships among clients and partners;
(3) the degree of application of innovator technologies;
(4) the management/evaluation of information for decision processing; and
(5) basic logistics functions.

Specific examples, case studies and best practices are provided to illustrate the evolution of SCM and support the development and applicability of the proposed SCM evolutionary framework. The latter has both operational and strategic value. Enterprises can use it as a useful tool for evaluating and managing the efficiency of their existing logistics and supply chain systems. Furthermore, the framework can be used as a strategic tool for identifying future trends and dynamics that may

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enforce and justify the adoption of e-business applications and practices.

Types of supply chain evolution

Internet and e-business applications significantly influence the operation of SCM (Hoek, 2001). New communication channels are required to satisfy the increasingly varied and sophisticated demand trends for lower prices and faster delivery. Consequently, firms are now facing pressure to expand beyond the frontiers of their traditional supply chains. Customers now expect Web-based order-status tracking capabilities, electronic proof of delivery, flexible manufacturing and immediate service based on call centers and Web-based customer service systems, self-service, and personalised interaction. Production, marketing, distribution and transportations are now blurred into a single procedure, creating the need for fulfillment and re-engineering. In this light, the ability to gather, disseminate and analyse information becomes the foundation of e-supply chain evolution, and consequently companies are trying to offer total integrated logistics services that address not only the main logistics functions, but also all the ICT needs of the supply chain (Grieger, 2002).

A reveiw of the literature shows that numerous approaches regarding the evolution and type of SCM are to be found. Some analysts, such as Burnes (1996), LaLonde (1998), Muzumdar and Balachandran (2001) and Noekkenved (2000) support a three-phase evolutionary process, while Straus (2002) advocates a four-phase evolutionary process, and others even advocate a five-phase process (Durchslag *et al.*, 2001; Poirer and Bauer, 2001; Stein, 2001). In this paper, these approaches are summarised and integrated within the following types of SCM (Figure 1):

- core logistics activities efficiency;
- co-ordination of internal organisational processes;
- inter-enterprises business exchanges; and
- establishment of dynamic networks between virtual organisations (Manthou *et al.*, 2002).

The first two types are related to a single enterprise (internal), while the last two relate to a cluster of enterprises (external). These types are analysed below.

The following five key dimensions were applied to identify and classify the four types of SCM evolution:

(1) business strategy;
(2) customer and partnership relationships;
(3) technology implementation;
(4) information/decision making; and
(5) orientation of logistics processes/activities.

These dimensions were used as they cover all the business and technology aspects of a supply chain member (Manthou *et al.*, 2002). Thus, enterprises falling into different SCM types have different properties and characteristics, as well as different means of implementation and utilisation of resources.

The SCM types are analysed in the following sections. Furthermore, synoptic tables including all the key dimensions are presented to illustrate the main character of each SCM type. Overall, enterprises can use these tables as a roadmap for both SCM strategic planning and transformation as well as operational, day-to-day evaluation of SCM systems.

Type 1: core logistics activities efficiency

Some analysts refer to this type (Table I) as "fundamental" or "inception" SCM (Dobbs, 1998; Poirer and Reiter, 1998). This type represents a company's first effort to apply supply chain techniques by pursuing logistics improvements in specific activities and specifically by leveraging its total volume over a smaller base of suppliers. Business benefits of this type include better quality, lower prices, inventory reductions and lower costs. Analytically, each functional area or department plans and operates in an isolated environment. The structure is strictly hierarchical and the various departments operate as individual units creating an environment consisting of "isolated islands" of ICT systems and information use, sharing and decision-making processes. Overall, this type is function- rather than customer-centric, as it focuses on creating value for the various departments/functions, and not on aligning processes and collaborating with the customer or partner. Consequently, opportunities for gaining a strategic advantage are limited.

Type 2: co-ordination of internal organisational processes

Analysts have called this type (Table II) "cross-functional", "developmental" or "integrated". Cross-business unit co-operation arises to achieve internal excellence. From an ICT perspective, this level represents the initial stage of e-commerce infrastructure development, whereby companies develop internal information support systems, networks (intranets) and enterprise systems, which in turn foster business process re-engineering and

Figure 1 The evolution of supply chain

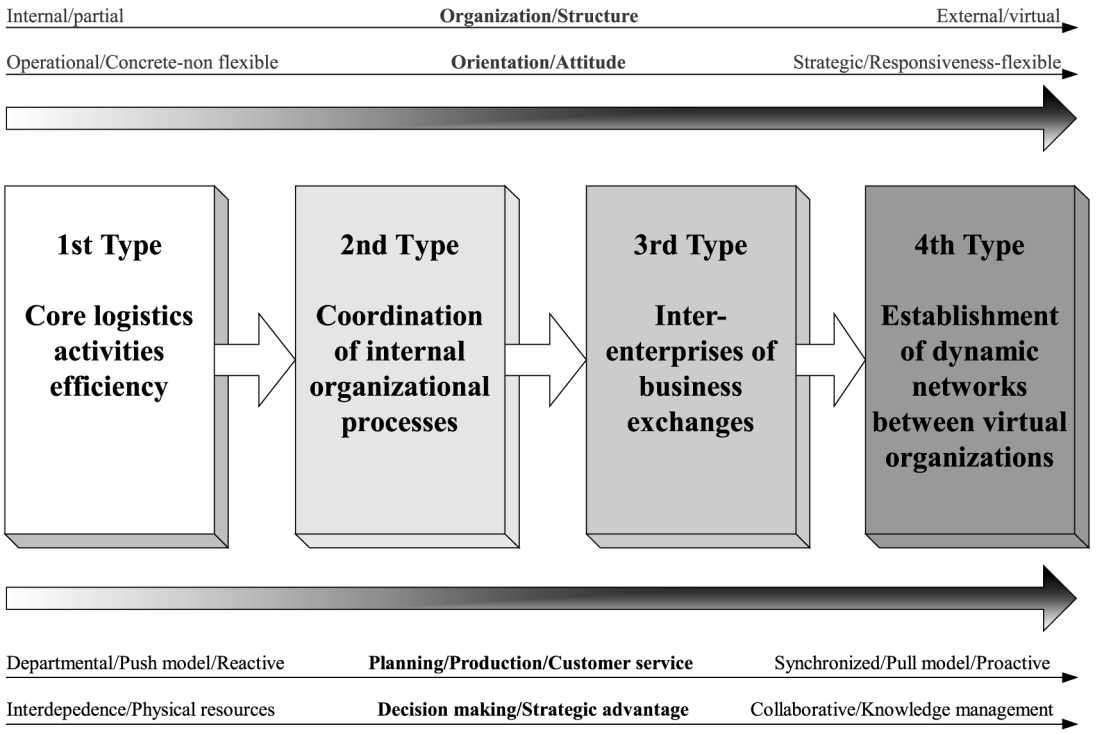

Table I Dimensions and key elements of the first SCM evolutionary type

Dimensions	Key elements
Business strategy	Narrow and functionally focused in a reactive mode
	Departmental, fragmented, partial
	Deep functional expertise
	Sales growth
	Cost reduction
	"Push" model
Customer and partner relationships	One-way communication
	Limited trust
	Win-lose interactions with vendors
	Reactive customer service
	Low, fixed supplier base
	Pure or segmented standardisation
Technology	Legacy/departmental systems, "island" of information systems, materials requirement planning (MRPI)
	Data-driven, batch process models
	National and industry-oriented electronic data interchange (EDI) data structures of information exchange
	Point-to-point direct connections
Information/ decision making	Silo-based, by functional managers and key associates based on limited information visibility and standardisation
	Limited information visibility and standardisation
	Decision-making based on historical data
Logistics processes/ activities	Limited dissemination of information and minimal interaction with other functional areas/business units
	Departmental procurement and sales planning and execution
	Limited feedback from customers, reactive customer service
	"Push" model
	Planning and execution based on historical data
	Limited visibility
	Manual/labour-intensive order processing

support the evolution of the supply chain. So, by utilising a centralised database environment, enterprise-wide systems (enterprise resource planning; ERP) can significantly contribute to the integration and co-ordination of ICT and business operations. Moreover, apart from supporting electronic communication and partnerships with main suppliers, intranets are also used to support and co-ordinate distribution and transportation management as well as to ensure the alignment of production with procurement. Regarding supply chain planning and execution decisions, these are taken at an enterprise-wide level and aim not only at performance and cost optimisation, but also at better customer service and automation of transactions. As enterprises grow and demand for expanded supply chain services rises from both main upstream and downstream players, companies are faced with increasing challenges and requirements for process integration along their whole supply chain.

Type 3: inter-enterprise business exchanges

The orientation of these types of companies moves to a more dynamic model that tries to balance internal improvement with external needs of the entire supply chain network (Table III). In the

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Table II Dimensions and key elements of the second SCM evolutionary type

Dimensions	Key elements
Business strategy	Information flow efficiency, spanning multiple business processes
	Prioritised improvements across the enterprise
	Enterprise-wide "push" model
	Multiple business process mapping
	Soft skills, ability to lead and work in cross-functional teams and in multiple business processes
Customer and partner relationships	Access in central database
	Interaction (forms, bulletin boards, FAQs, catalogues, e-mails)
	Low transparency, no centralised market
	Arm's length relationships
	Interaction in standardised processes
	Customised standardisation
Technology	MRPII, ERP, distribution resource planning (DRP)
	Total quality management (TQM), business process reengineering (BPR), activity-based costing (ABC), just-in-time (JIT)
	International EDI data structures
	Value-added networks (VAN)
	Intranets
	Internet
Information/decision making	Business process focus, medium effectiveness because of limited standardisation of information across the enterprise
	Internal, centralised (for corporate planning) share of information
	Integrated cross-functional decision making based on central database management systems
Logistics processes/ activities	Integrated systems based on MRP/ERP in order to make efficient long-range planning decisions
	Decisions based on central DBMS
	Cross-departmental decision making
	Integrated systems based on MRP/ERP in order to make efficient long-range plans
	Customer segmentation
	Management of marketing and sales based on integrated database systems
	Increased warehouse management and automation (picking, packing and shipments)

Table III Dimensions and key elements of the third SCM evolutionary type

Dimensions	Key elements
Business strategy	E- partnership, e-services
	Inter-enterprise business efficiency
	Best partner performance
	Extended enterprise, "pull" model (build-to-demand), Web-based services
	Alignment with inter-enterprise processes, inter-enterprise process optimisation
	Focused on inter-enterprise processes, extended enterprise management skills
	Inter-enterprise decision making
Customer and partner relationships	Data and information exchange
	Automated (front-end CRM)
	High inter-enterprise transparency
	Joint ventures, partial alliances customisation
Technology	Extended ERP, front-end CRM, partners relationship management (PRM), SCM
	Efficient consumer response (ECR), enterprise application integration (EAI), integrated demand forecasting, planning and scheduling
	High complexity (incompatible system interfaces, heterogeneous platforms and external systems)
	International EDI data structures or national and industry-oriented XML data structures
	Extranets, Internet
Information/decision making	Extension planning process beyond enterprise, limited collaboration
	External information-sharing with vendors and customers
	Decision making by cross-functional teams based on core competencies
Logistics processes/ activities	E-catalogs, e-procurement, e-orders, e-auctions
	Vendor management inventory (VMI), ECR
	Proactive customer service, one-to-one marketing, front-end CRM
	Automated customer service using e-business techniques and methodologies
	"Pull" model
	Planning and production based on CAD/CIM systems
	Strong linkage between plan and execution
	Logistics network optimisation

search for network improvement and customer satisfaction, external resources are added to internal teams. Enterprises also aim to create strong customer relationships and differentiate their services by providing personalised products/services and valued-added information. This stage is also characterised by a transition of the supply chain flow from a push model towards the consumer to a pull model, in which the consumer pulls the product/service via actual demand. The overall aim of such strategies and practices is the acquisition of greater market share. At the technology level, innovative Internet technologies are also exploited to execute transactions among business partners as well as to automate exchanges of business documents (e.g. purchase orders, invoices). At this stage, information exchange is the only requirement for accomplishing specific transactions, such as a product order from a supplier. Thus, contrary to dynamic networks of virtual enterprises, which have a more strategic character, these value-added partnerships are only applied in a strictly operational manner to silos of logistics departments. As these partnerships expand beyond the organisational boundaries, they are considered as "extended supply chains" or "integrated logistics networks", and their degree of operational integration and synchronisation along the supply chain becomes the more critical business success or failure factor.

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To achieve such integration, information management and sharing becomes a central and vital SCM issue (Barrett and Konsynski, 1982; Palvia and Lee, 1996; Shore, 1996, 2001). One popular characterisation of poorly managed information flows is the "bullwhip effect", in which demand variability amplification through the supply chain sequence leads to inaccurate forecasts, low capacity utilisation, excessive inventory and inadequate customer service (Lee *et al.*, 1997). Studying the high technology industry, Lee *et al.* (2000) concluded that information sharing could significantly minimise the consequences of this problem. Handfield *et al.* (2000) provided evidence of the crucial role of partners' co-ordination and relationship management for the success of SCM. Studying supplier development in 84 companies, they concluded that lack of supplier commitment and insufficient resources on the part of suppliers can substantially and negatively affect SCM efficiencies. However, although the technical issues associated with ICT in SCM and the ability to effectively design, operate and manage the technical infrastructure are critical to the success of these systems, social factors are also cited as being vitally important. Specifically, in investigating the effect of partnership quality on ICT outsourcing, Lee and Kim (1999) found that information sharing, participation and top management support were significantly related to partnership quality. However, similarity among corporate cultures was evidenced to have "no effect on partnership quality". Kumar (1996) addressed the issue of trust between manufacturers and retailers, while Hart and Saunders (1997) addressed power and trust in the adoption of EDI technology. Others who have considered social factors include Stuart and McCutcheon (2000), Lee *et al.* (2000) and Handfield *et al.* (2000). Recent studies (Kern and Willcocks, 2002; Sigala, 2004) proved that trust, information sharing, commitment and alignment of organisational culture are factors which determine success in ICT outsourcing relationships.

Finally, this type is also referred to as the "acceleration phase", because as it fosters different value chain constellations it creates new, dynamic business-to-business (B2B) models and innovative models (Poirer and Bauer, 2001).

Type 4: establishment of dynamic networks between virtual organisations

The final type involves the development of e-supply collaborative models and full network connectivity among virtual enterprises (Table IV). Firms also adopt advanced SCM concepts in order to optimise the use of mutual assets, minimise costs, and surpass consumer expectations. At the same time, external and dynamic environments are also created for leveraging e-business applications and enhancing supply chain optimisation. However, by converging e-business with the supply chain, new e-business models are created that help companies and their partners to achieve market dominance. Specifically, enterprises and their partners foster the development of communities, marketplaces or supply chain synergies aiming to meet common aims and objective goals (Poirer and

Table IV Dimensions and key elements of the fourth SCM evolutionary type

Dimensions	Key elements
Business strategy	Broad-based collaboration, customer value Dynamic network competitive advantage (real-time visibility, flexibility, customer responsiveness) Virtual business communities/networks Virtual, rapidly re-configurable, dynamic Broad-based collaboration, integrated organisational team structures at multiple levels Knowledge management systems Hard-skilled staff in advanced ICT
Customer and partner relationships	High trust Full sharing of information and processes Collaborative relationships Based on knowledge management (analytical CRM) High inter-enterprise knowledge management Pure customisation
Technology	Integrated e-business solutions, data- and Web-mining systems, analytical CRM CPFR, knowledge management (data- and Web-mining methodologies) High complexity (increased semantic diversity, many flavors of XML-schema chaos) International XML data structures (schemas) Dynamic virtual networks
Information/ decision making	Full sharing and information visibility, real-time collaboration Collaborative design, planning and demand forecasting, virtual network life-cycle management, collaborative proactive decisions Decision making based on analytical and knowledge management capabilities
Logistics processes/ activities	CPFR Long-range relationships Broad-based collaboration around business processes that extend beyond the enterprise to key customers and suppliers ECR Collaborative scheduling Sales, marketing and customer service based on knowledge management and analytical CRM systems Knowledge management Real time information and visibility Dynamic network optimisation

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Bauer, 2001; Durchslag *et al.*, 2001). Such marketplaces are either created or controlled by existing "mortar" companies (e.g. the autobytel e-marketplace), new start-up players (hospitalitysupplies.com) or by co-operations (e.g. industry consortia such as Covisint in the automotive industry, Transora in the retail industry and myAircraft.com in the aerospace industry).

The dynamic nature of the enterprise network gives a significant competitive advantage to participating enterprises and renders them capable of coping with the new conditions of the global market (Simchi-Levi *et al.*, 2000; Kulin and Rosenbaum, 2000). To achieve that, emphasis is given on the high level of information and processes integration among members (Folinas *et al.*, 2001; Manthou *et al.*, 2001, Hinterhuber and Levin, 1994; Pfohl and Buse, 2000; Sydow, 1996). Through collaboration, supply chain partners may become involved in such processes as advanced planning and scheduling, demand planning and scheduling, or inventory management (Hamel and Prahalad, 1990). More enhanced e-marketplaces also move towards product co-design, joint planning and production capabilities (e.g. Transora). Collaboration enhances the possibilities of virtual supply chain networks to flourish and boom. For example, co-operative virtual networks allow their members to jointly co-operate in:

- the design and development of new products;
- demand forecasting (by disseminating and sharing information along the supply chain);
- flexible usage of all available resources; and
- better and faster response to customer demand.

To foster and support collaboration, supplier alliances with extensive two-way information flows and integrated systems are essential (Stuart and McCutcheon, 2000). Integrated systems can utilise the existing information stored in ERP, e-business and customer relationship management (CRM) applications (Handfield and Nichols, 1999). However, at this stage, data sharing goes beyond internal systems and expands to include planning and control systems within supplier organisations. For this type of SCM, the philosophy is more than a database processing or management information system (MIS). Instead, the SCM philosophy is a decision support system (DSS) that helps managers to take decisions efficiently and effectively when they are planning, operating and controlling the networked organisation (Chopra and Meindl, 2000; Zheng *et al.*, 2000). For example, a system identifying demand changes on retailers' shelves may initiate changes to the aggregate production plan, the raw materials requirements, the purchasing plan, and overall, to all stages in the manufacturing and distribution network.

Evaluating SCM types: cases and best practices

Having discussed the different types and evolution of SCM based on Internet advances and business models, this section aims to illustrate the applicability and value of the proposed framework by identifying and discussing a series of cases and best practices.

Nowadays, most businesses have already adopted or are planning to adopt the first type of SCM (Cagliano *et al.*, 2003) in order to automate procedures of their procurement department and capture the benefits of decreased inventories and costs. A variation on and a more sophisticated implementation of such models is found in corporations that exploit ICT to apply SCM in a centralised manner, spreading but also optimising SCM costs at a corporate-network level. For example, Sigala (2003) described and analysed how five major hotel chains (Marriott International Inc., Hyatt Hotels Corporation, ClubCorp USA Inc., Bass Hotels and Resorts, and Fairmont Hotels and Resorts) achieved enterprise-wide procurement benefits by using avendra.com (an Internet-enabled procurement systems) in order to control and organise procurement centrally for all their hotel properties. Nevertheless, even in this case, SCM benefits are derived only from the procurement function, and particularly from centralisation (e.g. downsizing effects).

As discussed previously, further business benefits accrue when SCM practices are aimed at rationalising procurement along the whole business value chain. A typical example of the implementation and benefits of this second type of SCM is Benetton. Benetton was one of the first manufacturers in the industry to start collaborating and exchanging information with downstream supply chain players in order to better co-ordinate its production operations. Specifically, Benetton has allied itself with key retail stores to collect point-of-sales data and determine the product mix and the assortment of colours to be produced. Although this required heavy investment in internal and external ICT infrastructures, this agility of Benetton's supply chain would not have been successful without the re-engineering of its business processes. Specifically, Benetton's operational flexibility was enabled through a product and process redesign, whereby sweaters were first knitted in gray and

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then dyed to the desired color. In other words, Benetton exploited supply chain integration to foster benefits across its whole value chain and system, from sales and distribution to production processes and efficiency.

However, in order to be competitive in today's global and dynamic market, organisations need to forge tighter and closer working relationships with their supply chain partners. The Internet provides organisations with the opportunity to extend their internal information systems beyond their boundaries in order to incorporate their partners, and then all behave like a single, unified virtual enterprise. New e-business models and technologies support the successful implementation of e-supply chains by breaking down barriers among business partners all along the chain. New Web-based business networks are established which, by enabling the global visibility of the customer, the product, or supply information throughout the supply chain, are replacing linear supply chain models. In this way, Web-based networks provide professional customer response services, fast and accurate product delivery, rapid decision-making environments, and synchronised global supply chains. As a result, businesses can further enhance their customer relationships and gain the benefits of repeat business.

These benefits can be partly achieved by "extended supply chains", as described by the third type of SCM. Reyes *et al.* (2002) used a case study from the telecommunications industry in the US to illustrate the importance of inter- and intra-SCM, achieved not only by integrating internal systems but also by collaborating with both upstream and downstream supply chain partners and entities. The case study describes the specific supply chain synchronisation problem of a telecommunications original equipment manufacturer (OEM) and the implementation of an advanced planning equipment and scheduling (APS) system that extended beyond its four walls to address this problem. The OEM implemented APS to integrate its internal demand flow system with e-business software and enabled real-time collaboration with trading partners, which in turn resulted in specific business benefits that encompassed the whole supply chain. This case study highlighted the need to:

- focus on business results;
- adopt a common business model across the global supply chain;
- focus on process, people and technology;
- deliver value at regular intervals; and
- move fast.

Strong leadership was found to be paramount to the success of e-business systems, but APS was found to lead to competitive parity. Thus, Reyes *et al.* (2002) concluded that companies seeking a competitive advantage are currently establishing "private" collaborative commerce networks with their own trading partners. The benefits to suppliers from a strong supply chain facilitated by APS for e-business systems, as described in the case study, are that:

- it allows suppliers to forecast their inventory needs, eliminating the need to acquire products from alternative sources;
- it transforms customer relationships into supply chain partnerships and allows suppliers to differentiate themselves from competitors on their value-added service offerings; and
- it increases revenue from existing accounts while creating new customer revenue streams.

The benefits to customers from a strong supply chain facilitated by APS for e-business systems, as described in the case study, are that it allows them to (Reyes *et al.*, 2002):

- share inventory management functions;
- reduce on-site and in-transit inventory stocks;
- reduce working capital costs; and
- reduce the need for emergency shipments, thereby reducing transportation and administration costs.

Amazon.com and Barnes and Noble are also good examples, illustrating how evolving industry standards can affect data-sharing strategies between customers and suppliers. Amazon.com does not stock all the books advertised on its site, but shares customers' order data with suppliers to speed customers' orders. However, to further increase their operational agility and business benefits, businesses are increasingly exploiting Internet advances and models to form dynamic supply chain networks between virtual organisations and communities. Good examples of such dynamic networks, as described by the fourth type of SCM, are Smart Car, Coca-Cola Bottling Co., Baker Street Technologies, Lexmark Electronics, SciQuest.com, Motorola, value chain (for Dell.com), eHub (for Cisco) and Micron. To be successful, competitive and beneficial for all network members, increased levels of collaboration, commitment, information transparency and trust are required. Very often, business operational boundaries and operations become blurred. Specifically, the last three electronics companies share not only product development plans, forecasts and replenishment strategies, but they also have supplier personnel working in their plants and participating in their planning strategies. Micron Electronics, a $1.6bn computer manufacturer based in Nampa, Idaho, claims to have the most efficient supply chain in

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the computer industry. The improvements in its supply chain over the last two years are attributed to collaborative supply chain practices. The numbers support this: Micron was producing 2,100 computers a day in January 1998, while in 2002 this figure was 10,000-12,000 a day. Product lead times have dropped from as high as 21 days to below five days. In 1998, Micron carried $130.7 million in inventory, whereas today, it carriers $17 million. This has been achieved through close relationships with suppliers, especially Modus Media, which specialises in providing procurement and technology. The level of collaboration is high. For example, Modus employees work in Micron's plant, and attend meetings with Micron's sourcing, manufacturing and marketing teams. Modus employees replenish Micron's assembly plant and take part in new product launch meetings. This level of resource sharing allows for quick response and drives down costs for both companies. Gordon (2000) provides more information about this case study.

Cisco is also an excellent example of a company that has exploited the Internet to create a supply chain community. Hartman and Sifonis (2000) have described how Cisco achieved this and other business goals by creating "Manufacturing Connection Online" (MCO). MCO is a globally networked manufacturing environment that provides a central point of access for employees, suppliers and logistics partners. It allowed Cisco to reduce lead times, increase operational agility and so move to a "pull", make-to-order environment. To differentiate itself from the competition in what is essentially a commodity business, Cisco acquires companies who have leading technology and then integrates them rapidly within its systems. It also sells network solutions, not just components, to its customers. This requires the co-ordination of hardware, software and service components in many sales. The ability to provide these services and integrate many new businesses is enabled by Cisco's single enterprise system. This system provides the backbone for all activities in the company by connecting not only customers and employees, but also chip manufacturers, components distributors, contract manufacturers, logistics companies and systems integrators. Consequently, these participants can perform like one unified company because they all rely on the same Web-based data sources. Moreover, all its suppliers see the same demand and do not reply on their own forecasts based on information flowing from multiple points in the supply chain. Cisco's average turns for commodity items are even more impressive, reaching 25-35 turns a year.

However, by analysing several case studies, Levi and Levi (2002) demonstrated that although the Internet can help companies move away from the traditional "push" strategy employed by most supply chains, eventually many companies end up with a hybrid strategy, i.e. a "push/pull" supply chain. In a push-pull strategy, some stages of the supply chain – typically the initial stages – are operated in a push-based manner, while the remaining stages are operated in a pull-based strategy. The interface between the push-based stages and the pull-based stages is referred to as the push-pull boundary.

The book industry is a good example of the push-pull strategy. When Amazon.com established their supply chain, it was a pure "pull" system with no warehouses and no stock, and Ingram Book supplied most customer demand. Evidently, Ingram Book can aggregate across many distributors and take advantage of economies of scale. Thus, the pull model employed by Amazon.com was an appropriate strategy when Amazon.com was building its brand name. As volume and demand increased, two issues became clear. First, Amazon.com's service level was affected by Ingram Book's distribution capacity, which was shared by many distributors, whereas during periods of peak demand (e.g. Christmas), Amazon.com could not meet its service level goals. Second, by using Ingram Book in the first few years, Amazon.com managed to avoid inventory costs, but this significantly reduced profit margins. As demand increased, it was evident that Ingram Book did not provide any advantage for many of the book categories. This is also true because as Amazon.com could aggregate across large geographical areas, this allowed it to reduce uncertainties and hence inventory costs. As Amazon.com discovered these problems the company changed its philosophy, and now Amazon.com has several warehouses around the country where they keep stock of most of the titles they sell. Thus, inventory at the warehouse is managed based on a push strategy founded on long-term forecasts, while demand is satisfied based on individual request (i.e. a pull strategy).

In the same vein, GM and Ford have announced that they are changing the way they are designing, building and selling their products. Their challenge is to allow customers to customise and order cars online, and have the car show up at their door in less than ten days. Thus, GM and Ford are moving in a pull-push strategy whereby production is done based on a realised demand (i.e. a pull strategy), while delivery is according to a fixed schedule (i.e. a push strategy). Levi and Levi (2002) claimed that the push part of the supply chain is applied to the portion of the supply chain where long-term forecasts have small uncertainty and variability (e.g. forecast of the level of car

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components). The aim was to minimise costs, while the pull part is applied to the portion of the supply chain where uncertainty and variability are high (e.g. forecast of demand of particular types of cars) and hence the focus is on matching supply and demand and achieving customer service.

A further step whereby retailers and suppliers recognise that sharing of information is not enough is the strategy of collaborative planning, forecasting and replenishment (CPFR). CPFR is a process by which supply chain partners co-ordinate plans to better match supply and demand. This strategy was first developed and implemented successfully by Wal-Mart in collaboration with Warner-Lambert in early 1995. Pramataris (2002) described the use of CPFR at store level (called the "process of collaborative store ordering" or PCSO) in Greece by Hellas Spar Veropoulos (the third largest grocery retail chain in Greece) and three suppliers (Elgeka SA, Procter and Gamble Hellas, and Unilever Hellas). CPFR has emerged as a highly sophisticated business practice which aims to ensure that there is always enough quantity to meet consumer demand while maintaining optimum levels of stock across the supply chain. The essence of CPRF is about utilising technology capabilities and information sharing to support trading partner interaction and collaboration in meeting consumer demand. Utilising the principles of CPFR, a retailer and a consumer goods firm would work together jointly to create a single, combined promotion calendar in advance of the selling period. Both firms create sales and order forecasts, discrepancies or exceptions are identified, and appropriate managers are advised. The case study illustrated that the pilot implementation of PCSO lead to a 53 per cent decrease in out-of-shelf (OOS) situations between pilot (4.3 per cent OOS) and control stores (9.4 per cent OOS).

Conclusions

Transforming the system of SCM into a viable e-business strategy and model is critical to future success. In this paper, five dimensions (business strategy, partnership relationships, information/decision-making, technology and logistics functions) were used to illustrate the evolution of e-SCM and to classify several types of SCM. Based on this analysis, a SCM evolution framework was proposed and its implications for analysing current supply chain practices or identifying the specific requirements of future developments were illustrated through the discussion of several cases and best practices. Overall, it is demonstrated that as companies come to realise the need for real-time information systems and new business models, the benefits derived from an integrated supply chain seem to overcome the latter's implementation obstacles. Moreover, as organisations enter a new era of global competitiveness, e-SCM becomes a tremendous catalyst for achieving and maintaining a competitive advantage by enhancing and fostering operational agility and lower cost structure, product/service differentiation, increased market share and profitability.

The taxonomy of SCM practices identified and analysed in the paper confirms the existence of different e-business strategies amongst companies adopting Web-based solutions to integrate and rationalise their supply chains. However, it is suggested that future research efforts should be directed towards a deeper analysis of the relationships between the relevant variables of SCM evolution. Specifically, further research should be conducted to investigate whether there is coherence between the e-business strategy adopted and the integration mechanisms used across the supply chain. In other words, the alignment between e-business and supply chain management is worth investigating, particularly due to the numerous failures of Internet initiatives and the increasing incorporation of e-business models into business value networks. Further research is also required to identify any potential effects of contingent factors on the lower or higher adoption of e-SCM practices. However, to achieve the latter, large-scale cross-industry and longitudinal research is needed. Finally, studies are also required to measure and provide evidence of the benefits of e-business in SCM practices.

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