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Web Technologies and Supply Chains

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1. Introduction

This chapter is concerned with examining the role of web technologies across the field of supply chains and supply chain management (SCM). Supply chains and SCM are growing concerns for organisations as customers become more demanding, cost reduction is becoming more and more important and supply chains are increasingly complex as globalisation and the use of global partners becomes greater.

Supply chains embrace all those processes involved in creating and delivering products and services. They can be characterised as networks of processes and activities that “perform the function of product development, procurement of material from vendors, the movement of materials between facilities, the manufacture of products, the distribution of finished goods to customers, and after-market support for sustainment” (Mabert & Venkatraman, 1998, p538). The inputs that are used in an organisation’s supply chain may pass through the supply chains of many suppliers or manufacturers on their way to the organisation and outputs from an organisation may pass through many distributors, retailers or customer’s supply chains before it reaches the final customer (Ward & Peppard, 2002). This can be referred to as a supply chain network (SCN). Supply chains and SCNs have become an integral part of an organisation’s strategy. As such, organisations have become increasingly interested in the use of web technologies for strengthening supply chains and improving information sharing, collaboration and the responsiveness of their supply chains.

This chapter will examine the developments in web technology over the last 20 years and more recently the emergence of e-commerce, e-business, mobile commerce and web 2.0. It will explore the application of web technology to supply chains and SCNs, its role in transforming business processes, and in particular for collaboration, integrating business processes and developing visibility and information sharing across SCNs. It will highlight a range of challenges related to the use of web technology for supply chains and supply chain management such as trust, security, social and cultural issues and depersonalisation and the chapter will close by discussing future trends in supply chains and developments in web technologies.

2. Evolution of web technologies

The Internet is one of the latest technologies in a series of developments for communicating and disseminating information. It has become an essential business tool and organisations have been applying tools and technologies based on the Internet and www over the last 15 years. A broad range of creative solutions have emerged which have transformed business

strategies, business models, supply chains and business processes. It is an exciting field that offers many new opportunities but poses many different challenges (Li, 2007).

2.1 Internet & world wide web

The origins of the Internet can be traced back to a military project commissioned by the US Department of Defence in 1969. The project was initially referred to as ARPANET (Advanced Research Projects Agency Network) and was charged with the goal of developing a national communication system for the US military that would maintain communication in the event of a national emergency. The 70s saw the development of the Transmission Control Protocol/Internet Protocol (TCP/IP) which determined how electronic messages are packaged, addressed and sent over the network. This network later became known as the Internet. In the 80s, Internet access was established across the US through the creation of a backbone referred to as NSFNET, by the early 90s the Internet was commercialised and was extended worldwide through lots of interconnected backbones. The Internet experienced explosive growth and by mid-1994, the Internet had connected an estimated two million computers in more than 100 countries. By June 2010 there was estimated to be 1,966, 514, 816 people using the Internet around the world with a global Internet penetration rate of 28.7% (Internet World Statistics, 2010).

Essentially the Internet is a network of networks belonging to educational, commercial and governmental organisations and Internet Service Providers. The Internet reaches people worldwide, it is very cost effective to access and it is underpinned by a large-scale client-server configuration, supporting different operating systems and networks. In particular, the Internet opens up new perspectives for smaller and medium sized organisations as it is more affordable and accessible. One of the main drivers behind the success of the Internet is the World Wide Web (www) which provides a global information sharing architecture that enables a user friendly means of exploring lots of pages of information residing on different computers and networks. The Internet and the www can be readily used for globally communicating and sharing different types of information across organisations and between organisations.

2.2 Intranets and extranets

Increasingly, organisations have been using web technologies for developing internal networks which are limited to employees within the organisations (intranets) and intranets that are extended to authorised people outside the organisation (extranet). Chaffey (2009) summarises the different types of networks succinctly in Figure 1.

An intranet is a private communication system that exists solely within the boundaries of an organization allowing only authorised employee's access. Intranets are commonly used for communicating corporate strategy, corporate policies, PR and communications, announcements/bulletins, corporate documents, staff lists, phone directories, human resource issues, health and safety regulations, training materials etc. Individual departments may have web sites linked to the intranet which can be used for identifying who's who in the department, what's new in the department, departmental products/services, projects the department are involved in and relevant documents and tools. Intranets can be used for communicating on internal supply chain processes and activities and are particularly beneficial for sharing information that is only of value to people that work within the organisation and/or communicating sensitive proprietary information.

Furthermore, organisations are employing web technologies for allowing selected users outside the organisation to access parts of the intranet eg suppliers, customers or business partners. Extranets use the Internet to link multiple intranets and provide secure connectivity between corporation's intranets and the intranets of its business partners, materials, suppliers, financial services, government, and customers (Turban et al, 2010). Extranets can be used for supporting supply chain management and activities involving external partners such as procuring materials from suppliers, processing orders and delivering customer service. Dell Computers provide access to their extranet to suppliers and customers alike. Demand forecasting is shared with suppliers whilst customers can use the extranet for entering orders, monitoring the progression of deliveries and accessing customer support and sales reps provide customised presentations about products to business customers. Customers, suppliers and employees of Boeing use an extranet to do everything from perusing company maps to ordering plane parts.

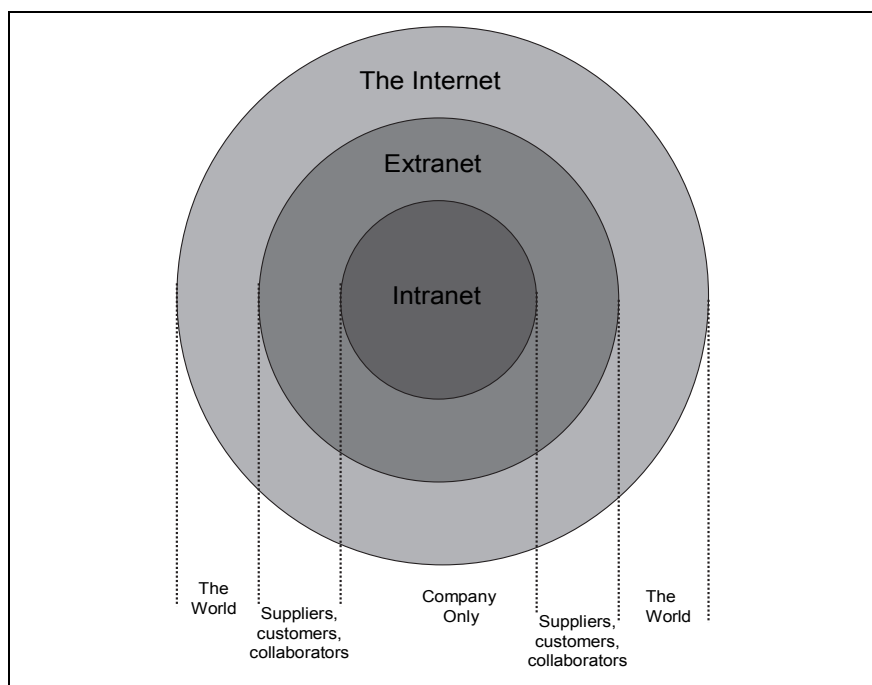


Fig. 1. Relationship between intranets, extranets and the Internet, Source: Chaffey (2010)

Moreover, there are many tools and technologies that have been developed with internet technology as the supporting platform which further enhance communication and provision of information. These include applications such as electronic mail, search engines, portals, collaborative tools, electronic data interchange (EDI), database management systems (DBMS), enterprise resource planning (ERP) systems, supply chain management systems, geographical information systems (GIS), radio frequency identification (RFID) tags, wireless and mobile technologies and more recently, web 2.0 technologies. Some of these will be expanded upon in the following sections.

2.3 Electronic Data Interchange

Electronic Data Interchange (EDI) has been used extensively for inter-organisational transactions and has actually been around since the 70s. EDI was originally used on secure private networks such as Value Added Networks (VANs).

EDI involves the electronic exchange of structured business documents in a standard format between trading partners. It has had many applications and has been used to share documents such as invoices, orders, products specifications and bill of lading between organisations. It is used extensively within many industries including automobile, consumer goods, transport, retail, chemicals, electronics and health. Supermarkets have used it to order goods to restock shelves and car manufacturers have used it to invoice dealerships.

More recently, though, organisations have started to use the Internet as a channel for EDI as it can be implemented at lower costs. The Internet also supports and enhances EDI in a number of additional ways including the ability to send e-mails with EDI, enabling direct input of information from internet pages and being able to map the contents of an EDI message to an Internet site. This is particularly useful for smaller to medium sized organisations in the supply chain.

2.4 Enterprise Resource Planning Systems

Enterprise Resource Planning Systems (ERP) were first introduced in the 90s as a follow up to the Materials Requirements Planning systems and Manufacturing Resource Planning systems. ERP systems are multi-application systems that automate and integrate various business operations of an organisation eg ordering, manufacturing, finance, distribution. A database management system lies at the core of the ERP system, collating data from one business process of an organisation and sharing it with another business operation. The ERP system is normally made up of areas such as: sales and marketing; materials management; production planning; quality management; engineering; human resources; finance & accounting and; customer relationship management.

There are many advantages associated with ERP systems including their capacity to integrate business processes, provide access to real time data, reduce duplication of data, ensure better accuracy and enforce consistent practices across the entire organisations. There are many key vendors including companies such as Microsoft, SAP, Baan, PeopleSoft and Oracle. As well as generic ERP systems being available there are also industry specific solutions eg airline management, banking, healthcare.

ERP systems have also been greatly influenced by developments in the web. ERP vendors have worked to stay abreast of technology and developed their products to make them compatible with the web and make all front end and back end applications available via the web. In addition, organisations are increasingly providing suppliers and customers within their SCN with access to their ERP system. This enables them to share important information, collaborate more easily and make more informed decisions that are beneficial to the whole SCN.

2.5 Collaborative tools

There are a variety of collaborative tools and technologies that support communication and working together on activities and tasks across the supply chain and SCN. Collaborative tools can be useful for cooperating, coordinating, solving problems and negotiating.

Groupware is a generic term that describes software solutions that enable groups or teams of people to work together and supports them in activities such as collaborative authoring, managing documents, group meetings & conferencing, and project development. The types of tools that these solutions may embrace are e-mail, bulletin boards, discussion groups, audio and video conferencing, groups calendaring and scheduling, document management

and workflow systems. They can collectively support collaboration within an organisation and between organisations.

For example, audio conferencing (which supports the transmission of audio data) and videoconferencing (which supports the transmission of live video) can be used in conjunction with shared whiteboard applications to allow two or more people to work on an activity collaboratively from different locations.

Workflow management systems allow documents to be routed through organisations and provide facilities for routing forms, assigning tasks and privileges and monitoring tasks. They are regularly used for supporting supply chain processes eg raising a purchase order, submitting a holiday request, processing a customer complaint. These types of systems ensure that information is directed to the relevant person responsible for completing the next business activity and it is completed in a timely fashion.

2.6 Radio Frequency Identification tags

A further technology that is provoking huge interest in the field of supply chains and supply chain management is Radio Frequency Identification tags (RFID). RFID tags support real time tracking of tagged goods throughout SCN. The tags are attached to products and emit signals containing detailed information regarding what the product is, the size of the product, where it was made, when it might perish, the product warranty etc. They can also be used to track a product as it passes through the SCN eg the factory floor, the warehouse, the distribution chain, the retailer and then at point of sale.

There are many strategic benefits for managing a supply chain including not only the ability to track the products, but also to monitor sales more closely, maintain appropriate levels of stock, reduce the level of stolen goods and enable organisations to launch product recalls more easily. Product recalls are something that particularly affects food manufacturers and pharmaceutical industries and RFID technologies provide them with the ability to withdraw specific batches of products from different parts of the world at a moment's notice.

There are many potential opportunities for using RFID tags for improving supply chain visibility and information sharing. They could provide a huge amount of intelligence and lead to significant developments in supply chain processes. The main factors that have held back the adoption of RFID tags to date have been the price of tags, hardware and IT infrastructure and physics related issues. Once these factors are overcome, further applications are likely to be initiated in other industries. In the retail industry, in particular, RFID technologies are increasingly used across SCN. There are people however, who consider RFID technologies to be an infringement of privacy.

2.7 Wireless & mobile technologies

Wireless networks have emerged more recently as a very flexible method of connecting to the Internet e.g. wireless WANs, wireless LANs, wireless PANs using technologies such as WiFi and Bluetooth which essentially means that people can access the Internet using a network which is not physically wired. Alongside developments in wireless networks, there have been an increasing number of different mobile devices becoming available ranging from mobile phones, smartphones, personal digital assistants (PDAs) laptop, ipods to ipads. A term often associated with mobile internet access is Wireless Application Protocol or WAP phones. They enable people to access information on web sites which has been specifically tailored using Wireless Markup language for display on the screen of mobile phones.

Wireless internet access and mobile devices provide easy access to the Internet, www, intranets, extranets and specific tools and applications. They are extremely popular due to the flexibility and freedom they offer. Employees can communicate from many more different places at convenient times eg employees can work from different locations, salespeople can access company systems when they are at customer premises. They also offer great potential for reaching customers as is evident from research by Wireless Intelligence (2008) which found that by the end of 2007 there were 2 billion subscriber connections (representing half the planets population). Also, mobile phone tracking allows the position of a mobile phone to be tracked even when a user is not on a call. This can benefit organisations who can market products to customers when they are on the move and within the locality of their business. On the downside, the channel capacity in wireless networks can be lower and issues such as security can be exacerbated.

2.8 Richer media

More recently a range of internet applications have been developed that provide a richer interactive experience. Key applications include Aysnchronous Javascript XML (AJAX) and Application Programming Interface (API). AJAX provides a method for exchanging data asynchronously between browser and server and avoids full page reloads every time a web page changes. This creates an impression of it being a richer application and also a more responsive interface. This can be beneficial for enhancing communication with suppliers and customers using applications on the Internet.

API similarly can improve communication by enabling greater interaction and sharing of content between different software. For example a company could display a video on a social networking site of their products and services or a price comparison site can use API to aggregate price data from different web sites in real time.

2.9 Web 2.0 technologies

The most recent wave of web technologies to be adopted across supply chains are recognised as web 2.0 technologies. Web 2.0 is about a shift from users being passively reading information on the web to becoming actively involved in collaborating and participating on the web. Web 2.0 is interchangeably referred to as 'social media', 'social revolution', 'user-generated content', 'collaboration' and 'community engagement'.

Web 2.0 was developed over the last ten years to encapsulate the rapid uptake in the web and associated technologies and applications, following the bursting of the dot.com bubble in the year 2000 (Sheun, 2008). Web 2.0 is also driven by the business revolution in the computer industry caused by the increasing move to the Internet as a platform but also through an attempt to understand the rules for success on that new platform (O'Reilly, 2005). The thrust behind web 2.0 is on "building applications and services around the unique features of the Internet, as opposed to building applications and expecting the Internet to suit as a platform" (Wikipedia, 2008). A range of services, technologies and applications commonly associated with web 2.0 are blogs, wikis, podcasts, RSS feeds, social networking, forums, multimedia sharing services, tagging and social bookmarking, text messaging and instant messaging.

Web 2.0 is about sharing information through linkages with people. It builds on the concepts of collaboration, contribution and community and thrives on openness and relationship building. Nations (2009) highlights that web 2.0 is a social web, with people

connecting with other people. It supports a more socially connected society and builds on characteristics such as openness, participation, cooperation, community and collaboration. Web 2.0 necessitates a shift in the philosophy of society to one where we aren’t just using the Internet as a tool – but we are becoming part of it.

There are a number of areas that web tools and technologies can be used to enhance supply chain communication. The types of supply chain activities that web 2.0 may be particularly beneficial to include activities such as marketing and advertising; collaborating and strengthening relationships with customers and suppliers, information and knowledge transfer; delivering added value to products and services; networking and research. Examples of specific supply chain applications are provided in Table 1.

Web 2.0 Tool	Example of Supply Chain Application
Blog	Blogs can be used for internal and external communication. For example, they can be used for delivering news on business developments, showcasing products and services, sharing expert advice, opinions and frequently asked questions (FAQ), gathering customer feedback and building a loyal customer base.
Wiki	Wikis can support organisations in document sharing and collaboration and for encouraging communication, knowledge transfer and collective intelligence amongst people involved in supply chain.
Forum/Discussion Board	Forums or discussion boards can be used to make business connections, share information, exchange views and seek advice on business-related matters where companies may lack the expertise.
Really Simple Syndication (RSS) Feed	RSS make it more efficient for organisations/people to check for new content on the web. As new content appears on relevant internal and external websites, the user is updated and the information is delivered. This is useful for market research and information/knowledge transfer.
Social Networking	Social Networking sites are particularly useful for organisations advertng products, providing links to company websites, increasing brand awareness, gathering customer feedback on advertised products and building a loyal customer base.
Multimedia Sharing	Multimedia sharing tools and technologies may be used for sharing audio, photos, videos, presentations and documentations. In particular organisations use them for showcasing their products and services or sharing images and videos of best practice across the supply chain.
Tagging & Social Bookmarking	Tagging and social bookmarking can provide organisations with a means for categorising, classifying and bookmarking content and valuable information on the web. These collectively could support gathering business intelligence and undertaking market research.

Table 1. Web 2.0 Tools & Supply Chain Applications

Web technologies have evolved greatly over the last 20 years. Key advantages of web 2.0 applications lie in the potential they offer for establishing more interactive and participative business connections and collaborations. They can be used to build communities based on interest, purpose or practice between business partners, regardless of location. They also offer greater opportunities for customer-centricity as customers are encouraged to openly feedback and share thoughts, experiences and ideas (Wagner & Majchrzak, 2007).

3. E-commerce, E-business & M-commerce

Web technologies have been increasingly applied across organisations over the last 20 years. The first wave of web technologies to be applied across the field of supply chain management has been commonly referred to as e-commerce. Amazon was one of the first companies in 1994 to embrace and take e-commerce forward. e-commerce involves supporting transactions and buying and selling products and services via the Internet (Jelassi & Enders, 2005). The buying and selling can involve a range of processes such as sales, ordering, billing, payment and distribution.

The 90s saw a huge rise in the number of dot.coms appearing on the Internet. However, excess supply and artificially inflated market sizes and revenues led to the dot.com crash of 2000 when many new internet-based firms went out of business. In the period following, organisations realised they needed to return to business fundamentals and craft sustainable business models and concentrate on increasing efficiencies and reducing costs. Many organisations also realised that they could not concentrate on only making front end processes available online and that they had to integrate them with the backend processes, in order to reap the full benefits.

The second wave of web technologies to be applied across the field of supply chain management was entitled e-business. This can be construed as much more than e-commerce. e-business involves the use of the Internet for all the front end and back end applications and processes that enable a company to service a business transaction (Kalakota & Robinson, 2000). This could involve many activities such as channel management, manufacturing, inventory control and financial operations. e-commerce falls under the umbrella of e-business along with the range of processes that make up the entire supply chain.

More recently, a further type of commerce to be widely recognised is m-commerce which is the use of wireless and mobile technologies for undertaking buying and selling on the Internet. This has become particularly popular due to its flexibility and availability. In fact, in some countries the majority of internet access is through mobile phones and m-commerce can be used for information and monetary transactions.

Table II provides examples of different types of online interactions that may typically occur as a consequence of e-commerce, e-business and m-commerce. These may involve business-to-consumer, consumer-to-business, business-to-business and consumer-to-consumer.

There are some companies that exist purely on the Internet (eg Last minute.com), some that use it as an addition to their core business (eg tesco.com) and others that began online but have expanded to incorporate aspects of real world assets (eg Amazon). Nowadays, most traditional businesses have some aspects of e-commerce or e-business eg. online retailing, online ticketing, online banking.

Type of Interaction	Example of Use
Business-to-Consumer	Online catalogues & prices Order processing eg Amazon Online customer service Brand awareness eg. Coco Cola
Consumer-to-Business	Customer Feedback on advertisements eg Irn Bru Selling products/services to organisations eg Priceline.com
Business-to-Business	Electronic Procurement eg Tesco Collaboration e.g product development B2B Marketplace Inventory Management eg. sharing forecasts
Consumer-to-Consumer	Virtual Community Product Recommendations Customers transacting directly Auctions eg eBay Social Networking Sites

Table 2. Different Types of Online Interactions supported by E-commerce, E-business & M-commerce

There are many drivers of e-commerce, e-business and m-commerce. Amongst these are the substantial cost savings that can be achieved through reducing purchasing, sales and operating costs and the efficiencies that can be gained and the speed at which orders can be now be fulfilled. Also, many organisations need to pursue online trading in order to remain competitive. They are under pressure to meet customer demand (many customer expect online availability 24/7), they can use web technologies to enhance their product and service offerings and stay abreast of developments in their marketplace. A key aspect of organisations that is being developed as a result of e-commerce, e-business and m-commerce are supply chain processes. The next section will explore supply chain processes and the impact the web technologies are having on supply chain processes.

4. Web technologies & supply chain processes

One of the main components of an organisation’s supply chain are supply chain processes. Bozarth and Handfield (2008) describe supply chain processes as being made up of a logically related sets of tasks or activities geared towards some kind of business outcome and Hammer (2002) indicates that these related activities work together to create a result of value to customers.

Supply chain processes can be categorised as primary, support or developmental supply chain processes. Primary supply chain processes add value directly to the product or service eg manufacturing, customer service. Whilst support supply chain processes don’t directly add value to the end product or service, they are necessary for supporting the primary supply chain processes eg human resource management. Finally, the development supply chain processes aim to improve and enhance primary and support processes eg market research.

Supply chain processes can vary substantially in terms of scale and scope. The scale of the supply chain process can range from being a very simple set of tasks to being a very

complex related set of activities. Equally the scope of the supply chain process may involve one department within an organisation or it may involve a range of organisations such as suppliers, manufacturers and customers. It is important for an organisation to identify and focus on its key supply chain processes as they will have the biggest influence on the overall supply chain. In particular, the Global Supply Chain Forum identified eight key supply chain processes that make up the core of a typical manufacturing company. These included: customer relationship management; customer service management; demand management; order fulfilment; manufacturing management; procurement; product development and commercialization; and returns. However depending on the nature of the organisation and the type of industry that the organisation operates in, the key supply chain processes may vary.

The accomplishment of core supply chain processes majorly influences the performance of the overall supply chain. Consequently, organisations have been seeking ways to improve or transform these supply chain processes in terms of: productivity; efficiency; customer satisfaction; cycle time; cost; quality; speed; flexibility and competitive advantage. Business improvement methodologies such as Six Sigma Methodology have been employed whilst other organisations have pursued more radical redesign of business processes using Business Process Reengineering.

Technologies have played a major role in the development and transformation of supply chain processes in recent years. The proliferation of the new telecommunications and IT such as the client/server concept, the Internet, intranets and the www has led to the automation and the integration of many supply chain processes and has made real time on-line communication throughout the supply chain a reality.

Cagliano, Caniato and Spina (2003) placed the adoption of web technologies across supply chain processes into three main categories including: e-commerce (sales, customer service & support); e-procurement (purchasing activities); e-operations (order processing, tracking, production planning & scheduling, inventory management, transportation planning). Early adopters focused on e-commerce initially. This tended to be followed by e-procurement and more recently e-operations. The following sections provide examples of the application of web technologies across specific supply chain processes.

4.1 E-Procurement

Procurement broadly entails a company's requisitioning, purchasing, transportation, warehousing and in bound-receiving process. More specifically purchasing can involve: identifying user need for a product; evaluating potential suppliers; bidding, negotiating and selecting suppliers; approving purchases; releasing and receiving purchase requirements; and measuring supplier performance.

E-Procurement essentially involves the application of web technologies to the procurement activities of an organisation. Typically this will involve technologies such as ERP systems, stock control systems, e-catalogues, e-mail, EDI, document management software, workflow systems and accounting systems. There have been many drivers for e-procurement including uncontrolled spending, the processes being very time consuming, costs far too high and organisations using too many suppliers.

The potential impact of e-procurement on competitiveness and profitability is huge as business to business procurement can involve one of the largest costs for an organisation. Some organisations spend 50 to 60 percent of their revenue on buying goods and services.

There are many benefits associated with e-procurement such as cost reduction, reduced inventory levels, improved cycle time, enhanced strategic sourcing and corporate-wide purchasing reporting.

Many companies recognise these benefits and have developed procurement systems. Motorola, for example, developed a procurement system based around an ARIBA web based procurement system and linked to an their oracle financial system, signature authorisation tool, workflow system, EDI and e-mail. The procurement system handled everything from the requisition stage through to the payment stage. The system has streamlined and speeded up the whole process, provided transparency, allowed more controlled spending and made substantial cost savings.

4.2 Inventory management

A further supply chain process that is being developed through web technology is inventory management. Inventory management can be described as “stock or items used to support production (raw materials and work-in-process items) supporting activities (maintenance, repair) and customer service (finished goods and spare parts)” (Bozarth & Handfield, 2008). Inventory is an extremely valuable resource to organisations and the levels of inventory within their cycle stock, safety stock, transportation inventory, smoothing inventory and other types of inventory have to be well managed. Material Requirements Planning is a business planning techniques that was introduced into manufacturing companies in the early 60s for managing inventory and scheduling replenishment orders. This was superseded by Materials Requirements Planning (MRPII) in the 1980s which moved towards having one integrated system containing a database that could be accessed by different parts of the company. ERP systems went one stage further by better integrating and organising all the information on which planning and control depended upon and, more recently, as indicated earlier in the chapter, web ERP systems have emerged making them more accessible and cheaper. These type of systems in particular play a big role in allowing the exchange of inventory information between organisations and within organisations.

Organisations such as Sun Microsystems use ERP systems to share inventory information across their supply chain and SCN. This includes information such as their forecasted demand, customer orders, production schedules, current inventory levels and bill of materials.

4.3 Transportation management

Transportation management is also being developed through the use of web technology. An early legendary extranet transportation application was Federal Express's shipment tracking service. Fedex is the largest express transportation company in the world and were one of the first companies to make their intranet system accessible to customers for arranging delivery of goods and tracking the progress of goods to their destination. The FedEx site allows customers to log on, type in their package tracking number and view the relevant delivery information.

Coupled with this many organisations are using RFID technology for monitoring the transportation of goods and giving them an up-to-date picture of all 'goods in transit'. Moreover, Geographical Information Systems (GIS) can be used to determine transportation routes, likely weather conditions and a more accurate expected delivery time.

4.4 Customer relationship management

Customers are becoming more and more demanding. There is a greater choice of products and services readily available to them and there is a greater expectation for them to be more personalised. Organisations recognise that they need to take a more cohesive approach to customer relationship management in order to build and sustain long term business with customers, address individual requirements and maintain customer loyalty.

Many web tools can be used for developing customer relationship management. Initially, marketing tools such as e-mail, viral marketing, banner advertising and affiliate networks can be used for acquiring customers. Online customer registration can be set up to create a customer profile and the information used in the future for developing the relationship with the customer. Customer relationships can be developed by providing them with personalised portals that highlight information that they may find useful and allows them access to selected applications and tools. Customer actions can also be tracked (eg enquiries, orders, complaints) and stored in company databases, and analysed to determine customer buying or behavioural trends. Companies can use this information to help them better understand their customers and market their products better. An effective customer relationship management system will provide a 360 degree view of the customer eg content of interactions, frequency of interactions, responses.

One company that has led the way in terms of customer relationship management has been Amazon. Amazon is primarily an online retailer which began through selling books but has now expanded into a huge range of products and services. Paramount to Amazon's success has been employing web technologies and achieving customer loyalty and repeat purchases. Using web technologies, the company provides a secure ordering and payment system, manages and assigns inventory to customer orders, provides fast and reliable fulfilment, ensures proper shipments and provides on-line tracking. The companies web pages are tailored to individual preferences for a personalised service and contain product information, customer reviews, recommendation lists etc. The company uses different tools for analysing the popularity of products and the suitability of web page design.

5. Internet-based industry consortiums

A number of industry consortiums have also being using web technologies to set up joint business platforms or electronic marketplaces that support inter-organisational supply chain processes. The electronic marketplaces make the exchange of information between the different organisations involved in the supply chain more fluid and aim to improve the efficiency of the overall SCN in the relevant industry. Different initiatives have been driven by slightly different concerns in various sectors. A few of these industry initiatives will be highlighted.

DaimlerChrysler, Ford Motor Company and General Motors led such an initiative in the car industry. They were involved in establishing Covisint which is based on ANX (Automotive Network Exchange). It is a central hub where the manufacturers and suppliers can do business on a single, secure, global business environment and provides a suite of tools including procurement (catalogues, auctions etc), collaboration, sharing design data, quality and portal facilities (Covisint, 2010). One of its major goals was to develop a highly secure and reliable extranet that members could exchange large volumes of design data.

In the consumer-goods sector, Collaborative Planning Forecasting and Replenishment (CPFR) is an initiative between consumer-package goods manufacturers and the retailers that sell their products. The aim of this initiative is to integrate demand and supply side processes to improve efficiencies, increase sales, reduce fixed assets and working capital, and reduce inventory for the entire supply chain whilst satisfying customer needs (CPFR, 2011). Participants have included organizations such as Wal-Mart, Procter & Gamble, Gillette, Nestle etc. This internet-based industry consortium has been used for sharing inventory data, forecasts and ordering information.

A further initiative that will be mentioned is Rosettanet, part of the high technology and electronics industry. It includes major Information Technology, Electronic Components, Semiconductor Manufacturing and Telecommunications companies working towards creating and implementing industry-wide, open e-business process standards (Rosettanet, 2010). It provides a global forum for supplier, customers and competitors to work together on reducing cycle times, inventory costs, improving productivity and measuring supply chain ROI. For example, it is used to automatically update manufacturer's product information on online catalogues.

All of these specific industry consortiums support and enhance business to business transactions. The next section will explore how the spectrum, of web technologies can potentially transform supply chains.

6. Supply chain transformation

Web technology is being used for developing and in many cases transforming supply chains and SCN. Key areas which are being enhanced include building stronger collaborative links between organisations, providing a platform for integrating internal and external supply chain processes and enabling visibility and real time information sharing. These key developments can enhance product and service offerings and a organisation's competitive position.

6.1 Collaboration

A variety of forces have led to a greater need for stronger collaboration between organisations within SCN. Customers are demanding faster, more specialised responses and organisations need to work more closely together in order to streamline and improve the efficiency of the SCN and be more effective in matching demand with a suitable level of supply.

Lambert et al (1996) suggest that there are different degrees of collaborative relationships among supply network members ranging from arm's length relationships, partnerships to vertical integration. Partnerships are becoming increasingly common for strengthening collaboration across supply networks. They involve a degree of joint planning, joint commitment, mutual trust, openness, shared risk, shared rewards, information exchange, operating controls across organisations and corporate culture bridge-building (Cooper et al, 1997). Partnering provides a way of strengthening supply network integration, exploiting unique expertise of each partner, taking advantage of profit making opportunities and providing sustainable competitive advantage that will enable them to 'lock out' competitors (Lambert, Emmelhainz & Gardiner, 1996).

The duration, breadth, strength and closeness of partnerships will vary between supply network members and probably over time. Factors that will affect the degree of partnership

that should be established with other supply network members are whether or not they will be involved with the supply members on a long term or short term time basis, whether or not they are core to the functioning of the organisation and whether or not they contribute to the strategic outcomes of the organisation.

Web technologies have provided many opportunities for widening the scope of inter-organisational and intra-organisational relationships. They offer the flexibility for establishing new collaborations with different suppliers, customers, logistic providers and partners and different tiers of suppliers and customers. For example, organisations can now interact with globally dispersed suppliers that were not possible before due to logistical and practical reasons and organisations can provide electronic customer service and support to medium and smaller sized organisations that it was either too costly or impractical to service in the past face to face. Moreover, organisations can more easily pursue on-line interactions with suppliers and customers that are not in adjacent tiers in the supply network. For example, organisations may collaborate with suppliers a couple of tiers removed on supply chain management issues such as demand replenishment for particular products or the design of a specific product. Furthermore, some organisations are cutting out a couple of tiers completely between them and their end consumers and conducting sales, marketing and customer service and support directly.

There are also opportunities for using web technologies to enable globally dispersed people to collaborate on particular supply chain activities. For example, Testing Engineers within the UK division of Sun Microsystems can now collaborate electronically with Testing Engineers in the USA. In the past these employees may have communicated occasionally on the phone but now they can actually benefit from the advantage of being able to establish and develop a formalised virtual team. This allows organisations to leverage a greater pool of knowledge and develop higher quality products or service. On-line collaboration allows greater flexibility for establishing relationships, interacting and pooling resources.

6.2 Integration

The overall aim of supply chain management is to create value for end customers and organisations in the SCN. In order to accomplish this, organisations need to consider integrating supply chain processes internally and externally with other organisations in the SCN.

Technology can be used to improve the efficiency of individual processes but often the real costs savings are achieved through integrating different processes together. Process integration can reduce customer lead times, reduce inventory, speed of decision making and transactions in ways that are not feasible through focusing on individual process. Currently, the primary enabler of supply chain integration is the Internet which enables many different systems, tools and technologies to be fully integrated into a common network. ERP systems, SCM systems, EDI systems, financial systems, procurement systems, customer service and support systems, document management systems, decision support tools, project management tools and database management systems can be integrated and information can be shared between the different systems.

Integration should begin with internal processes (front and back end supply chain processes) and then extended externally to customers and suppliers. Initially external integration should begin with first tier supplier and customers or critical trading partners but over time this can be extended to 2nd and 3rd tier suppliers and customers and in some

case organisations may even support a degree of integration between suppliers and customers. Integration will allow employees to better coordinate supply chain activities and share information and resources. The impact that a decision in one part of the supply chain can have on another part of the supply chain will become much more visible and transparent.

6.3 Visibility & information sharing

Web technologies provide greater opportunities for supporting visibility and real time information sharing within and between organisations in the SCN. This will provide decision makers up and down the SCN with greater information and more detail regarding the operations of the overall SCN and enable them to make more informed decision.

Within an organisation, internal information sharing allows manufacturing departments to draw up capacity plans using order planning information, the procurement department to determine purchase orders using order fulfilment information and inventory level information and customer service can use information from order fulfilment when providing appropriate levels of support to their customers.

Organisations can provide their suppliers with improved information flows containing product updates, online scorecards or detailed materials planning information, enabling suppliers to improve their own inventory management and material flows and thus improve relationships between the two organisations. Organisations are also receiving greater information from customers allowing them to have a better understanding of customer requirements, a greater planning awareness and again improved inventory management. Moreover, customers can also benefit from being better informed with information on the status of their orders, promised delivery dates, invoice totals, return notifications, product updates, software distribution etc. These types of benefits will improve relationships with customers and make them more likely to buy the organisation's products or use their services in the future.

Moreover, portals are increasingly being developed to provide suppliers and customers with tailored facilities, applications, information and resources. Technologies such as cookies, data warehousing, data mining and virtual communities are being used to gather information that will further help organisations to personalise interactions. Personalisation is likely to provide the supply network members with a stronger affinity with the organisation and will potentially make other supply network members more likely to demonstrate a reciprocal level of service or commitment to the organisation.

Web technologies provide opportunities for improving supply network collaboration, integration and information sharing. Stronger collaborative supply networks have greater likelihood of leading to more streamlined, coordinated, specialised and effective product or service offerings that will offer more potential for sustainable competitive advantage.

7. Challenges

There are a range of challenges that are directly related to the use of web technologies across supply chains and supply chain management and may potentially affect the impact of web technologies for supporting and building collaborative supply networks. Amongst these challenges is trust, security, social and cultural issues and depersonalisation. Supply chain managers should identify these challenges and take measures to reduce or eliminate them.

7.1 Trust

Trust majorly influences whether or not collaborative partners openly communicate and willingly share information using the web technology. If one party suspects that the other party will take advantage of them or use information against them there is likely to be a reluctance to work together and share information.

Trust is something that generally grows over time and will take time and effort to build up between business partners.

The parties involved need to agree common goals, clear guidelines and monitoring methods and there needs to visibly be clear and equal benefits in collaborating with each other. "Ethical behaviour comes down to business partners setting expectations initially about the relationship and data sharing and then meeting these expectations" (Wisner et al, 2005).

7.2 Identity

There is also concern that widespread use of technology across supply chains may lead to depersonalisation of inter-organisational relationships across the SCN. Regular use of web technology can make it difficult to build cohesive and strong bonds with business partners and consequently trickier to collaborate on activities, integrate business processes, be creative with each other and maintain open communication.

A level of identity and personalisation is crucial for the effective formation and functioning of business partnerships. Identity plays a critical role in developing a level of commitment between the business partners, understanding the meaning and getting the most from the communication that is taking place and enabling the interaction to be more effective.

Research suggests that business partners actively using web technology for communicating should maintain a strong level of identity through periodic face to face interactions, regular communication and periodic social interactions. Stronger bonds with business partners will ensure that partners are more likely to 'go the extra mile' in the future when there are supply chain issues or complexities.

7.3 Security

Supply chains are of critical importance to the success of organisations and by making supply chain processes and key business information available on the web, organisations are making themselves vulnerable. Security is one of the most important issues or challenges affecting supply chains supported by web technology. It is an ongoing concern for all organisations and in particular for those organisations using the Internet for developing inter-organisational linkages. Organisations are sharing a lot of important business information eg payments, client lists, network contacts, finance, orders up and down the SCN.

There are many security threats facing organisations ranging from viruses, phishing, hacking, spam, fraud, identity theft to web vandalism and levels of security are being threatened even further through the uptake in wireless and mobile usage, web 2.0 technology and cloud computing.

Organisations within the supply chain will need to have clear frameworks in place for ensuring a high level of security. Security frameworks are likely to embrace areas such as encryption, authentication, firewalls, regulatory compliance and backup systems. The security frameworks should be well communicated to business partners so that on the one hand they also take appropriate security measures but on the other hand, they have the confidence that inter-organisational networks are secure enough to share business information.

7.4 Social & cultural issues

Furthermore, organisations may actively introduce web technologies into their supply chains and enable or constrain people from communicating regarding supply chain processes and activities in different ways. However, organisations alone, do not determine the actual uptake of the web technologies and the ways in which employees use it e.g. who they communicate with, what information they choose to communicate. Structuration theory proposes that the patterns of communication are not only influenced by the standards and procedures of the organisation but also by the social interpretations of employees (Walsham, 1993). The two influences operate continually and simultaneously to determine the actual uptake of technology. Therefore even if an organisation fully promotes the introduction of web technologies into their supply chains, the actual uptake may be less than anticipated if the contextual environment does not embrace the technologies.

Culture will have an impact on the way that people adopt and use web technologies for supply chain processes and activities. It will influence the way that people tend to communicate verbally and non-verbally and the way that people will perceive things. Although more people are using web technologies there is still a minority who are not as comfortable using the technology and who prefer employing conventional mediums. For this very reason, many customer service and support processes within organisations provide conventional channels such as the telephone as a means of accessing service and support as well as e-business channels. Some people simply perceive the telephone as being more traditional, user-friendly and personal and more suitable when they wanted to talk to someone for encouragement and support.

As well as organisations facing various challenges, there are a number of future developments in supply chains that need to be taken into consideration.

8. Future issues

There are a number of future developments within the field of supply chain management that organisations should be aware of when they are developing web technology across their supply chains and SCN in the future. The Future Supply Chain 2016, published by the Global Commerce together with Capgemini, identifies an array of sustainable parameters that organisations will need to take into account in their future supply chains including areas such as “continuing to delight customers”, “carbon emission”, “urban restrictions”, “sustainability”, “customer satisfaction”, “supply chain performance”, “financial”, “external factors eg price changes”, “information technology”, “visibility”, “working together”, “collaboration”, “transparency” and “networking”. These parameters will have an impact on the design of future supply chains. Issues such as collaboration, networking, working together, visibility and transparency will continue to be at the forefront of competitive and innovative supply chains. Some further issues which are emerging will be discussed, in relations to web technology, under the following headings: globalisation; cost reduction; green issues; technological developments.

8.1 Globalisation

A growing trend in the field of supply chain and supply chain management is globalisation. Organisations are increasingly expanding into new marketplaces, using foreign suppliers, dealing with foreign customers, handling a greater number of tiers of global suppliers and customers and accessing the services of global SCN services. In essence, this means that SCN

are becoming even more complex and difficult to manage. However, web technologies can provide opportunities for supporting the process of globalisation, enabling integration and visibility of information and maintaining communication with global suppliers, customers and logistic providers. The web offers opportunities for maintaining 24 hour communication and service across different parts of the world although online services/systems may need to be tailored to suit different countries to take into account different languages, product requirements, website layout, promotional offers and so on.

8.2 Cost reduction

Organisations will continue to be concerned with reducing their costs across their supply chain as a means of improving profits and gaining significant competitive advantage. Cost reduction will typically revolve around areas such as reducing purchasing costs, reducing inventories across the supply chain, reducing waste, improving the efficiencies of business processes and outsourcing business processes that are not regarded as core competences. Web technology will have a big role to play in all of these areas. For example, web technology can enable greater collaboration, integration and visibility of information, which will enable organisations to capture real time inventory data and reduce the levels of stock that need to be maintained. This will in turn reduce warehousing costs and the danger of obsolete products.

8.3 Green issues

There are a range of green issues that have become extremely topical in recent years including being 'environmentally friendly', 'recycling', 'conservation' and 'reducing carbon emission'. Supply chains are increasingly being seen as part of organisations' environmental solutions. Customers are demanding to know where products have come from, how they are made and how they are distributed.

Organisations are under pressure to develop green supply chain programmes and improve environmental standards across different processes such as procurement, engineering, distribution and manufacturing. Organisations are increasingly designing products that can be recycled. For example, Kodak take back and recycle 85% of the parts in their single use cameras. Web technology can support green initiatives in a number of ways: allow organisations to more readily use substitute suppliers that are more environmentally friendly; increase automation of supply chains thus reducing the level of paper used and; support the monitoring and recycling of different product parts.

8.4 Technological developments

Many people are already starting to ask what the future web trends will be and how they will impact organisations. There are a number of key concepts that look promising with regards to the web and are gaining a large amount of interest.

Firstly, the semantic web is being developed in order for computers to be able to understand the underlying 'meaning' of data and to relate and compile information without any human intervention. This will allow computers to make inferences and solve problems and it is anticipated that the technology could be extensively used in areas such as business intelligence. This could have potential application in supply chains and supply chain management and could be used in business processes such as research and innovation and customer relationship management.

Another area under development is the use of more high-powered graphics. Already virtual worlds have emerged (eg second life) and it is likely that 3D graphics will be integrated as part of the web. This could provide organisations with the capability to display documents, including the links between them, in three dimensions and could be useful when working on a business activity or task. High powered graphics could also enhance the richness of communication with customers and suppliers by adding a high degree of visualisation and sophistication.

Organisations need to remain technologically aware and be continually searching for new and innovative supply chain applications.

9. Conclusion

This chapter has covered a range of issues associated with the application of web technologies to supply chains. The chapter began with an account of the evolution of web technology since the Internet began through a military project commissioned by the US Department of Defence in 1969. The Internet developed dramatically since commercialisation in the early 90s and has given rise to the proliferation of intranets and extranets and supports technologies such as EDI, ERP, collaborative tools and RFID. Mobile and wireless technologies have enabled easier access to the Internet and current web developments such as richer internet applications and web 2.0 have lead to greater interaction, collaboration and participation on the web.

The chapter then explored ways in which the Internet has been applied across businesses in terms of e-commerce, e-business and m-commerce and across key supply chain processes that make up the overall supply chains. Examples were provided such as inventory management, customer relationship management and transportation. More revolutionary is the fact that web technologies are being used for enhancing and transforming supply chains through building stronger collaborative links, integrating internal and external supply chain processes, supply chain visibility and real time information exchange.

There are many challenges that may hamper the use of web technologies across supply chains such as trust, identity, security and social and cultural challenges and finally, there are a number of future developments such as globalisation, cost reduction, green issues and further technological developments that must be taken into account.

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Over the past few decades the rapid spread of information and knowledge, the increasing expectations of customers and stakeholders, intensified competition, and searching for superior performance and low costs at the same time have made supply chain a critical management area. Since supply chain is the network of organizations that are involved in moving materials, documents and information through on their journey from initial suppliers to final customers, it encompasses a number of key flows: physical flow of materials, flows of information, and tangible and intangible resources which enable supply chain members to operate effectively. This book gives an up-to-date view of supply chain, emphasizing current trends and developments in the area of supply chain management.

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