

FOUNDATIONS OF E-SUPPLY CHAINS

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ABSTRACT

The rise of the Internet has enabled information driven E-supply chains that possess unique properties, which are critical in the global economies of tomorrow. The establishment of an e-supply chain requires universal supply chain visibility, which in turn can only be achieved through integration of the information systems of all supply chain partners. Greater value can be derived by harnessing this visibility in the development of supply chain automation and planning tools that will increase productivity, flexibility and responsiveness of the E-supply chain. Some of the solutions that will increasingly form part of these e-supply chains include electronic marketplaces, collaborative exchanges and B2B process controllers. E-supply chains will also be increasingly customer-centric and will promote outsourcing of non-core activities in the chain.

1. INTRODUCTION

The prolific growth of the Internet has completely transformed the nature of businesses and the manner in which they compete. Not only have new business models emerged but more importantly traditional businesses have benefited from a new lease of life afforded by the automation of their existing processes and the transformation of their existing supply chain relationships into computer mediated collaboration in e-supply chains.

E-supply chains have materialized from the application of Internet technologies in the management of supply chain interactions. Particularly, the fundamental enabler for well-managed e-supply chains is ubiquitous visibility, to all supply chain participants, of information pertaining to their supply chains. This visibility is only possible if the enterprise systems of all supply chain partners are integrated to share information in real-time, either through direct integration between the systems or through electronic marketplaces that centralize supply chain data and transactions. Various applications and business processes such as make-to-order, CPFR and VMI can be defined on this ubiquitous information backbone.

In this paper we attempt to decompose a typical e-supply chain in terms of its basic building blocks. We begin by describing the increasingly global nature of supply

chains so as to put our understanding of e-supply chains into context. This is followed by a discussion on the various constituents of an e-supply chain namely information hubs, electronic marketplaces, extended supply chain planning and B2B process automation tools. Subsequently, we shall also look at some of the emerging trends impacting e-supply chains. We hope that such a presentation would enable readers to identify the various areas of interest and the issues in the supply chains of tomorrow.

2. GLOBAL SUPPLY CHAINS

Supply chains today are increasingly dispersed and global in nature. No single company takes responsibility for all the activities in the supply chain. In fact, there is a tendency for companies, to focus on their core competencies and partner with other companies having complimentary strengths while fulfilling the complete needs of the customer, giving rise to an integrated supply chain network. An integrated supply chain network is a group of independent companies, often located in different countries, forming a strategic alliance with the common goal of designing, manufacturing, and delivering right-quality products to customer groups faster than other alliance groups and vertically integrated firms. The structure of an integrated supply chain network held together by a logistics and information network is given below in Figure 1. Such an integrated supply chain provides the basis for application of various information technologies that transform it into e-supply chains.

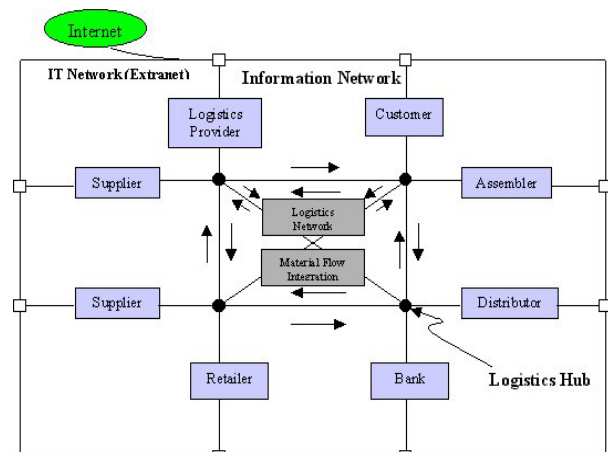


Figure 1: Integrated Supply Chain Network

Such networks are common in the energy, automobile, pharmaceutical, aerospace, electronics, computer, food, and apparel industry sectors. In global manufacturing of this kind, components may be sourced from several countries, assembled in yet another country, and distributed to the customers all over the world. These networks are not generally under single ownership but are group formations of independent companies in alliance for a specific and special purpose. They compete with similar cooperating networks. A well-designed logistics network provides streamlined material flow between all partners, cutting down the lead-time and cost of moving the raw materials, subassemblies, and finished goods to their destinations. A typical customer order triggers several B2B and B2C logistical operations. An extranet, a secure and reliable communications network linking all the companies of the enterprise, provides the information integration. By providing the right information at the right time to all the stakeholders, the extranet enables efficient logistics and effective decision-making. This integration will reduce the inventory levels and also the cost of delivery. Essentially information substitutes inventory. In other words, if one knows when his / her order is scheduled on the assembly plant and on the transport carrier, then the need for inventory and safety stock is reduced.

The Internet has fuelled the growth of E-commerce and has revolutionized the so-called front-end systems of order placement, sales, and marketing. Fast and easy ordering of customized goods over the web has raised the expectations of fast, reliable and convenient delivery among consumers. This story of great expectations is repeated in the world of Business-to-Business e-commerce as well. Manufacturers now take ownership of components only when they enter the factory floor and expect the suppliers to own the inventory until then.

As the Internet and e-commerce has evolved, from the likes of Amazon.com and B2B procurement to i2 trade matrix and a B2B marketplace focus, so too has the need for back-end fulfilment and logistics capabilities as companies struggle to get products to market. In our view, all successful companies in future will be logistics companies. Companies must not only be able to design and market products, they also must be able to source its components, build it, move it, store it, pay for its manufacture and deliver it to the market — on time and at a competitive price and collect the cash. Thus, logistics becomes an integral and critical part of businesses. It needs to be embedded in all phases of manufacturing from product design (design for logistics) to order fulfilment and installation and service.

3. E-SUPPLY CHAIN BUILDING BLOCKS

E-Supply Chains can be designed and studied through a systematic approach, which considers the various levels at which information technology can be applied in a traditional supply chain. As mentioned earlier the fundamental building block of e-supply chains is

visibility. Visibility of information across the supply chain allows supply chain partners to automate some of their inter-organizational processes. For example, if the manufacturer is aware of the inventory levels at the retailer end, he or she may automate the replenishment process when the inventory falls to a certain critical level, as is done in the Vendor Managed Inventory policy. Such inter-organizational workflow automation within the supply chain forms the second block of an e-supply chain. And finally, even greater efficiencies can be harnessed from visibility and workflow automation through integrated planning of activities across the supply chain. Supply chain planning technologies form the third major building block for e-supply chains. We shall discuss these components of an e-supply chain, presented in Figure 2 in greater detail in the following sections.

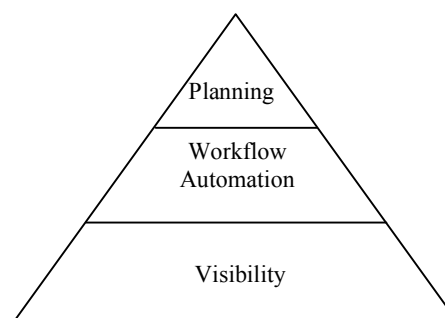


Figure 2. A framework to design and study E-Supply Chains

3.1 Visibility

The communications technologies such as the Internet and wireless, information technologies such as XML, Java, WAP, etc. have made the ubiquitous flow of information seamless. It is now possible that a customer order placed with the retailer centre or on a corporate web-site is now instantly available to the Original Equipment Manufacturers (OEM) and all its suppliers who can then plan and execute their activities so as to meet the unique requirements of that specific customer order. To a certain extent such a scenario was achievable with EDI links between all the supply chain partners as well. However EDI has its drawbacks. They are very expensive to maintain, require dedicated links to be formed between each of the supply chain partners and more importantly relationships cannot be formed dynamically with new partners when the customer requirements demand so.

In the Internet age the shortcomings of EDI have been addressed by the formation of information hubs in the supply chain that have various incarnations in the form of collaborative exchanges, public marketplaces, private marketplaces and independent trading exchanges. Electronic marketplaces are similar to physical marketplaces wherein buyers and sellers gather together to transact in goods, services and information. However, unlike traditional marketplaces, all the interaction between the buyers and sellers takes place in a virtual

environment, through web-based search, negotiation and collaboration tools. By establishing only one integrated link to the electronic marketplace, each of the supply chain partners can be aware of all the information relevant to the supply chain and the market demand and supply.

Two of the main variations that have emerged for electronic marketplaces are public marketplaces and private marketplaces or collaborative exchanges. The importance and usage of both of these is discussed below with the help of scenarios from the logistics industry.

Public marketplaces primarily provide a platform for companies to locate, manage and collaborate with their partners, thereby reducing the effort expended in sourcing for reliable products and suppliers and coordinating with them. The primary focus of the public marketplaces is to reduce the search and transaction costs associated in dealing with sellers or buyers in a fragmented marketplace. Furthermore, the electronic marketplaces catering to specific industries can be integrated together, as shown below in Figure 3, to provide both buyers and sellers access to a range of related services. For example, the vertical exchange shown below could be focused purely on the trading of electronic chips and may rely on the logistics exchange to provide warehousing and fulfilment services for transactions between the buyers and sellers. This exchange may also connect to other related verticals such as that for trading in computer assemblies to act as a conduit for the electronic chips that may be traded on the exchange.

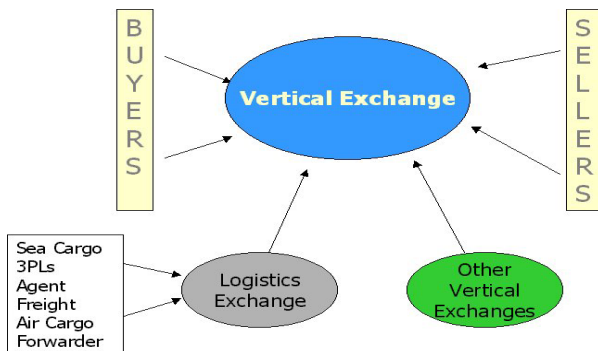


Figure 3: Vertical Exchanges

Private marketplaces on the other hand have a very operational focus, wherein existing relationships between supply chain participants are strengthened through information sharing, so as to synchronize the entire set of activities in the particular supply chain. This is best illustrated by an example as given below for the B2B Logistics value chain.

Most of the large logistics companies currently have software such as warehouse management systems (WMS) and transport management systems (TMS) to manage their warehouses, transportation and other activities. Added to this, the Internet has made possible

quick and easy transfer of information between these systems. As a result the B2B logistics infrastructure process can now be deconstructed and reconstructed as a collaborative marketplace, leading to increased visibility and better decision-making as discussed below.

Consider an international B2B inbound logistics process as given in Figure 4. The activities in the process include: warehousing, freight forwarding, and custom's clearance at seller end, air or sea transport, customs clearance, freight forwarding, and warehousing at buyer end and finally delivery to the buyer. Most of these activities and their associated subsystems are computer controlled using WMS, TMS. The information associated with these facilities is stored in these information systems. Suppose we separate the physical aspects of facilities and products from their informational components. We connect all the informational components by an extranet and provide visibility of capacity, inventory, price and schedule information to all the companies and the shipment details to the customs and the customers. Then the value chain gets reconstructed as a collaborative market place where each partner has information on all the stakeholders and the shipments. Now, a distributor can make sales plans around not just the product in his warehouse, but also on the product waiting for clearance from customs, on the product in the manufacturer's shelves, on the 3PL trucks, etc. The Internet thus enables frictionless B2B commerce and improves the visibility along the B2B delivery process. This enables synchronized scheduling between the suppliers, logistics providers and manufacturers with a consequent reduction in inventory and lead-time.

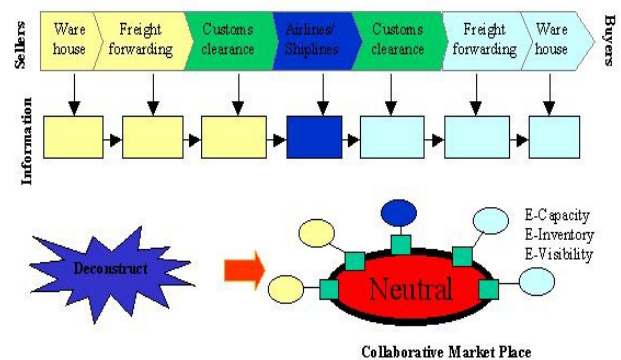


Figure 4: B2B Logistics Value Chain and Collaborative Processes

The key to successful B2B logistics then is collaboration between the clients and the logistics provider, in the form of collaborative transportation management (CTM), collaborative design for fulfilment and collaborative scheduling of logistics activities. These collaborative relationships are just beginning to become popular and will continue to do so through real-time integration between the various logistics providers, private exchanges and independent trading exchanges. Such cooperative relations enabled by technology will

provide sustainable competitive advantages to logistics companies.

Furthermore, when electronic marketplaces will become prevalent at all the various interaction points within the supply chain a marketplace embedded supply chain network may be formed. A typical scenario for a marketplace-embedded supply chain network is shown below in Figure 5.

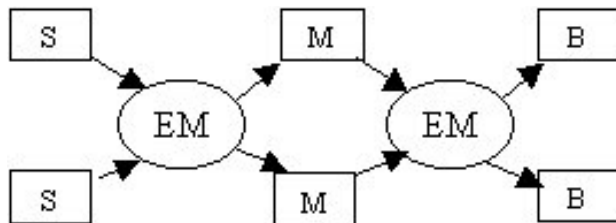


Figure 5: Material flow in a marketplace-embedded supply chain network.

3.2 Supply Chain Workflow Automation

The second major element of E-supply chains is that of supply chain workflow automation tools that build upon the visibility within the supply chain. These workflow automation tools fundamentally automate many of the commonly occurring interactions between companies by harnessing the visibility within the supply chain. As may be expected, some of these applications are also delivered through electronic marketplaces. Some of the commonly deployed supply chain workflow automation applications include available to promise, track-and-trace and vendor managed inventory, electronic procurement and dynamic pricing.

Available-to-promise applications, require complete knowledge of the material availability and unused manufacturing capacity within the supply chain. The process of accessing and processing this information to provide an availability notification can be automated only when there is visibility into the supply chain as shown in Figure 6. Similarly, dynamic pricing applications need to automatically collate information on the supply and demand, which is then passed to the planning engine in order to generate the pricing for each individual order.

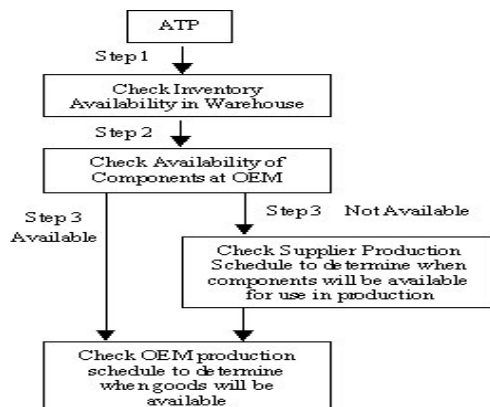


Figure 6: B2B Controller for available-to-promise

Track-and-trace services offered by the logistics companies, process the information on the activities within the fulfilment of a particular item, in order to provide the latest status report on the location and condition of the item. This concept can be further extended to include track and trace of work-in-progress, raw materials and finished goods within the supply chain.

Electronic procurement applications have automated the entire procurement process in many large organizations, removing cost and inefficiencies in the purchasing department, especially in the procurement of indirect materials. Electronic procurement applications incorporate electronic catalogues from a large group of sellers and make interaction with all of them easy and cost-effective through an automated workflow.

Another example of where supply chain visibility is applied to automate supply chain interactions is that of Vendor Managed Inventory, wherein manufacturers can track inventory levels at the retail and distribution centres and automate the process of replenishment to these centres.

Thus the development of applications for workflow automation is a key strategy in the establishment of successful e-supply chains.

3.3 Supply Chain Planning

Despite the significant savings and tremendous opportunities afforded by supply chain visibility and workflow automation, their true power can only be harnessed when it is accompanied by intelligent decision support tools that optimise the automated movement of materials based on the information available from supply chain visibility. Such an automated and optimised process will lead to lower inventory levels and greater asset utilization while meeting customer requirements. As a result these planning tools incorporate a much greater degree of efficiency in the operation of the supply chain. For example, the planning of optimal VMI replenishment cycles built on a strong foundation of supply chain visibility along with automation provides the basis for value adding planning solutions.

In terms of supply chain excellence through planning the ultimate goal is the synchronization of all the activities right from the raw material supplier to the final delivery to the customer. This may be achieved through solutions, which optimise scheduling of activities on a global level, instead of sub-optimal scheduling in individual organizations. One of the typical possibilities that arise in as a result of global scheduling is synchronization of manufacturing with the schedules of airlines, something that was not possible earlier, as shown in Figure 7.

However, one key issue in such global scheduling is that every participant in the supply chain needs to agree upon the optimal solution, which is generated by the planning

tool. There are a couple of situations where this challenge can be effectively addressed. This concern will not arise in case of supply chains dominated by a single channel master that will enforce the schedules on the other participants in the supply chain. The second scenario, in which such global supply chain optimisation is possible, is when all the supply chain partners adopt collaborative planning practices, such as that defined by the Collaborative, Forecasting, Replenishment and Planning Model. In fact collaboration and trust between supply chain partners has become the key mantra for the development of effective planning solutions for e-supply chains.

Another technology that may be applied for Supply Chain Planning is data mining. Data mining is particularly useful in supply chain management given the large amounts of data available in the enterprise systems on the functioning of the supply chain. This data may be mined to understand the dynamics of the supply chain and the patterns in the various supply chain metrics. This understanding on the performance of the supply chain can be used to initiate steps that align the supply chain performance with the desired performance of the supply chain. Such performance measurement through E-Business Analytics provides the basis for continual supply chain improvement.

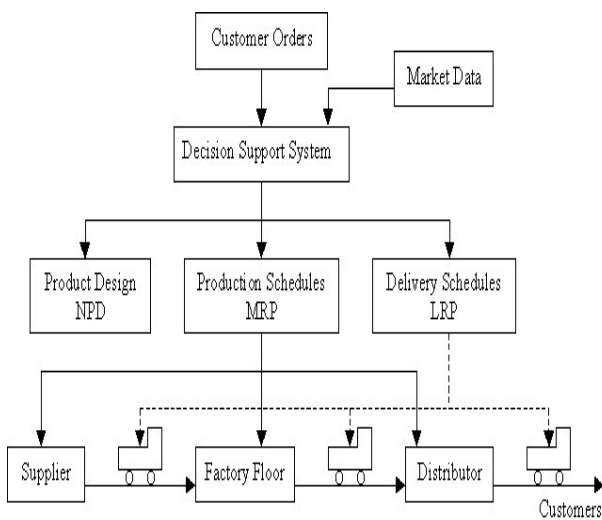


Figure 7. Collaborative Global Supply Chain Planning and Optimisation

Hence, continually improving efficiency through supply chain planning and performance measurement provides the key final building block for E-Supply Chains.

4. OTHER TRENDS IN E-SUPPLY CHAINS

Having understood the fundamentals of e-supply chains, it is necessary to understand the emerging trends in supply chains that will impact the nature of future e-supply chains. From the gamut of changes taking place around us, two of the main changes facing E-Supply chains today are - Customer Centricity of the Supply Chain and Outsourcing of Supply Chain Activities.

4.1 Customer-Centricity

The demand for greater value from the customers has resulted in the trend of logistics companies providing customer-centric services and solutions. In fact in their pursuit of achieving operational excellence in their areas of expertise, customer companies now expect increased participation and greater responsibility from the logistics service provider in the supporting activities within the supply chain. As a result, companies such as FedEx, UPS, Circle, MSAS, DHL and InSite offer professional logistics and supply chain services, customized to the business user requirements, operating philosophy, and business strategies.

Instead of trying to fit the customer needs into a standard transportation and warehousing model, they work with the business customers to develop a customized logistics solution that maximizes service, based on transit times, product considerations, and costs, shown in Figure 8. Additionally, some provide professional assembly and installation for a wide variety of items including PCs, printers, sporting goods, home furnishings, and office furniture/systems. All items are tracked and managed by the companies, using a state-of-the-art information system from pickup to delivery. Furthermore, given the central role of the logistics provider in the supply chain, the logistics service providers are expected to and often do deploy information-based services to strategically manage the inventory levels across the supply chain, increasing the customer service levels while reducing inventory and warehousing costs. The NEC warehouse managed by FedEx in Singapore is a best of the breed example of customer centric logistics.

The Traditional Supply Chain *Starts with Assets. Core Competencies*



The Customer-Centric Supply Chain *Starts with the Customer*



Figure 8: Customer Centricity.

Customer-centricity of logistics providers in the context of their involvement with vertical independent trading exchanges will result in the development of vertical logistical solutions, catered to a specific industry, for the users in the trading exchange. Vertical logistics is expected to be a major growth area for logistics companies to establish and maintain their competitive advantage.

However, with increased customisation at each stage of operation it becomes difficult to manage the various activities efficiently. Hence, the business processes of the logistics service provider need to be flexible enough to meet the varying and diverse needs of the various clients. This is where investments in new warehousing,

transportation and information technology can play an important role in making it economically feasible for logistics companies to develop customized logistical solutions and to manage the resulting complexities efficiently.

4.2 Outsourcing

The proliferation of the Internet has also made it easier and cheaper to coordinate activities between business partners. As a result, it has made it competitive for companies to specialize in their core capabilities and outsource their non-core activities to service providers who complement their offerings. In particular there is a trend in outsourcing of logistics to third party logistics service providers (3PLs). The trend towards outsourcing is also supported by recent management theories, which suggest that the corporations should focus on core capabilities, outsourcing activities that can be done effectively elsewhere. In fact the outsourcing of supply chain functions and ultimately the supply chain sub-processes in their entirety will be inevitable for many companies in the future. This is true not only for Internet companies which wish to acquire fulfilment capabilities with little time and money investment, but also for traditional manufacturing companies which wish to cut down on their expenditures on their non-core activities. Outsourcing partnerships will be offered to logistics service providers by large manufacturing enterprises and by trading exchanges, which will require the specialized fulfilment expertise without too much cost and hassle. A prerequisite for logistics companies to exploit this opportunity is good connectivity with their partners and the establishment of good relations with them. These attributes will be highly desired by the partners, who wish to acquire much needed fulfilment capabilities and also exercises certain degree of control over the execution.

There are already several examples of total outsourcing, where a 3PL (or group of 3PLs) handles the dot-com company's entire backroom operations. The 3PL receives the goods from vendors based on Internet orders and performs warehousing, order picking, assembly, packaging, and shipping, as well as the huge job of handling returns. Other companies outsource portions of the e-business supply chain, such as the warehousing and order fulfilment or the shipping and delivery. With the Internet retail revolution in its infancy, the logistical demands on this industry are going to skyrocket, and 3PLs should be among the major beneficiaries--if they can perform.

Outsourcing a major logistics contract is a strategic business decision. Thought has to be given to determine the areas where a 3PL provider can add value and lower overall costs, while enhancing elements like cash flow, inventory investment and, especially, customer service. The decision to outsource any function can have a profound impact on a company. A poorly chosen provider can create havoc, but a well-constructed

outsourcing partnership can have a positive impact on cash flow, inventory costs, customer satisfaction and profits.

5. CONCLUSION

The above discussion brings out the growing importance of infocommunication technologies for coordinating among multiple partners of the supply chain and, ultimately, as a source of value and competitive advantage. As competition shifts from head-to-head competition between firms to competition between supply chains, competitive success will depend increasingly on the ability to coordinate and integrate the production activities at geographically dispersed and organizationally distinct locations. The new supply chain structures that are emerging will play a fundamentally important role in the future of businesses.

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