Supply Chain Management

July 2000

Jayashankar M. Swaminathan
The Kenan-Flagler Business School
University of North Carolina, Chapel Hill, NC-27599
Email: msj@unc.edu

This paper is forthcoming in the International Encyclopedia of the Social and Behavioral Sciences, Elsevier Science, 2001 (the largest reference work ever in Social and Behavioral Sciences).
1. Introduction

Supply chain management is one of the most essential aspects of conducting business. Many people outside of the direct community (in research and industry) do not realize this because an ordinary consumer often experiences only its effects. Recall the times when the item that you wanted was not available in your favorite garments or grocery store, recall how many times you got a great “deal” at the end of the season, recall the sudden increases in gas prices due to shortages, recall the times when your e-commerce site promised availability but later could not send the required product or sent you the wrong product or recall the times when your customized product (like a personal computer or kitchen cabinet) was delayed to a great extent. All the above and several other experiences that consumers have on a routine basis are direct consequences of supply chain practices followed by firms. As opposed to business to consumer transactions, supply chain practices have immediate impact on business-to-business transactions. A few years back Toyota had to shut down its manufacturing facility in Japan due to supply shortages for its brake pedals, Boeing took a charge for several million dollars a couple of years back due to insufficient capacity and part shortage resulting from an inability of the supply base to ramp up production, while firms such as Dell Computers, Wal-Mart and 7-Eleven Japan have consistently outperformed competition due to their great strengths in supply chain management.
2. Definition

Supply chain management is a vast topic as a result people often give it a different definition based on their own personal experience. To some supply chain management is all about managing the supplier base, determining what to outsource and to whom and managing relationships with the various suppliers. To some others it is efficient ways of transferring goods from one place to another taking into account the distribution and transportation costs. To another set of people it is all about how the different firms in the distribution channel or value chain are integrated in terms of information systems and inventory management practices. To yet another group it is effective management of fixed and variable assets required for running the business. In a sense all these definitions are like the blind men defining the elephant based on its different organs. A comprehensive definition of supply chain management can be given as follows.

A supply chain is the set of entities that are involved in the design of new products and services, procuring raw materials, transforming them into semi-finished and finished products and delivering them to the end customer. *Supply chain management is efficient management of the end to end process starting from the design of the product or service to the time when it has been sold, consumed and finally gotten rid of by the consumer. This complete process includes product design, procurement, planning and forecasting, production, distribution, fulfillment and after sales support (see Fig 1).*

Supply chain management issues can be classified into two broad categories – *Configuration* and *Coordination*. Configuration level issues relate to the basic infrastructure on which the
supply chain executes and Coordination level issues relate to the actual execution of the supply chain. Configuration level issues include the following topics.

**Supply Base Decisions:** How many and what kinds of suppliers to have? Which parts to outsource and which to keep in-house? How to standardize and streamline procurement practices? Should one use vertical marketplaces for auctions or should one invest in developing highly integrated supply partnerships? How long or short contracts with suppliers should be?

**Plant Location Decisions:** Where and how many manufacturing, distribution or retail outlets to have in a global production distribution network? How much capacity should be installed at each of these sites? What kind of distribution channel should a firm utilize – traditional brick and mortar, direct to consumer via Internet or phone or a combination?

**Product Portfolio Decisions:** What kinds of products and services are going to be supported through the supply chain? How much variety to provide to customers? What degree of commonality to have across the product portfolio?
**Information Support Decisions:** Should enterprise resource planning software be standardized across functional units of a firm? Should the supply chain work on standard protocols such as XML (extended markup language) or on proprietary standards?

Coordination level issues include the following topics.

**Material Flow Decisions:** How much inventory of different types of products should be stored? Should inventory be carried in finished form or semi-finished form? How often should inventory be replenished? Should a firm make all its inventory decisions or is it better to have the vendor manage the inventory? Should suppliers be required to deliver goods just in time?

**Information Flow Decisions:** In what form is information shared between different entities in the supply chain – paper, voice via telephone, EDI (electronic data interchange), XML? To what degree does collaborative forecasting take place in the supply chain? What kind of visibility is provided to other entities in the supply chain during execution? How much collaboration takes place during new product or service development among the supply chain partners?

**Cash Flow Decisions:** When do suppliers get paid for their deliveries? What kinds of cost reduction efforts are taken across the supply chain (or expected of suppliers)? In a global firm, in which currency will a supplier be paid?
Capacity Decisions: How to optimally utilize the existing capacity in terms of manpower and machines? How to schedule on a manufacturing line to complete jobs on time? How much buffer capacity to have for abnormal situations with excess demand?

As evident, Configuration and Coordination issues are inter-dependent. Configuration issues can be viewed as strategic long-term decisions whereas Coordination issues are medium to short term decisions. Generally firms develop a strategy for the Configuration level decisions and then constrain the Coordination decisions based on those.

3. Complexities associated with supply chains

As evident from discussions in the earlier section supply chain management spans several functional and geographical areas. This introduces complexities both in terms of design and execution of supply chains. Some of the pertinent factors that complicate supply chain management decisions are as follows.

Multiple agents: Supply chain issues need to be decided by different entities sometimes having different interests. For example, a retailer may want that the distributor provide very high availability for the products but at the same time not charge anything additional from the retailer. The distributor may sometimes agree to that but in turn may want information about actual customer sales, which the retailer may not want to share. Even when decisions have to be made within the same firm there could be incentive issues. For example, the marketing or sales department, typically a revenue center presents the future demand forecast to the manufacturing department that is a cost center. Clearly, there is incentive for the former to over-forecast and the latter to under-produce (as compared to the forecast). This creates
several difficulties while deciding on the amount of inventory to be stocked. Another related issue is encountered where marketing department may push for huge amount of variety in the product/service offerings; the manufacturing department may not want to embrace that because additional complexities are created during execution.

**Uncertainty:** Accurately matching supply and demand is the ultimate goal of effective supply chain management but that is complicated by uncertainty at various levels of the process. There is uncertainty in product and technology development, there is uncertainty in predicting customer demand, there is uncertainty in day-to-day operations and manufacturing and there is supply uncertainty. Typically, uncertainty creates more inefficiency in the system. For example, if the final demand for a sweater at a store cannot be predicted accurately then the firm either stocks too little (in which case it suffers from stock-outs) or produces too much (in which case it has to salvage the inventory through a huge sale at the end of the season). Similarly, the uncertainty in supply may necessitate additional buffer inventory.

**Information Asymmetry:** Since supply chain processes extend across multiple functional units within a firm and often across different firms there is a high degree of asymmetry in terms of information. This is caused primarily due to two main reasons – one relates to lack of adoption of information technology and the other relates to reluctance to share information with other supply chain partners. The lack of information causes several problems during actual fulfillment. For example, when a consumer goes to an e-commerce site and buys an item off the electronic catalog the consumer expects to receive the product on time. The consumer is not aware that the inventory status on the product may be updated only once a
week and that the information on the site may be outdated. As a result, the consumer is disappointed when the product does not arrive on time.

**Lead Time:** Each and every task in the supply chain process needs time to be completed and the resources (labor, machines or computers) have limited processing capacity. As a result, not all tasks can be completed after the actual demand is known and some of the tasks need to be done up front (which may or may not get utilized based on the actual demand realized). Further, the limited capacity associated with the resources creates variability in the actual realized lead-time, which in turn necessitates greater resource requirements at the next stage in the supply chain.

The above complexities lead to several types of inefficiencies in the supply chain that are often perceived as the “bad effects” of inefficient supply chain management. Some of the major inefficiencies can be classified into the following categories.

**Poor Utilization of Inventory Assets:** One common effect of poor supply chain management is having excess inventory at various stages in the supply chain, at the same time having shortages at other parts of the supply chain. Since inventory forms a substantial part of working assets of a firm, poor management could lead to huge inefficiencies. Lee and Billington (1992) provide an excellent overview of pitfalls and opportunities associated with inventory management in supply chains.

**Distortion of Information:** Another effect relates to lack of visibility of demand and supply information across the supply chain which causes the bull whip effect. This effect describes how a small blip in customer demands may get amplified down the supply chain because the
different entities in the supply chain generate and revise their individual forecasts and do not collaborate and share actual demand information. Lee, Padmanabhan and Whang (1997) describe the causes and controls for this effect.

Stock Outs: Poor supply chain management also results in late deliveries and large stock-outs. Fundamentally, these effects are caused due to an inability of the firm to predict the requirement for raw material and equipment capacity together with the uncertainty associated with obtaining deliveries of products on time from its suppliers. Fisher et. al. (1994) describe how accurate forecasts in the apparel industry could potentially reduce this inefficiency.

Customization Challenges: As the degree of customization has increased in the marketplace, one of the immediate effects of poor supply chain management relates to late deliveries of customized products. Firms are developing several strategies in order to provide variety while keeping costs under control. These include delaying differentiation of the product and introducing more commonality and modularity in product lines (see Swaminathan and Tayur 1998).

4. Supply Chain Models: Past, Present and Future

The science related to supply chain management traces its history back to the early 1950’s when several researchers were interested in understanding the optimal policies related to inventory management. One of the first pieces of work in this stream relates to the models developed by Clark and Scarf (1958) for managing inventories at multiple-echelons. Several hundreds of researchers have studied related inventory problems under stochastic and deterministic environments over the last half a century. This research is concisely captured in
the research handbook edited by Graves, Rinnoy Kan and Zipkin (1995). There is a large amount of literature in the area of transportation and distribution as well as plant location models in the context of supply chain management. Traditional researchers focussed on developing optimal policies and rules for specific supply chain issues assuming a centralized control of the supply chain. Over the last decade researchers have started to study problems which take a decentralized multi-agent approach to analyzing supply chain problems, integrate information availability across the supply chain with logistics decisions, develop new models for supply contracts and demand forecasting and integrate product design with supply chain management. A collection of prominent pieces of research in this area is contained in Tayur, Ganeshan and Magazine (1999). In addition to academic research, several firms in the last decade have successfully developed and employed large analytical and simulation models for supply chain optimization and execution. Arntzen et. al. (1995) describe one such system developed for Digital Equipment and recently, IBM was awarded the Franz Edelman Award by INFORMS (The Institute for Operations Research and Management Sciences) for a supply chain optimization project which led to $750 million in inventory savings.

In the twenty first century, firms face severe challenges in terms of global competition and customer requirement for greater variety, shorter and reliable delivery times and lower prices. The advent of electronic commerce has created immense opportunities but at the same time has made firms more vulnerable to logistics pitfalls. Today customers do not just buy products but they buy *delivered* products. As a result fulfillment is as important as making the sale. As opposed to traditional channels where inventory could be stored to hide other inefficiencies in terms of leadtime and poor forecasts, in the fast paced electronic business environment such arrangements are not as useful. As a result, firms are beginning to pay
more attention towards supply chain management. Both business to consumer and business to business e-commerce environments have introduced several issues related to supply chain management which are likely to be studied by researchers in the near future.

The prevalence of the Internet has led to the development of vertical marketplaces that promise to reduce the inefficiencies in the buying process in several industries. On one hand, these marketplaces are likely to reduce the cost of goods for the manufacturer due to more competition leading to better prices. This line of thought indicates that in future supply chains may be more agile and supplier relationships may be short term oriented. On the other hand, several firms realize that greater benefits can be attained if some of these marketplaces can in fact be used for process integration and collaboration across the supply chain. In such an environment, firms need to develop greater trust so that they would be willing to share information with their supply chain partners. Researchers today are trying to identify under what conditions one or the other scenario may play out and what kinds of new models and analysis need to be developed. A related effect of the Internet is the expansion of global supply chains. Today it is much easier for any supplier located in a remote part of the world to bid on contracts from large firms in developed nations with whom they may not have done business in the past. Issues related to coordination of global supply chain management are likely to be an integral part of supply chain management research in the future. Another important research topic is the reverse logistics issues related to supply chain management. Traditionally researchers have only concerned themselves with efficient movement of goods from supplier to the customer. Now a greater number of researchers are studying problems related to disposal of used products, refurbishing old products, making packaging more environmental friendly and basing supplier selection on environmental criteria in addition to traditional criteria related to cost, quality and reliability. Another new stream of research is
the study of supply chains in the service industry. As opposed to traditional manufacturing oriented supply chains, service supply chains are more complicated due to the inability to store inventory. Uncertainty is handled in those cases using additional buffer capacity. Finally, researchers are beginning to focus more on the integration of product design and supply chains and developing models to understand the concepts related to design for supply chain management.

**Bibliography**


