XIII. Supply Chain and Transportation: A Smorgasbord of Issues

by Konstadinos G. Goulias

Abstract
In this paper a variety of issues on the relationship between supply chains and transportation is provided. Although some of these issues are complementary to the presentations made by other analysts at the 2nd Conference on Agro-Industrial Logistics in Mediterranean Area, a few different directions for research are also highlighted. The first section provides an overview of supply chains and supply chain management objectives to guide the subsequent discussion. In the second section a brief review of the global market is followed by an outline of the issues encountered when attempting to manage supply chains worldwide with an example of global supply chain management. The newly emerging area of carbon accounting, offsets, and the carbon neutral supply chains is also mentioned. In the last section an overview of modeling propositions is presented in terms of network considerations and hierarchical considerations.

XIII.1 Introduction

A supply chain is a network of facilities and distribution options that performs a variety of functions including production and procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers. Supply chains exist in service, agricultural, and manufacturing organizations. The complexity of the chain may vary greatly from industry to industry and firm to firm. Supply chains are continuously emphasized by business executives with one of them stating “companies will not compete, their supply chains will.” This competition may take the form of optimally managing the chain.

Supply chain management is a strategic concept that involves understanding and managing the sequence of activities from supplier to consumer and integrating these activities effectively so that real value is added to the entire product supply pipeline. It is in essence the integrated management of the sequential flow of logistical, conversion, and service activities from vendors to the ultimate consumers and it is necessary to produce a product or service. Due to its benefits it has become a major trend in business motivating radical changes in the way we produce, transport, and deliver goods to markets. It involves businesses examining the total costs of transportation, warehousing, purchasing, manufacturing, marketing, design, business partnerships and alliances, and the relationships and trade-offs among all of them. This is done within their business and among their business partners, in an effort to decrease total costs while simultaneously increasing product quality and customer service (Bowersox and Closs, 1996, and Bovet and Sheffi, 1998). As a result many journal articles and books have been written on this topic to provide descriptions and examples of strategies employed by companies practicing supply chain management. It should also be noted that fewer articles recognize the potential of supply chain management to cause negative impacts such as truck and passenger vehicle traffic increases (Marker and Goulias, 2000).
Supply chain management evolves following phases. First improvements in physical distribution are introduced. Then, some kind of integrated logistics management is developed. Finally, an overall attempt is made to create optimal supply chain management. Particularly relevant to this conference is the grocery stores supply chain(s) that are the retail outlets of the agro-industrial products. The majority of the grocery store supply chains contain the flow from manufacturers to wholesalers to retailers to customers. There are, however, many variations because each manufacturer is the supplier of numerous grocery stores. In turn, each grocery store is supplied by many manufacturers. This is further complicated by lack of integration among manufacturers, wholesalers, distributors, third party logistics providers, and retailers and the variety of options they use in managing flows of goods and their logistics network(s).

All this is changing from a traditional to a new form of supply chain. The traditional grocery supply chain is one with a large number of links, with items that often spent up to three months in the supply chain, retailers typically buying in bulk, and goods delivered to distribution centers. This very often produces the bullwhip effect, which is the appearance of customer demand as highly variable when in reality it is relatively constant (Lee, Padmanabhan and Whang, 1997). In addition, it also forces overstocking and understocking of different products to avoid lack of availability and requires a separate fleet for perishable goods. In the new form of grocery supply chain we see many innovations including bar-coding and electronic data interchange about point-of-sale between retailers and manufacturers. This leads to faster reaction to demand, reduction of inventory, speeding of the flow, and bypassing of wholesalers and distributors. Shipping is taken over by third party logistics (3pl) companies that are also doing the warehousing and logistics with frequent and more efficient operations. In this way, we see smaller and more frequent shipments based on near real-time inventory information, more accurate forecasts, smaller inventory required, and shorter residency time of items in inventory. This leads to lower costs, better service, and the elimination of supply chain links. In addition, a new trend in the industry is demand chain management in which businesses attempt to understanding and managing customer demand while striving to add value for customers and for the enterprise simultaneously (Chase, 2008). In this sense travel demand management and transportation system management predate private enterprise in their attempts to use optimally system capacities. Table 1 shows key characteristics between the two forms in terms of a few factors.

Table 1 Differences Between Traditional and New Forms of Supply Chain
(Modified version of the Cooper and Ellram, 1993 list)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Traditional</th>
<th>New Forms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inventory Management</td>
<td>Firm Focused</td>
<td>Coordination in the Chain</td>
</tr>
<tr>
<td>Inventory Flows</td>
<td>Interrupted</td>
<td>Seamless and Visible</td>
</tr>
<tr>
<td>Cost</td>
<td>Firm Minimized</td>
<td>Landed Cost Minimized</td>
</tr>
<tr>
<td>Information</td>
<td>Firm Controlled</td>
<td>Shared with Supply Chain Team</td>
</tr>
<tr>
<td>Risk</td>
<td>Firm Focused</td>
<td>Shared with Guaranteed Volumes and Joint Asset Investments</td>
</tr>
<tr>
<td>Planning</td>
<td>Firm Focused</td>
<td>Supply Chain Team Focused</td>
</tr>
<tr>
<td>Interorganizational</td>
<td>Firm Focused on Low</td>
<td>Partnerships Focused on</td>
</tr>
</tbody>
</table>
Coyle et al (2002) warn us that one of the challenges of supply chain management is to maintain the visibility of the inventory in the entire pipeline. They also claim that another challenge is to minimize the uncertainty, which may lead to building stock inventory to be on the safe side and to buying practices that are suboptimal. Efficient Consumer Response (ECR) is the grocery industry supply chain management strategy attempt to eliminate inefficiencies and deliver better value to consumers. It re-engineers the entire supply chain from a "push system" in which manufacturers push their products to the consumer into a "pull system" in which product travel down the pipeline on the basis of consumer demand. This can be considered to be an e-commerce form and can lead to substantial savings in throughout time (Kurt Salmon Associates, 1993). However, most real-world pipelines do not satisfy the integration and information-sharing requirements for true transparent pipeline management. Some of the key events to move towards that goal are: a) eliminate barriers to information, b) improve communication, c) reduce uncertainty, d) develop strategic partnerships; and e) shift the focus and importance from the form to the supply chain. All this is aided in one way or another by a variety of forces that include: a) gaining control of consumer demand worldwide; b) a major push for globalization as the data in the next section show; c) increased competition requiring leaner organizations and major consolidations; d) government deregulation in most industrialized countries; and e) a push towards environmental responsibility and the internalization of external costs.

XIII.2 The Global Market

Data published by Global Insight (www.globalinsight.com) show that in the next forty years China, India, Brazil, and Russia will start approaching the Gross Domestic Product of the US, surpassing Germany, the U.K., France, and Italy. There is also a distinct possibility that China will become the highest ranking country in GDP by 2050. This unequal growth around the world has tremendous implications for world trade and the flow of goods and it poses considerable challenges and opportunities when one thinks in terms of logistics and supply chains. Moreover, countries and entire regions appear to be specializing in their attempts to become competitive creating even larger demand for transportation. A sample of this comes from the project worldmapper (www.worldmapper.org) and displayed in Figure 1. On the one hand, Europe, the US, Canada, and Japan are major importers of fruit. On the other hand, Central and South America, some Western European countries, many Eastern European Countries, and portion of Africa are major exporters of fruit. In a similar way we can map the world according to cereal imports and exports also shown in Figure 1.

An evolving trend to handle this ever increasing world trade is containerization, which by many in the industry is considered a major revolution in handling goods accompanied by the building of larger ships to reach major economies of scale. In fact, 90% of the world trade is by sea. In the US, an example of the amount of goods handled in this way is from the Bureau of Transportation Statistics of the United States that reports (www.bts.gov) container trade in 2005 and 2006 becoming the double of ten years earlier rising to 46.3 million 20-foot equivalent units (TEU) that passed through U.S. ports in 2006 (2/3 of these stay in the US). During this same time world container trade increased by 3 times. Again, a geographic
A concentration of movements is observed with 55% of TEUs coming by the west coast of US ports.

Each territory's size on the map is drawn according to its land area.

The size of each territory shows the relative proportion of the world's population living there.

Territory size shows the proportion of worldwide net exports* of fruit (in US$) that come from.

Territory size shows the proportion of worldwide net imports* of fruit (in US$) that are received.

Territory size shows the proportion of worldwide net exports* of cereals (in US$).

Territory size shows the proportion of worldwide net imports* of cereals (in US$).

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* Net exports are exports minus imports and net imports are imports minus exports.

Note: The maps are equal area cartograms described by Gastner and Newman (2004).

Figure 1 The world in terms of import and export projections

The European Union, which is the world's largest trading block, is also impacted by all this with 90% of EU external trade by sea, 40% of EU internal by sea (and expected to increase), moving 3.5 billion tons of cargo per year. A positive aspect of these developments is the relatively clean transportation by sea (when compared to air travel and truck travel). However, studies in major ports show that handling of cargo at ports requires more attention to claim environmental benefits. In fact, the Port of Los Angeles in California, which is a major hub of the US, a variety of policies are implemented including: a) introduction of cleaner trucks; b) refueling stations for natural gas trucks; c) vessel speed reduction; d) alternative maritime power (shore power); e) fuel standards; f) main and auxiliary engine improvements for emission reduction; g) performance standards for cargo handlers; h) performance standards for harbor craft; i) rail switch engine modernization; and j) rail with cleaner locomotives.
There is global movement to resolve many of these problems to facilitate optimally functioning global supply chains (see http://www.gfptt.org/). Some consensus has been reached on issues to be considered in this area that include: a) identification of actors and roles played by each; b) understanding of the response to policies; c) developing communication and electronic data interchange; d) understanding the impact of consolidation; e) identifying barriers and institute policies to remove them; and f) increasing the role of modeling and simulation to identify solutions. For example, Freightwise is a €13 million project that attempts to build on cooperation with public and private stakeholders. The project has 55 partners from 14 European countries and is supporting real life transport chains, as its developers claim, using 9 business cases that cover major surface freight movements. It is very important to note the architecture and the virtual transportation network that Freightwise includes not only the usual actors in moving goods (shippers, receivers, forwarders etc) but also administration (e.g., customs) and traffic and infrastructure managers (see http://www.freightwise.info/cms/mainnav/Project).

Another issues worth mentioning in this paper is about supply chains and the natural environment and particularly emissions of CO2. With aggressive moves by governments and advocacy groups in the creation of a green market we see two related phenomena emerging. The first is an offset trade market in which companies can buy offsets (futures and options) to counterbalance their inability to manage production and decrease CO2 production (see the exchange web site at http://www.europeanclimateexchange.com/default_flash.asp, and Bellassen and Leguet, 2007). The second is an attempt to develop carbon neutral supply chains in which the amount of CO2 produced in the supply chain is offset by a variety of mitigating actions that include partnerships with the local supply chains. From a policy perspective these are excellent news for small local producers who can partner with multinational companies (e.g., http://www.dole.com/CompanyInfo/PressRelease) to help them reach carbon neutrality while at the same time deriving major developments boosts.

XIII.3 Modeling and Simulation

From the discussion above, in decision making we need appropriate models to manage the overall chain, assess impacts of policies, identify bottlenecks, and optimize actions. All this may cannot be done by a single entity such as a company but it is a project that spans different public and private agencies either through a consortium or a new entity such as a private-public partnership. This complicates modeling and simulation because of the added actors in the process and the different goals and objectives each actors follows. Over the past 30 years many freight models have been proposed and used in different contexts including traffic management studies, investment studies, logistics, shipper/carrier mode choice, pricing and a variety of charges and policy simulation, location studies, and competition modeling. These are also becoming routine additions to the travel model used in regional and statewide transportation long range plans. However, global supply chains are by far larger and more complex than regional transportation models and they involve many additional actors. In fact, Wigan and Southworth (2006) reviewing the available freight models concluded that a more concerted effort is needed today to address the policy issues we are interested. Among the many considerations made by these two authors, three major aspects characterize a new generation of freight models that are designed with and for logistics and are suitable for supply chain management studies.
(Figure 2). The first consideration is a view of the modeling and simulation context as a web (or a network) of relationships. This network is ordered from the producer to the consumer representing multiple supply chains. The second consideration is the inclusion of transactions as a modeling layer. The third is an emphasis on communication among layers.

Another aspect of supply chain modeling and simulation is accounting for the inherent functional and geographical hierarchies. Boile (2005) in the context of managing empty containers in the US identifies three distinct levels of analysis that are global, regional, and local at each level we have different actors, roles, and actions for the same containers moving through the transportation system.

However, when we consider the carbon footprint of supply chains modeling and simulation is even more complex and complicates the methods by a few orders of magnitude. Moreover, auditing of these programs requires more sophisticated tools than currently available. All this is extremely encouraging for university-based research and shows we need to see a convergence of research fields such as climate change, transportation, and supply chain management, ecology.

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XIII.4 References


