TRANSPORTATION LOGISTICS IN GLOBAL VALUE
AND SUPPLY CHAINS

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1. INTRODUCTION

Globalization represents the cross-national functional integration and coordination of spatially dispersed economic activities. As globalization is becoming the norm in an increasing range of economic sectors, the resulting worldwide coordination of production and supply emerges as a complex harmonization process -- across differing cultures, various economic systems, shifting government regulations, and a host of international rules and agreements.

Globalization is fundamentally changing the environment of business decisions. Corporate decisions have to be increasingly taken in the new context where business operations are subject to worldwide forces of fierce competition. Firms have to respond strategically in order to stay competitive in this arena. Firms have typically two sources for gaining a strategy-driven competitive edge: a) the continuous creation of new products and incorporation of new technologies, and b) the firm’s decisions on the rationalization of existing operations. The latter device of rationalization involves, among other actions, the streamlining of production processes and broadening of the sourcing of raw materials and intermediate goods to a global market. In order to reduce overall costs and produce significant profits, the best practice firms are both sourcing and marketing in an increasingly interdependent international market.

While global sourcing responds to the needs of manufacturing and service enterprises for cheaper materials and components, the resultant cost savings can be realized only if there are efficient logistical services which permit efficient global sourcing. According to the International Institute for Management and Development (IMD) logistics refers to the movement and storage of goods – intermediate and final – associated with the information flows from the beginning to the end of the supply chain (IMD 1993). While there are many elements in efficient
logistics--for example, the capture, storage and retrieval of information on goods, materials management, design of manufacturing strategies and the like -- a reliable, cost effective transportation system is fundamental to the integrated logistics system.

There are innovative ways in which firms are combining transportation and distribution systems to increase their efficiencies in the globally competitive environment. Though the transportation logistics systems vary with type of product and geographical scope of the market for raw materials, components and finished products, there is a common objective underlying the various strategies. The common objective is to get the right product to the right place at the right time so the cost of holding inventory is minimized. In 1998, more than 60% of production and sales were processed from direct orders rather than from stock (Gwilliam, 1998). The Cato Institute showed that carrying and holding costs represented 25-30% of the value of inventories in U.S. firms due to “product, depreciation and interest” (IMD, 1993). Inventory reduction has become of paramount importance for the firm, and has become feasible due to changes in production technology--with use of computer controlled manufacturing, robotics and other uses of information technology for cost effective smaller production runs. Logistics for effective inventory management is a key to this new geography of production as component production facilities are distributed in a number of countries and regions within a country.

Logistics is increasing in importance as restructuring of firms often entails relying on external vendors - an attribute of Just in Time production systems. Considerable research attention has been devoted in recent years to Just in Time or lean production systems, as well as to ‘flexible specialization’ in production, which has emerged in the context of rising wages in advanced economies and overall excess capacity relative to demand (Piore & Sabel, 1984; Storper & Scott, 1992). The flexible specialization theory maintains that manufacturing
production chains are switching from vertical integration, representative of the mass or Fordist production systems, to fragmented and vertically disintegrated forms. Consequently, the advantages of scale economies in mass production are being replaced by economies derived from horizontal, globally based input-output linkages (Markusen, 1996). A discussion of the difference between mass production and lean production from an engineering perspective can be found in Preiss (1997). A variety of organizational, and geographic arrangements have emerged, in practice, to capture the upstream and downstream advantages of such globally based material-component-output linkages. Efficient and reliable transportation and distribution are crucial for inventory management in such global production chains.

As reliable delivery of input materials and component parts to manufacturing centers and of delivery of product to markets have become crucial, the pressures for cost minimization are transforming transportation, storage and handling practices. Moreover, the increasing trend in intra-firm trade, resulting from intra-firm division of labor on a global basis, is also dependent on reliable delivery schedules. Thus, cost reductions through global sourcing need to be supported by systems ensuring reliable delivery from spatially far-flung suppliers and vendors. Cost advantages are quickly eroded if subcontractors and component suppliers fail to deliver on time. Such failures can arise if part of the global production chain is located in low wage countries, where barriers to cross-border transit abound and create poor logistical practices. In such situations control over spatially disaggregated delivery schedules becomes problematic and the smooth operation of the production system is threatened. Logistical innovations are emerging to address such challenges. Improvements in transportation logistics, associated with supply chain management, represents one component of the state-of-the-art logistical innovations.
This paper on transport logistics attempts to systematize the links between transportation logistics and supply chain operations. It identifies the elements of these processes and draws attention to significant factors and variables governing these processes. As transportation logistics is in its formative and dynamic stage, we have considerable information on the practices of firms, most of which are "learning by doing". Our knowledge of transportation logistics is thus rich in case experience and limited in standardized information. The role of logistics in globalization is discussed in Section 2. The characteristics of transportation logistics are discussed in section 3. The spatial consequences are explored in Section 4. The paper concludes by highlighting some potential trends and emphasizes data needs.

2. LOGISTICS IN THE INTERNATIONAL INTEGRATION OF ECONOMIES

Two of the primary drivers of globalization in recent times have been: a) the lowering of tariff and non-tariff barriers to trade, and b) the sharp decline in transportation and communication costs. The ‘free trade’ regime encouraged by the United States in the post-World War II era, as represented by the General Agreement on Trade and Tariff (GATT) and the World Trade Organization (WTO), has greatly reduced different kinds of trade barriers between countries, thereby stimulating the rapid growth of cross-border movement of goods largely in North America, Europe, East Asia and select Newly Industrializing Countries (NIC).

At the same time, technological change in the transportation and the information technology (IT) sectors is ushering in a period of low cost / high value transportation services. Indeed, the combined effects of changes in transportation and the complementary information
technologies are not only visible in the offer of traditional transportation services with more speed and reliability and lower costs, but also in the introduction of new classes of transportation services. A variety of examples of the latter types of new services are discussed later.

Land and water transportation costs have steadily declined in the post war years. The average ocean freight and port charges per U.S. import and export cargo decreased from $95 to $29 per short ton between 1920 and 1990 (Frankel, 2000). Air cargo rates have not only fallen in the last 30 years; jet air travel, and refrigeration have made trade possible in previously non-tradable perishable goods such as cut flowers and live lobsters. Air express cargo routinely carries high volumes of high value added goods and mail packages across continents. The ratio of c.i.f trade value (measured as cost to the importing country) to f.o.b. trade value (measured as it leaves the exporting country) is the common measure of shipping costs. Using this measure, the margin for U.S. trade declined from 9.50% to approximately 6% between 1950 and 1990. Frankel (2000) claims that this understates the true decline as the composition of trade has changed and c.i.f costs vary widely across commodities and trading partners. Across commodities, the c.i.f. margin varies from .8% for aircraft to 25.1% for low value added commodities such as earth, stone and salt. Across countries, the c.i.f. margin ranges from 1.7% for Mexico to 25.8% for Guinea (Frankel 1997).

There is a controversy regarding the role of technology in explaining these declining costs. Contrary to Krugman (1995)’s position, Bordo, Eichengreen and Irwin (1999) claim that technological progress has been very influential in explaining the decline in transportation costs. Much of this technical improvement stems from the Information technologies (IT) which not only increase the capacity and functionality of cars, trains, ships, and planes as well as that of roads and the air traffic control system, but also support, and indeed make possible, the
organizational and coordination functions which comprise transport logistics and supply chain management. Such developments in the *enabling and space-shrinking technologies* of transportation and communications are fundamentally transforming the space-time relationships between various parts of the world. These technologies permit the management and coordination of globally dispersed set of diverse economic activities. They permit increasing division of labor in production as component processes are subdivided and reallocated geographically. This implies that different stages of the partitioned production process—material assembly, component production and final assembly—are carried out in different parts of the world.

In this context, the drive to reduce costs has encouraged global sourcing as manufacturers and wholesalers source intermediate and final goods from a global market place. The World Bank (2000) estimates this international ‘sourcing’ activity at $800 billion. While ocean freight rates and other transportation costs have been declining steadily over time thereby increasing the flow of goods between countries, the current form of globalization with horizontally integrated, interdependent production chains, has been largely facilitated by accompanying logistical innovations, which have permitted countries to more fully capture the benefits of transportation improvements. In turn, the global production chains promote evolution and improvement in the form of further logistical innovations.

Logistics, defined as “the integrated analysis and active management of an enterprise’s overall supply chain, from sources of inputs to delivery of finished products” has had an enormous impact on goods transport services (Willoughby, 2000, Pg.12). In a deregulated market shippers have to compete on costs of transport and service quality. This has put a downward pressure on total logistics costs (which include warehousing and transport) by approximately 40% on average. The productivity gains from such cost reductions vary by type
of industry and trading partner. Also, logistics costs measured as a percentage of GDP (when interest on the inventory is included) has declined from 13% to 10% between 1989 and 1997 for the U.S. (Schneider, 1998). The cost of logistics accounts for 20% of the total manufacturing cost in the OECD countries on average - varying by industry type. It accounts for 30% of the cost in the food industry and 11% in the automotive.

Logistics is increasing in importance in the globalization process as production has become locationally footloose. Enterprises in OECD countries, and especially Newly Industrializing Countries (NICs)—S. Korea, Taiwan, Brazil, Chile, etc. -- are linked to the U.S. in terms of shipments of intermediate and consumer products. Increasing modernization of low wage economies, accompanied by the continuous reduction of tariffs and opening up of erstwhile closed economies, are encouraging transnational firms from OECD countries to rationalize their production systems on a global scale.

Many of the NICs are heavily dependent on manufactured exports. In East Asia and the Pacific, the proportion of manufacturing exports to total exports is currently over 75% on average (Gwilliam, 1998). In 1997, U.S. trade with the Asian Pacific Economic Cooperation countries (APEC) totaled $955 billion, approximately 65% of it’s global trade. U.S. imports from APEC have increased approximately 60% since 1990. In South Asia, Southeast Asia, and Latin America the share of manufactured goods to total exports is above 50%. These trends in the last 15 years have caused trade to double, while world output has grown only by 50%. This increasing ratio of trade to output adds pressure on distribution systems where cost minimization, profit maximization and strengthening of market presence are all sought.

Given the differences in logistical environments in U.S. and other advanced economies on the one hand and developing economies on the other, some of the issues of integrated
management of distribution activities across these two types of economies need to be highlighted. The supply chain characteristics of the relatively more industrialized developing countries, termed the NICs, are shown in Table 1. This table highlights the differences between U.S. supply chains and those of NICs such as S. Korea and Brazil. These differences matter, since U.S. multinationals have joint ventures and manufacturing and assembly operations in these countries, and source their components from, and send their exports to, these NICs. Multinational location decisions by U.S. firms are influenced by the logistical options available in NICs or regions within these countries. For instance, the U.S. investment in Maquiladora industrial plants along the U.S. Mexican border was clearly influenced by the proximity of these plants to the well developed U.S. logistical networks. Similarly, the shift of computer assembly to Singapore reflects the high quality of that country’s logistical system, particularly it’s port facilities. The strength of the global supply chain is as strong as its weakest link.

The organizational and management issues involved for an American global corporation in implementing a global supply chain—located partly in the U.S. and partly located in an NIC—can be clarified by returning to Table 1, which captures the prevalent characteristics of the supply chain systems in NICs as well as some emerging trends in them. The manufacturing sectors in these relatively lower wage countries appear often in economic processing zones or metropolitan areas, located near coastal or river ports to take advantage of water transport. They tend to use labor-intensive processes in most sectors. Due to inadequate or congested infrastructure, the firms are predominantly vertically integrated, reflective of previous manufacturing systems of advanced economies. However, the distribution and retail networks, supporting these
Table 1. Supply Chain Characteristics of Newly Industrializing Countries

<table>
<thead>
<tr>
<th>Supply chain characteristics</th>
<th>Supply</th>
<th>Manufacturing</th>
<th>Distribution</th>
<th>Retail</th>
<th>Consumer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Limited local supply</td>
<td>Vertical integration</td>
<td>distributors play the major role</td>
<td>50% or more sales through informal markets</td>
<td>small middle class</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Labor intensive processes</td>
<td>Inadequate infrastructure</td>
<td>direct store deliveries (DSD)</td>
<td>High proportion of low income consumers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Growth of economic processing zones</td>
<td>Limited availability of logistics services</td>
<td></td>
<td>Consumers w/ buying power concentrated in large cities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Concentration of production in metro areas</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emerging Trends</td>
<td>Increased use of suppliers drawn from advanced economies &amp; other</td>
<td>Investment in production transportation &amp; communication technology</td>
<td>Development of improved transportation service</td>
<td>Increasing multinational retail presences</td>
<td>Growing middle class purchasing power</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Assembly operation of final goods</td>
<td>Third party logistics</td>
<td></td>
<td>Increasing information about product diversity, quality &amp; name brand</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Exports of components &amp; intermediated goods</td>
<td></td>
<td></td>
<td>*Increasing competition between multinational firms for market share</td>
</tr>
</tbody>
</table>

*Increasing competition between multinational firms for market share

Source: Modified from Weller (1995)

manufacturing activities, lag behind in scope and capacity -- reflecting the small size of the middle class and an earlier stage of spatial organization of service activities. In these countries, the presences of informal markets, and the relative immobility of consumers, are predictable byproducts of weaker economic status. Direct store deliveries from wholesalers and factories are common in NICs as retail establishments carry small inventories. Direct store deliveries depend on a vast number of distributors using various modes and trucks of wide range of vintages to serve the thousands of establishments. Consequently, virtually all retailers lack distribution networks. In such an operating environment there is little room and scope for logistics services.
The consequence is that NICs have limited availability of local supply chain services, as understood in the U.S..

As the NICs are rapidly changing, Table 1 presents information on emerging trends in manufacturing and distribution sectors and in the supply chain system. The conditions are changing as these countries continue to push the envelope of domestic processing capability as shown in the row of emerging trends. NICs are investing in transportation infrastructure, and in communications and electronic technologies. The manufacturing sectors are moving into more advanced industrial operations of assembly operations of sophisticated components and intermediate goods. The distribution sectors are changing as indicated in the row on emerging trends. With the rise of incomes and growing purchasing power of the expanding middle class, there is an increasing multinational presence in the retail sector. Product diversity in consumption items implies larger shipments of imported items. U.S. third party logistics firms are entering into partnerships with local shippers and transporters, as the export market for U.S. firms continues to increase in these economies driven by their large and growing population bases, growing middle classes and rising expenditures on consumer durables. There is an emergence of third party carrier sector as domestic trucking firms are increasing their capacity and sophistication. The main constraint in NICs is the shortage of capital, relative to need, for infrastructure development in the short run.

As global firms from the U.S. and other OECD countries are incorporating lower and lower income NICs into their production chains, the logistical challenges of integrating those countries into global supply chains multiply. Table 2 illustrates these additional difficulties for such a country (Indonesia as experienced by a global logistical firm). With a less developed industrial infrastructure than say S. Korea, Indonesian manufacturers have poorly developed cost
management practices, distributor networks, and low customer service orientation—all of which handicap a well functioning logistical system. The poor distribution system, while needing heavy vehicle and facility investment, offers poor operational conditions and reliability, so that more than 14 days inventory has to be maintained—limiting JIT operations. As to be expected in a industrializing country, the poor quality and service of transport vehicles and operators, slow order processing system, and shortage of warehousing limit the scope of timely, reliable transport services.

The ability of NICs to be competitive in marketing their manufactured products depends on speed and reliability of delivery in addition to product quality and cost. Logistical excellence in transportation is, thus, a global necessity and not only restricted to OECD countries. Globalization implies integration across countries with differing technological and infrastructure capabilities.
Table 2. Logistics Challenges in Indonesia

<table>
<thead>
<tr>
<th>Supplier (manufacturers)</th>
<th>Distribution</th>
<th>Transport</th>
<th>Customer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordination of wide network of distributors Cost management</td>
<td>achieving geographic &amp; store coverage - Heavy investment in fleet &amp; facilities - Mgmt. of large number of subscale transport agents</td>
<td>Lack of equipment available en route Lack of &quot;professionalism&quot;</td>
<td>coordination of &gt;100 deliveries per day at ea. Outlet</td>
</tr>
<tr>
<td>Managing high-SKU but low-volume deliveries to retail outlets - Frequency - Narrow delivery Windows</td>
<td>Lack of inter-island shipping - missed schedules - poor quality</td>
<td>Substandard trucks</td>
<td>Lack of central warehousing on large storage facilities</td>
</tr>
<tr>
<td>Expensive, less-than-truckload shipments</td>
<td></td>
<td></td>
<td>Slow order processing system w/ suppliers (high lead times)</td>
</tr>
<tr>
<td>Need to hold &gt;14 days' inventory due to supply chain complications</td>
<td></td>
<td></td>
<td>Warehousing security</td>
</tr>
</tbody>
</table>

Source: Knoop, 1996.

3. TRANSPORTATION LOGISTICS IN INTEGRATED LOGISTICS MANAGEMENT

3.1 Transportation Logistics: Objectives and Attributes

The objective of transportation logistics, one component of integrated logistics management, is to compress time along the whole supply chain. This involves not only reducing delivery time in shipments from suppliers of raw materials, intermediate goods and components to factories, but also the distribution of final products from factories to wholesalers, retailers and end users. It also includes distribution of spare parts to repair establishments for after sales service. As the JIT (Just-in-time) production system is increasingly the norm in many industries,
shipments have become time dependent. Firms gain value from reducing stock keeping units (SKU’s) and from being able to respond rapidly to changing market conditions (Caldwell, 1998). For example, in 1998, Dell Computers carried only 8 days of inventory – less than 25% of its 1995 inventory pattern (Schneider, 1998). Dell Computer in Ireland produces in direct response to customer orders via the internet—an example of the current trend toward pull logistics where orders for shipments are pulled to meet demand.

Another service improvement offered by transport logistics providers, namely the reduction of order cycle times, confers productivity gains on industrial producers and shippers. For example Phillips International reduced its average order cycles from 23 weeks to 5 weeks in the decade between 1980-1990 (Gwilliam, 1998). By 1998 it was further reduced to 2 weeks. The reduction in order cycling times is based on cost tradeoffs between production, stockholding, marketing and transportation with the goal of minimizing overall costs.

In transportation, logistics information substitutes for inventory. Information technology has fueled the logistics revolution by linking the shipper and customer through information flows and analyses. Logistics can reduce overstocking, eliminate costly shipment bottlenecks and delays in delivery schedules, and offer time and cost savings to the supply chain participants. By providing necessary timely information on the freight on the move, the requirements of the production processes to all relevant actors in the supply chain.

While transportation is only one component of integrated logistics management, the current trend is toward increasing it’s contribution, and thereby, it's critical importance. Transportation, in the knowledge economy, is not limited to just movement of goods across space. It no longer only performs a mere pre production (moving inputs) and postproduction (delivering outputs) linkage function. It is a value-adding component that is incorporated into
strategic management and operational decisions of firms through transportation logistics. Currently, the scope of transport logistics has grown such that it is influencing what to produce, where to produce, and in what quantities. Thus the function of transportation is undergoing a structural change, which is reflected in the evolution of transportation logistics.

Logistics adds value in both pre-production and post-production stages - termed as inbound and outbound logistics. The relationship between inbound and outbound logistics to the manufacturing process is shown in Table 3. Porter (1990), in discussing the competitive advantage of firms, drew attention to the important role of logistics in the value chain. The objective of inbound logistics is to harmonize supply chains with production needs so that cost minimization in procurement and inventory management can be achieved. Inbound logistics involves also optimal mode choice and coordination of intermodal services. Decisions also need to be taken regarding the distribution network: should deliveries be made directly to the factory or should the inputs be stored in central or regional warehouses?

Outbound logistics has three elements, namely, whether the shipment from the factories should be stored in warehouses, warehoused in trucks or sent directly to customers. If they are to be stored in warehouses, decisions need to be taken regarding the logistics provider – an in house logistics department/division or the contracting out of these services to third party firms. The factors, to be considered at each stage, are listed within the columns. Warehouse characteristics refer to its location vis a vis critical transportation routes and market. Internal layout of the warehouse impacts the efficiency of loading, unloading and storage. Inventory size and the amount of time components and products stay in the warehouse affect warehouse size. All these variables are part of strategic decisions.
In early stages of transportation and distribution logistics, the focus was on local optimization, that is, optimizing inbound logistics or outbound logistics for particular shipments. The current trend is toward global optimization, that is, across the whole value chain. The objective of integrated logistics is to synergize delivery while reducing shipment costs and cycle time. It includes adding of flexibility and accuracy of shipments. Agility or flexibility is important as inventories are to be kept at a minimum and logistical firms must be able to respond to shifting production and customer needs. Accuracy is important as shipment errors mean loss of time by not getting the right goods.