Freight Transport, Seamlessness, and Competitive Advantage in the Global Economy

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EJTIR, **6**, no. 1 (2006), pp. 23-38

Freight transport has emerged as one of the most critical and dynamic aspects of the transport sector where change has become the norm. It is now the main element supporting global commodity and more generally supply chains. Yet the lack of seamlessness and inefficiencies in general as well as the rising costs and complexities of shipping and delivering goods are adding to profit pressures faced by manufacturers across the globe. Our paper first discusses the concept of seamlessness, and then examines some of the consequences of the lack of seamlessness in terms of freight transport inefficiencies. We then begin to examine the new developments in which intermodality, technology (e-commerce), and logistics are changing and will have the impact of heightening competitive advantage and reducing constraint points in production value chains and global production networks. Finally the intent is to show how research on this theme might be advanced in a trans-Atlantic framework.

Keywords: freight transport, seamlessness, intermodality, technology, global production networks, supply chains

1. Introduction

In the last decade especially there has been a steady growth of global trade and concomitantly freight transport. The drivers of the shifts in transportation and in the distribution of goods are the increased trend toward knowledge sharing, the vertical disintegration of firms, the enlargement of markets, the success and consolidation of the network-firms which are becoming more specialized in their core business. The emergence of information networks with faster contacts and transaction times imply faster and more reliable shipments, particularly in innovative sectors (biotechnology, informatics, nanotechnology) but also in the more traditional manufacturing activities. The development of transport services and adequate infrastructures to handle freight flows have become an important factor of economic competition between regions (Capineri and Randelli, 2004; Leinbach and Bowen, 2004; Leinbach and Bowen, 2005b). The whole world is becoming our market but also our competitor. But competition takes place more at the level of sourcing and distribution processes than of production (Eldon, 2004). Thus, the increase of competition has made it necessary for firms to reduce or even eliminate stocking and distribution costs and to follow the "speed imperative". The best-known illustration of this is just-in-time (JIT) production (Dicken, 2003), which reduces inventory stocks (and concomitantly the space and staff that must be devoted to this function), enhances quality control by making defective work more immediately apparent, and accelerates time to market. Nowadays, the increased opportunities for communications, the efficiency of transport operations as well as the increased standardisation of production processes, make it possible to integrate supply chains on a world wide scale (Hall and Braithwaite, 2001).

The object of attention must of course be the "seams" themselves. By this we mean the point s of friction where smooth flows can become constrained or interrupted. This becomes more complex as we imagine networks of different types intersecting with one another. In a simple way of course we have infrastructural seams (differences in rail gauges and changes in modes), operational seams (signalling systems, speed constraints), functional seams (processing points where goods change form and value as well as distribution points where repackaging and finishing occurs before onward movement) and of course institutional seams (tariffs, taxes, pricing, data sharing, customs).

The lack of seamlessness has numerous consequences and can be witnessed at several levels (Aeppel, 2004). First of all, as logistic activities are highly concentrated in few gateways (ports and airports) and in strategic logistic regions which often shows congestion, delays in loading and unloading can cause bottlenecks in the chain. Thus, some companies are setting up distribution centers next to their overseas factories from where finished goods or components are shipped directly to an end customer rather than trying to bring goods into the U.S. or Europe first and then ship them to the customer. That can shave weeks off delivery schedules. Other moves include hiring third parties that specialize in operating global distribution systems, setting up warehouses closer to main gateways, and bringing in products through less overtaxed ports, including those on the East Coast of the US. Companies are also investing heavily in new information technology that allows them to plan and schedule production and anticipate disruptions to far-flung supply chains. Other examples show a return to regional suppliers even if production costs may be higher.

Bottlenecks can be found also at infrastructure level: in Europe 75% (16000 km about) of the railway network and 10% of the road network (7500 km) are daily subjected to congestion. The solution to the saturation of main links in Europe has been foreseen in the creation of Trans-European networks and corridors and in the development of short sea shipping. At the moment in Europe most of the logistic activities are concentrated in the *Golden Triangle* (Amsterdam – Paris – Frankfurt / Main) which serves the biggest logistics operators (for example TNT Express Worldwide): such location is accessible within four hours from the main industrial areas (the *European core*). But, due to the emergence of Asian countries, new routes are required (i.e. Suez Canal, trans-Asian railway) and it seems to indicate the future development of new logistic regions (i.e. the Mediterranean).

2.The Drive Toward Seamlessness

Various adjustments and enhancements, both subtle and conspicuous, to transport services have impacted the sector and its relations with the globalization process. Accommodating new technologies, new markets and new organizational structures has required major changes on the part of providers and consumers, whether individuals or firms. The pressure of competition requires that firms increasingly be focused upon greater efficiency. Essentially this points to the gradual evolution of a "seamless" transport market (Leinbach and Bowen, 2005a). The basic notion suggests an environment in which national and modal boundaries neither delay movements nor hinder the choice of the most efficient route and/or modal combination for the movement required (Willoughby, 2000). The liberalization of many national (and increasingly regional and international) transport markets and the innovation dynamics of technology driven services strongly influence this drive for seamlessness.

The backcloth for the drive toward seamlessness in transport services is first and foremost the increasing internationalization and arguably, the increasing globalization of economic activities. Transport and communications especially play a fundamental role as enabling mechanisms in this process. While internationalization has been occurring for centuries, the activities associated with this have been impacted by critical innovations. One major element in these developments has been the expansion of the transnational corporation and spatially disaggregated production chains (Leinbach and Bowen, 2005b). The coordination and regulation as well as the geographical configuration of these networks have immense importance for the profitability and viability of commerce as practiced by enterprises (Dicken, 2003). In a very real way, transport services hold these global production networks together (Henderson et al., 2002). The nature of transport services and the way they are applied has become an immensely important consideration for firms as they seek to maintain a competitive advantage.

Having identified the quest for a seamless transport market it is important to identify the forces which are driving this quest. First in a general perspective, it is clear that intense competitive pressures require goods- and services-producing firms to manage almost simultaneously multiple inter-organizational information and material flows. The global scale of this task makes it especially daunting. But attaining efficiencies in this complex endeavor allows firms to source, manufacture, and deliver their goods and services better, faster and cheaper. This development has forced a radical rethinking in the architecture of production, the importance of traditional supply chain relationships and the role of logistics.

Logistic activities have become a strategic actor in the transport systems and in the competitive assets of regional economy. In 2000 logistics activities contributed to the 16% of world GDP (18% in EU) and the market of this sector has increased by more than 6% on average, while logistics outsourced services grew by 11,2%. Transport and logistics are outsourced for about 30% of the firms and their costs account for 10% to 30% of the total production cost of an item, although the percentage varies according to the type of product.
Logistics has become an integral part of the modern production process. This term encompasses the process of planning, implementing, and controlling the efficient, effective flow and storage of goods, services, and related information from point of origin to point of consumption for the purpose of conforming to customer requirements. Perhaps more

critically, logistics enables companies to get the right goods to the right place at the right time in the right condition and at the right cost. Important changes in technology, markets, institutional structures and management theory have led to new ways of conceptualizing this process and the development of new efficiencies. Recent developments in logistics include the introduction of the notion of *reverse logistics* that focuses upon the supply chain that flows opposite to the traditional process of order acceptance and fulfilment. For example, reverse logistics includes the handling of customer returns, the disposal of excess inventory and the return journey of empty trucks and freight cars. As part of this and closely related is the notion of *green logistics*, the process of collecting, moving, and storing used, damaged, or outdated products and/or packaging from end users. In addition, *lean logistics,* which has evolved to the term *agile logistics,* has become important (Hines, Jones, Rich, 2001). These two similar concepts in logistics, which have been derived from the Toyota Motor Company, propose a new way of looking at the supply chain and an alternative way of rethinking the logic of value creation. Central to each concept is a detailed understanding of inefficiencies so that radical or incremental improvements may be made through a framework called "value stream mapping". Overall the rationale is to contribute toward the development of more general logistical systems (Greis and Kasarda, 1997; Hines, Jones and Rich, 2001). Evolving this goal further has moved toward the development of integrated logistical systems where manufacturing and logistics are fully integrated. This process will be characterized by a deep enterprise wide exchange of information that provides for a fast and flexible flow of materials and products (McKinnon, 2001; Kasarda and Rondinelli, 1998; Greis and Kasarda, 1997). It is important to note that logistics in the economy has two dimensions: logistics management in manufacturing and distribution organizations, and logistics organizations providing services to the manufacturing and distribution companies.

Second, one of the most remarkable shifts in corporate strategy and operational activity in recent decades has been the externalization of production so that corporations are now reliant upon external resources. Once centrally located operational activities such as product design and development, services and facilities management, logistics and even manufacturing have been taken over by suppliers. Consequently there has been an increased emphasis on managing the external relations of production and the control of resource flows from source to consumer. These activities have come to be represented by the term "supply chain management" as a way of analyzing and detailing the flows of products and materials in complex organizational structures (Hall and Braithwaite, 2001, 81). In addition international flows have been expanded as a result of a huge retailing demand. Enterprises such as Walmart and Carrefour are increasingly conspicuous as a consumer of intermodal transport.
The search for competitive advantage at a global scale has forced firms to rely heavily on outsourcing, to seek out favorable labor and resource advantages and to attain insofar as possible flexibility in resource access regardless of distance (Eldon, 2004). The implications for transport are that longer and more customized linkages must be achieved through alliances across modes and nations. There is in addition a growing need for secure and efficient transactions which obligates the transport industry to apply procedures and equipment which will foster this (Russell and Saldanha, 2003; Cook, 2003).

Third, it is important to recognize that globalization, logistics and supply chain management depend to a considerable extent upon the ways in which separate modal systems can be brought together into intermodal structures (Slack, 2001). A key factor in the development of intermodal structures has been the application of containerization (Hayuth, 1987). The container has entered virtually every ocean shipping market over a wide range of freight types and has revolutionized shipping. While slower to enter other modal systems, containerization using units of varying dimensions is also being applied in the road transport, rail and airline industries. The implications of containerization are vast. For example, application of this innovation has produced a higher capitalization in terminal facilities because of the need for specialized machinery. Containerization has produced traffic concentration and the emergence of load centers where hub/feeder network structures have evolved in order to justify the capital costs of the system (Airriess, 2001a; Robinson, 1998)[1]. In addition the containerization revolution has produced a need for larger site requirements of intermodal terminals and increasingly important as a result of the need for larger and larger capital outlays as restructuring of the container industry is taking place (Slack, 2001: pp. 148; Airriess, 2001b). This process of concentration and restructuring is being widely felt and is not unique to the container industry (Bowen and Leinbach, 2004). The ramifications and further expression of intermodalism and containerization are discussed below.

Fourth, the role of time in global operations has been heightened. The move to just-in-time management of production and distribution processes and the attempt to maintain zero inventories to lower costs has become essential. Differentiation between products and services is founded on so called time-based competition (TBC) (Meersman and Van der Voorde, 2001). Basically firms must develop strategies for production and delivery with the purpose of supplying customers with products and services in as little time as possible. Cost, value and speed are not tradeoffs but objectives in their own right. The responses from transport must include a greater sensitivity to the timing of connections, arrivals, departures and the capacities of vehicles and storage units. The demand for real time information access and exchange means that transport operations must expand their reliance on efficient communications and computer networks through electronic data interchange (EDI) for scheduling and tracking. Finally opportunities for economies of scope (scope economies exist whenever the same investment can support multiple profitable activities less expensively in combination than separately, e.g. when it is less expensive to produce two products together than it would be to produce each one separately) and customized production runs require flexibility in modal choice and timing (Janelle and Beuthe, 2002).

The rapidly changing demands of the marketplace now force firms to organize their operations around real-time information about consumer needs and the availability of productive capacity. Traditionally logistics has been fed information on customer requirements from long-range forecasts that drove the production cycles of firms. Firms now require current and immediate information about the location of productive activities as well as information linking the locations with available transport opportunities. Thus the need for seamlessness is being driven in the first instance by the challenge of rapid and flexible customer response. One way of capturing the response to this need is through the extended enterprise, a group of strategically aligned companies that focus on specific market opportunities. In this way firms can exploit the collective resources of the entire extended

[1] According to the American Association of Port Authorities, the world cargo traffic s concentrated in about 10 ports which find at the top of the list: Singapore, Hong Kong, Kaohsiung (Taiwan), Rotterdam, Busan (South Korea), Long Beach, Hamburg, Los Angeles, Anversa and Shanghai

network of suppliers, vendors, buyers and customers (Greis and Kasarda, 1997). Obviously fitting logistics in an integrated manner to these networks by the selection of appropriate modes and services is crucial (McKinnon, 2001).

Finally the rise of E-commerce and E-business through the Internet has brought important consequences for the transport system and logistics especially. In the U.S. alone recent information indicates that E-commerce shipments are most dominant in manufacturing where 18.3 percent ($270 billion) of total sales are attributed to such transactions (U.S. Census, 2003). E-shipments are dominant in five industry groups: transportation equipment, beverage and tobacco, electrical equipment, appliances and components and computer and electric products. Secondary areas of importance are merchant wholesalers (drugs, motor vehicle parts, professional equipment) retail trade (especially nonstore retailers), and selected service industries (e.g. travel arrangements, publishing, brokerage, securities and commodity contracts, computer systems designs). B2B ecommerce represents 93 percent of all E-transactions. According to an enquiry carried out in Europe (Eurostat, 2002) on firms with more than 10 employees, 7.7% of enterprises of business services use B2B markets while only 2.7% of manufacturing firms do. The rise of E-commerce produces implications for stocks of goods and, in particular, produces the need for transport of smaller batches and the need for attention to reverse logistics. The response by the integrators, firms which provide time-definite services and "integrate" the air and ground functions performed by airlines, forwarders, and ancillary service providers, to these situations will be detailed below.

3. **New Expressions of Seamlessness**

The elaboration of production networks, both across borders and within countries, since World War II has been manifest in, and has depended upon, a corresponding expansion of transport services, over land, in the air, and at sea. The critical role played by transport services within the evolving international economy is evident not only in the quantitative growth of such services but also in qualitative changes within this sector: in the speed of transport services, in the degree of integration across transport modes, in the development of information-intensive transport and logistics services, in the increased dominance of large global transport firms and alliances of firms, and in the shifting geography of the networks over which transport services are delivered. It is these changes that are the focus of this section.

While individual transport modes have been transformed by technological innovations (e.g. the jet engine), much of the recent reduction in transport costs (including costs measured in terms of time) has come through measures to reduce the barriers traditionally separating different modes (i.e. road, rail, sea, air). The clearest illustration of intermodalism is containerization, through which containers can be relatively easily transferred among ocean, rail, and road (truck) transport systems. Interestingly, the Boeing 747 was designed in part to accommodate the same containers, with the width of its fuselage set equal to two such containers and the nose of the aircraft designed to lift in order to facilitate easy front-loading. In practice, sea freight containers are rarely transferred to aircraft due in part to their weight; but there is an important intermodal connection involving lighter air freight containers and truck transport. A final example of intermodalism is the truck-to-rail transfer of trailers.

The success of intermodalism depends upon the more general internationalization of standards that has facilitated globalization. In this regard, the dimensions of a sea freight container can be likened to the technical specifications of the nearly universally available computer operating systems and office software suites that emerged in the 1980s and 1990s (Borrus, 2000). Intermodalism is also contingent upon regulatory changes and greater incorporation of information technology into transportation systems. With regard to the former, transport has been among the most strictly regulated services sectors in many economies, with different bodies regulating separate modes. To permit goods to be passed easily among modes has required some degree of regulatory harmonization. With regard to the latter, smoothing the connection among modes has been facilitated not only by common standards and specialized equipment (to lift a container from a ship to a waiting truck, for instance), but also by the development of systems permitting the rapid dissemination of information about shipments. We explore the importance of information technology in transport services further below.

Intermodalism is regarded as a particularly important cure for land transport congestion but has contributed to that same problem in some areas. While the expansion of global economic activity has been predicated upon the earlier discussed advances in long-haul transportation, most trips, both for people and for goods, are relatively short-haul. One result has been worsening congestion on highways in densely populated conurbations. Intermodalism offers a partial solution by shifting a portion of interurban trips to rail. But intermodal transfers have exacerbated congestion within certain urban areas, especially those adjacent to major seaports that attract and disgorge a colossal volume of containers daily. In response, Los Angeles, for instance, built the Alameda Corridor, a 32-kilometer, partially below-ground railway linking the port of Los Angeles to the vast rail yards and transcontinental rail lines downtown (Philips, 2002). Completed in 2002 at a cost of US$2.4 billion, the project eliminated dozens of grade crossings and sharply reduced truck traffic on urban highways, and is regarded as a model for other cities. Indeed, it is precisely in the overlapping major hubs of transport modes that the "speed imperative" (Kasarda, 2000) of the global economy is most threatened. In addition the growth of “freight villages” has become a new from of intermodalism especially in Europe. These are intermodal terminals located inland from the port where the container traffic is unloaded and repackaged away from congested areas. These terminals usually involve motor carrier and rail access, often through dedicated highway infrastructure. In addition they are equipped with sophisticated information and technology software that allows tracking and tracing of goods. An example of this occurs in both Bologna and Verona in the north of Italy, in Dresden (Germany) or in Sogaris (France).

Intermodal freight transport as a part of total freight transport in Europe has grown, from about 113 to about 214 million tkm per year during the period 1990-1997[2]. During the same period, the market share of intermodal freight transport in total volume of freight transport work has increased from 5% to 8%. Within the above figures, the market share of the international intermodal transport has been about 91%, and of the domestic one about 9%. In the international market, rail has carried out about 20% of the intermodal transport volumes,

[2] As far as total freight (goods) transport is concerned, intermodal traffic has grown in Europe by an average rate of 2% per year or for more than 75% during the period 1970-1999.

inland waterways 2%, and short-sea shipping 78%. In domestic market, rail has carried out about 97% of the volumes, and inland waterways 3%. However, an evidence has also shown that the market share of intermodal transport in terms of total volume of freight transported (tonnes) has always been modest, only up to 2% in 1987, with an expectation to approximately double by 2010 (EC, 1997*b*; 1999). There is an obvious reason for such modest market share of the intermodal freight transport. Most of intermodal freight services take place in medium- to long-distance Trans-European markets-routes (over 500 km), in which only 10% of total freight transport demand exist. Contrary, about 90% of this demand exists in the markets - distances up to 200 km where road haulage has dominated. (Janic, Bontekoning, 2001). The accession of the candidate countries to the European Union will influence logistics and transport flows in a number of ways.

Similarly intermodalism has become one of the most significant transformations of freight transportation in the United States over the past two decades. The space-time articulation of transfers from one mode to another has enabled shippers to fully realize the respective time and cost advantages of various modes[3]. With intermodalism, new significant hubs have emerged on the transportation map of the U.S. In addition the accessibility gap between central and peripheral U.S. regions has also been reduced. The impact that the intermodal transportation network has on the ability of regions to position themselves more effectively in the national and global space-economy has so far not been studied. A number of problems prevent the implementation of intermodal transport on a broad scale. The involvement of various actors in intermodal transport, not only leads to an increase of the costs and a rise of the prices asked but also to a non-transparency of the process, which makes it less attractive for shippers and 3PLs to switch from conventional transport to intermodal transport.

4. Information Technology, Transport and Logistics

Virtually no sector of the economy has been untouched by the advent of new information technologies (IT), and their impact upon transport services has been profound. The use of IT has permitted the development of faster, more reliable, more precisely timed logistics strategies, within which information-intensive transportation services are central. As noted earlier, logistics, broadly defined, refers to the management of the flow of goods (e.g. raw materials, components, finished goods) through supply and distribution chains. The internationalization of production networks combined with the heightened attention to time as a factor in competition (Schoenberger, 1994) has made the operation of those chains a far greater concern for firms in a wide range of industries. In a somewhat self-reinforcing fashion, the decline in transport costs has contributed to keener international competition (particularly from China), which in turn has fueled deflation which has placed still greater pressure on firms to reduce costs, an important part of which is the cost of transportation and logistics (Delaney and Wilson, 2003).

[3] The average time a ship needs to cross Atlantic is 6 days (average New York – Rotterdam) and the average time of door to door delivery is 4 weeks at the best. For this reason logistic services are becoming important in reducing the overall time costs.

Several examples will give some sense of the breadth of applications of IT that have fostered a greater degree of seamlessness in transport and logistics. First, crossdocking is an increasingly pervasive practice in which goods arriving on one vessel (e.g. truck, freighter aircraft) at a hub or other central facility are immediately dispatched on another vessel bound for the goods' final destination, obviating the need for any storage time at the intermediate location. Crossdocking depends on IT tools including bar code scanners linked to complex database management systems. Second, the efficiency of many different transport modes has been enhanced through the use of global positioning systems, permitting express firms, for instance, to minimize pickup and delivery times. Third, warehouse management information systems permit the movement of goods within transport hubs and terminals to be largely automated, minimizing both handling costs and errors (Although when such systems fail to work well as during the initial teething problems at Hong Kong's Chek Lap Kok Airport in 1998, the result can be near paralysis).

The use of IT has also enabled firms to more closely track and control the flow of goods so that the time embodied in a production process in not merely sped up but is also more carefully managed (Schoenberger, 1994). The best-known illustration of this approach to logistics is just-in-time (JIT) production (Dicken, 2003), which reduces inventory stocks (and concomitantly the space and staff that must be devoted to this function), enhances quality control by making defective work more immediately apparent, and accelerates time to market. For instance, in 2000, National Semiconductor outsourced its logistics to UPS. From a newly built global distribution center that UPS operated for the chipmaker in Singapore, delivery times to customers in North America and Europe were trimmed from five days to two days; the use of IT in this system enables National Semiconductor and its customers to track the location of shipments at any point in the supply chain (Shah, 2000; Haddad, 2001).
Those gains, however, come at the cost of greater vulnerability to supply chain interruptions. That vulnerability has been exploited by some workers to enhance their bargaining position (Herrod, 2000), with perhaps the best example being the strike by dockworkers on the West Coast of the United States in 2002. It is ironic then that the same rapid reduction in transport costs and concomitant elaboration of global production networks which has weakened the power of manufacturing workers in many industries has augmented the power of workers at strategically crucial junctures in the world's supply chains.

More generally, the vulnerability of attenuated supply chains has placed a break on the degree of internationalization in many industries so that localization (evident, for example, in the tendency of auto parts suppliers to locate plants very close to the auto assemblers they feed) is an important trend even in a time of falling transport costs (Dicken, 2003). Indeed, the persistence of spatially clustered production complexes (e.g. Silicon Valley) is testament to the fact that falling transport costs is, in many industries, dwarfed by the effect of localization externalities (e.g. nontraded interdependencies like the circulation of specialized knowledge among clustered firms) and geographic path dependency (Storper, 2000).
Due in part to localization, more efficient supply chain management, and the deregulation of major transport modes, the cost of transport and logistics is on the decline in the United States and the same trend can be expected in other major world markets. Business logistics cost US firms $910 billion in 2002, or about 8.7 percent of gross domestic product, down from its peak of 16.2 percent in 1981 when high interest rates exacerbated inventory costs and transport deregulation had yet to yield major savings (Saccomano, 2003). Unsurprisingly,

an important contributor to the falling share of the economy committed to transport and logistics has been reduced inventories.

The externalization of logistics functions over the past decade (as in the case of National Semiconductor and UPS) has fueled the rapid growth of what is referred to in the industry as third-party logistics (3PL) (Zhu et al, 2002). 3PL firms carry out logistics functions that would once have been performed by either the shipper (i.e. the first party) or the recipient (i.e. the second party). Much of the burgeoning 3PL business is carried out by major freight forwarders (the traditional intermediary between a shipper and an ocean freight or sea freight carrier). These firms leverage the volume of the shipments they control, their warehouse space (within which they perform value-added functions like minor assembly), their expertise in state-of-the-art logistics practice, and their advanced IT systems to lower the cost of portions of a customer's supply and/or distribution chain. A more recent development is the advent of so-called 4PL services, in which a firm may take over a client's entire transport and logistics operation. The importance of IT and of externalized logistics is both expected to grow with the rapid expansion of business-to-business and business-to-consumer E-commerce.

The major 3PLs are faced with a number of problems and challenges: they have to locate their *scope* in terms of services offered to shippers; they have to extend their geographical *coverage* (i.e. pan-European services); they have to offer a *variety of transport options,* including the use of intermodal transport and *additional services* including the operation and management (SCM) of complex distribution/supply structures for their customers. Hence, a 3PL must have a better understanding how to organise their networks (i.e., where to place hubs, how to integrate different transport modes, etc.). Increased logistics capabilities of European 3PLs improves the competitiveness of European production companies and plays an important and active part in the organization of production and distribution systems (OECD, 1996; McKinnon, 1998). It is important to note that price, time and reliability are important factors in the decision process of the firm, but frequency and flexibility emerge as important decision factors when firms operate in a logistic context (Bolis and Maggi, 2003). Firms also ascribe the greatest importance to the minimisation of the risk of the transported good loss and damage.

5. Conclusions: in search of sustainability and seamlessness

There is currently a significant debate surrounding issues of freight transport sustainability. The problems to be faced are: excessive emissions that are detrimental to local and global environments, excessive fatalities and injuries, excessive use of finite petroleum resources, excessive congestion levels and the impact that these have on the unsustainability of modern supply chains. Transport, and particularly freight transport, has recently been growing faster than GDP. Thus, despite the increasing concerns about the environmental impact of transport and increasing attempts to regulate transport through a more sensitive price mechanism in many countries, the transport intensity of the economy has been increasing. Moreover, energy consumption for transport activities has increased by 47% since 1985, compared to 4,2% of other economic sectors (*EEA, 2001)*. In particular in EU, transport energy consumption has grown by about 2.0 % per year during the period 1990-2000, and equalled 365 Mtoe (million tonnes oil equivalent) in 2000 (some 35 % of all energy use). As a consequence of the growth in energy consumption, CO2 emissions from transport also continued to increase. Aviation is the sector's fastest growing energy consumer and road transport is the biggest, consuming around 72 % of transport energy (including marine bunkers)[4]. The increased transport demand and the continuing shift of transport demand towards road and air, combined with the increasing use of heavier, more powerful vehicles and trucks, have offset the improvements in fuel economy of improved engine technology.

Overall four categories of measures have emerged: technology based ones (change in vehicles and fuel, reduction of empty hauling, etc.); infrastructure based ones (improvements in efficiency of infrastructure networks); flow based ones (managements of traffic and logistic flows); demand based ones (modal substitution, pricing incentives, regulatory measures). For the transport sector, policy priorities in the EU action plan to improve energy efficiency include incentives for optimal occupancy of vehicles, the promotion of new and alternative infrastructure and subsequently modal shifting and improving intermodal transport systems, developing alternatives to air transport, completion of the internal market in rail transport and changing behaviour regarding mobility. Some data on empty hauling are worth mentioning: empty backhauls make up only 25 % of total truck vehicle-kilometres in Germany (German Federal Ministry of Environment and Nuclear Safety, 2000) but more than 40 % in the Netherlands. In the United Kingdom, empty backhauls fell from about 33 % to 29 % of total truck vehicle-kilometres between 1980 and 1996. This may be explained by longer journeys, more drops per trip, more load-matching services, a growth in the reverse flow of packaging, material/handling equipment, and greater efforts by shippers to obtain return loads (OECD/ECMT/IEA, 1999). Although interest in these strategies is strong, barriers to their implementation are still substantial.

From a technological point of view, the applications of IT have fostered a greater degree of seamlessness in transport and logistics. First, crossdocking is an increasingly pervasive practice in which goods arriving on one vessel (e.g. truck, freighter aircraft) at a hub or other central facility are immediately dispatched on another vessel bound for the goods' final destination. Crossdocking depends on IT tools including bar code scanners linked to complex database management systems. Second, the efficiency of many different transport modes has been enhanced through the use of global positioning systems, permitting express firms, for instance, to minimize pickup and delivery times. Another example is warehouse management information systems which permit the movement of goods within transport hubs and terminals to be largely automated, minimizing both handling costs and errors. Changes in transport technology have been critical in this regard. In sea transport, for instance, containerization, which was began in the United States in the 1950s, reduced the Hong Kong-New York shipment time from 50 days in 1970s to 17 days by the late 1990s, with most of the time-savings coming through the dramatic reduction of handling time in seaports (Pearson, 2001). A single container, which might hold, for instance, 33,000 pairs of Nike sneakers or 132,500 VHS movie cassettes, can be unloaded from a ship and placed on a

[4] Ireland, Luxembourg, Portugal and Spain show the highest growth in transport energy consumption in the period 1990-2000. These are the countries showing the highest growth in GDP in this period (varying from 33 to 113 %), whereas the average GDP growth for EU-15 is 23 % in this period. Finland, Norway, Germany and the United Kingdom show the lowest growth in transport final energy consumption, which is related to moderate growth in passenger and freight transport compared with the European average.

waiting truck in fewer than five minutes (Worthen, 2001) and then later transferred to a train in a similarly efficient manner.

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