Challenging the Derived Transport Demand Thesis: Issues in Freight Distribution

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Abstract

One of the core concepts in transport and economic geography states that transportation is a derived demand, both for passengers and freight transport alike. This assumption is reflected in the conventional literature which underlines that transport exists because it is the expression of a spatially differentiated function of supply and demand and is thus considered to be "derived" from other activities. However, recent developments in logistics and supply chain management underline a paradigm shift in the consideration of freight transport as a derived demand. In many sectors of activity, the functions of production, consumption and transportation have become embedded to the point that it is difficult to tell them apart. This paper investigates to what extent the concept of derived transport demand is being challenged by supply chain management strategies. To remediate for some of the inadequacies of the conventional perspective, it is suggested that several segments of freight-related activities should be considered as part of an integrated transport demand. While operationally derived demand still applies to freight distribution, strategically – at the level of global commodity chains – integrated demand appears to be the emerging paradigm that is worth investigating further.

Keywords: Transport Demand, Derived Demand, Logistics, Freight Transport, Planning, Distribution, Global commodity chains.

1. Introduction

One of the core concepts in transport and economic geography leans on the assumption that transportation is a derived demand, a concept that equally applies to both passengers and freight transport. As the conventional perspective shown in many textbooks underlines, without activities taking place at an origin and destination transportation loses its purpose and thus cannot take place (Bamford, 2001). Transportation is consequently an activity which is dependent on other activities; an auxiliary function much like a service. Fairly unnoticed from the economic geography and transport community, there has been a growing body of evidence that questions this core concept. "Since the origin of transportation as a field of scientific inquiry, the tenet that 'travel is a derived demand' has been accepted with little question. This view pervades modern transportation planning approaches." (Mokhtarian and Salomon, 2001). Although this statement was made for the transportation of passengers, we argue that the issue of freight has even more profound implications for the concept of

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derived demand, of its relevance and applicability. Understanding transport demand and to what extent is it a derived demand remains an issue to be investigated (Preston, 2001). It has been argued that contemporary developments in freight distribution underline a new dynamic environment, often global in scale, which challenges the conceptualization of transportation as a derived demand (Hesse and Rodrigue, 2004). Logistics is thus more than a functional change in freight distribution, since the paradigm it provides changes the structure of distribution itself. Before going further with this reconsideration, it is worth providing a basic review of what derived transport demand implies.

1.1 Derived Transport Demand: A Review

The basic idea behind transport as a derived demand is that transport itself is not necessary unless required. There must be at start a *functional complementarity*, implying a supply / demand relationship. For instance, elements of a supply chain are integrated with another, notably through a supplier / customer relationship which regulates this demand. Demand for transportation of a unit (either of passenger or freight) is thus derived from a supply at an origin and a demand at a destination, a concept better known as *spatial complementarity*. It states that if a location produces / generates a surplus that another location requires, then an interaction (and thus transportation) is possible because a supply / demand relationship has been established between those two locations and a market can thus exist. The same goes in the other direction of the interaction, which creates a situation of reciprocity common in many spatial flows such as commuting, tourism or international trade. As transportation cannot exist on its own and cannot be stored, many economic activities involve a derived transportation demand, which comes in two categories:

- **Direct derived demand**. Considers movements that are directly the outcome of economic activities, without which they would not take place. For instance, work-related activities commonly involve commuting between the place of residence and the workplace as there is a supply of labor in one location (residence) and a demand of labor in another (workplace). For freight transportation, all the components of a supply chain require movements of raw materials, parts and finished products on modes such as trucks, rail or containerships.
- **Indirect derived demand**. Considers movements created by the requirements of other movements. The most obvious example is energy where consumption from transportation activities must be supplied by an energy production system requiring movements from zones of extraction to places of consumption. Warehousing can also be labeled as an indirect derived demand since it is a “non movement” of a freight element. Warehousing exists because it is virtually impossible to move commodities instantly from where they are produced to where they are consumed.

Transportation can also be perceived as an induced (or latent) demand which represents a demand response to a reduction in the price of a commodity (Noland and Cowart, 2000). This is particularly the case in the context where the addition of transport infrastructures results in traffic increases due to higher levels of accessibility. Roadway congestion is partially the outcome of induced transport demand as additional road capacity results in mode shifts, route shifts, redistribution of trips, generation of new trips, and land use changes that create new trips as well as longer trips (Noland, 2001). However, the induced demand process does not always take place. For instance, additional terminal capacity does not necessarily guarantee additional traffic as freight forwarders are free to select terminals they transit their traffic through, such as it is the case for maritime shipping (Slack, 1993).

1.2 Freight Transport Demand

The evaluation of freight transport demand follows a long tradition that links the demand with numerous factors related to the economy, the firms and the respective modes concerned (Allen, 1977, Winston, 1983). One of the most significant determinants in freight demand is variations in the GDP as the more active an economy is, the more freight in circulation due to manufacturing and consumers demands. The nature of the economy, such as the respective share of the primary, secondary and tertiary sectors, contributes to the level of freight intensity (Bennathan, Fraser and Thompson, 1992). In spite of paradigms stating the dematerialization of the economy, the quantity of freight being transported has steadily increased. The case of the United States is particularly relevant with a growing commodification of the economy, the growth of related freight movements, and the longer distances at which this freight is being carried (Figure 1).

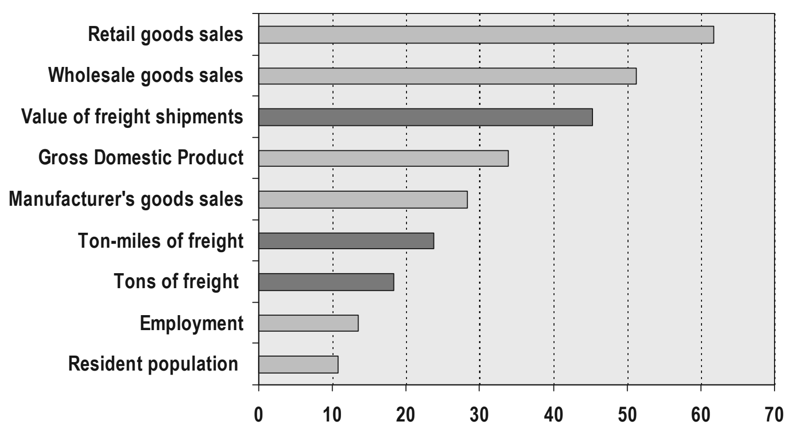

Figure 1 Increases in U.S. Commercial Freight Shipments and Related Growth Factors, 1993–2002
Source: U.S. Department of Transportation, Bureau of Transportation Statistics.

In the great majority of analytical conceptualizations, freight is labeled as a *dependant variable* affected by a set of complex and interdependent factors, each having its own weight. A compilation of these factors leaves a long and exhaustive list which can be refined and nuanced ad infinitum (Table 1).

Table 1 Factors behind Freight Transport Demand

Economy	General derived demand impact. Linked with the GDP. Function of the structure of the economy in terms of resources, goods, and services.
Spatial structure	Effect on ton-kms and on modal choice.

Globalization	Effect on ton-kms. Function of international trade structure. Containerization and intermodal transportation.
International agreements	Both concerning trade and transportation. Economic specialization. Increased transborder traffic. Simplified custom procedures.
JIT practices and warehousing	Decreased inventories. More shipments. Smaller line hauls. Shift to faster and more reliable modes. Use of 3rd party logistics providers.
Strategic alliances	Between carriers, shippers and often producers and retailers. Lower distribution costs.
Packaging and recycling	Increased transportability of products. Lower freight density. Reverse distribution.
Regulation and deregulation	Increased competition, level of service and lower costs. Growth of intermodal transportation.
Fuel costs, taxes and subsidies	Large and volatile cost components, specifically for energy intensive modes. Preferred mode or carrier.
Infrastructure and congestion	Efficiency, operating costs and reliability.
Safety and environmental policies	Operating speed, conditions and costs. Capacity and weight limits.
Technology	Containerization, double-stacking, automation and robotics, handling and interchange systems and automated terminals. Information systems (IDE). Lower costs, increased efficiency and reliability and new opportunities.

Source: adapted from Cambridge Systematics (1996) Quick Response Freight Manual, Federal Highway Administration, Office of Planning and Environment Technical Support Services for Planning Research, http://tmip.fhwa.dot.gov/clearinghouse/docs/quick/Quick.pdf.

As such, freight transport demand is much more complex and is consequently more difficult to predict than passenger demand, mainly because of the following (Cambridge Systematics, 1996):

- *Freight forwarders* decide whether a shipment is made or not and which mode and route it will take. As decision makers, they thus have their own routing rationale which can be based on ownership or control of a transport chain in preference to costs. A growing share of freight transport is being controlled by a declining number of distributors.
- The freight transportation market is highly *segmented and specialized* considering the wide variety of commodities being transported, ranging from raw materials, energy, to high value and perishable goods. Container transportation and air cargo are two very different freight industries, one mainly operating under cost constraints while the other operating under time constraints. So each freight market has its own behavior and level of functional integration.
- The *units of measurement* related to freight are various, ranging from monetary, quantity, weight, volume and load unit (TEU, carload, truckload, etc.),

implying many interdependent (but not easily interconvertible) ways to model and forecast demand. Monetary measures, which are subject to the confusion and unpredictability of exchange rates and inflation, are preferred for high added value freight, while weight figures are preferred for bulk.

- There are many *components in the freight transport costs* that take into account the many services freight handling requires in its composition, transport and decomposition. They range from the activities of handling, transferring, storing and moving freight, to activities related to its management with the complex information processing and exchange involved. Each freight movement generates a large amount of transactions and information flows (Roberts, 1999).

In view of the intricate complexities in contemporary freight distribution, is the concept of derived demand being challenged for several sectors of freight transportation? It must be readily acknowledged that the functions of production, consumption and distribution have become closely embedded making their respective differentiation problematic. The emergence of *global production networks* (Coe *et al*., 2004; Hendersen *et al*., 2002) and *global commodity chains* (Gereffi and Korzeniewicz, 1994; Gereffi, 1996) (GPN/GCC) underlines this growing integration. Although the literature on GPN/GCC investigates numerous actors, forces, geographies and their respective embeddedness, limited attention is placed on the role of transport and logistics to support this integration. Have the logistics sector and the emergence of global freight distribution triggered a paradigm shift in the functional and spatial relationships behind the concept of derived demand? This paper will try to provide conceptual and empirical evidence to substantiate the debate. First, the major challenges to derived freight demand are discussed; to what extent the emerging geography of distribution necessitates a reconsideration of its core assumptions, namely that freight demand is derived? Second, the concept of integrated demand is introduced; to what extent these challenges can be reconciled with a new conceptualization? Last, a discussion is provided about the implications of the concept of integrated demand to core activities involved with the estimation of freight flows, namely freight planning; what integrated demand involves for freight planning as well as for spatial and functional complementarity?

2. Challenges to Derived Freight Transport Demand

Synthetically, five core and interrelated elements appear to be challenging the traditional concept of derived demand. They imply the operational scale at which distribution systems are evolving at, changes in supply/demand relationships, the increased level of functional integration of supply chains, the new role and function of distribution centers, and how the time component is dealt with in supply chains.

2.1 Operational Scale

It is well known that the globalization of the economy has seen the emergence of global supply chains with their space of flows (Dicken, 2003). The operational scale of the involved actors has consequently expended substantially with *geographical integration*, a process well understood by contemporary economic geography. For the transport sector, multi-scale transport systems have emerged alongside, linking global processes with local realities through *functional integration* (Figure 2). These systems are dominantly regulated by large platforms and hubs benefiting from the network effect of convergence. Many such platforms simply cannot be bypassed, especially for globally-oriented flows, although a level of competition between platforms to attract freight flows may exist. Intermediate locations thus have become fundamental in the geography of freight circulation as they provide connectivity between corridors of circulation.

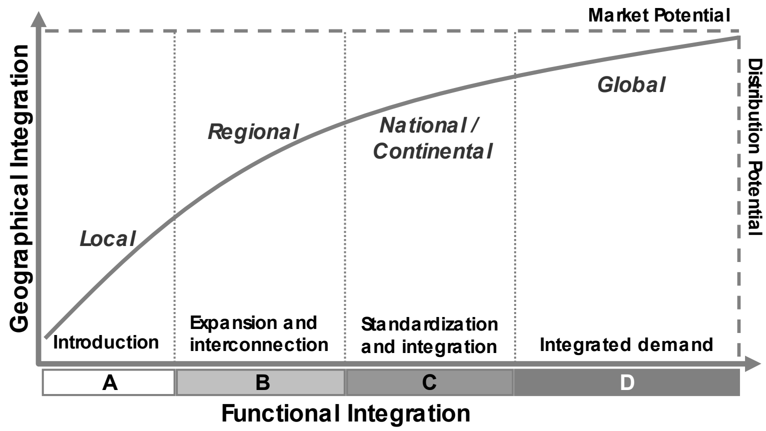

Figure 2 Extension of the Operational Scale of Freight Distribution

The purpose the extension of the operational scale of freight distribution is to insure that a production system reaches its optimal market potential in addition to its optimal production costs, namely by a combination of strategies related to the exploitation of comparative advantages and a wider market base. Although an optimal market size can never be attained due to regulations preventing monopolies and differences in consumer preferences, the trend to insure maximal market exposure is unmistakable. The emergence of global brands and global production networks clearly underlines this. Improving market potential cannot be done without improving the distribution potential. Within freight distribution, four distinct cyclic phases of geographical extension and functional integration can be identified:

- A) *Introduction*. Initially, a freight transport system is introduced to service a specific opportunity in an isolated context of local scale.
- B) *Expansion and interconnection*. As the marketability and the development potential of a distribution system becomes apparent, a phase of expansion and interconnection occurs. The size of the market serviced by this distribution system consequently increases as it becomes adopted in new locations. At some point, independently developed distribution systems connect and the emergence of hubs becomes apparent.
- C) *Standardization and integration*. This phase often involves the emergence of a fully developed distribution system servicing vast national markets. The major challenge to be addressed involves a standardization of modes and

processes, further expanding the commercial potential of the concerned supply chains. Modal flows are moving more efficiently over the entire network and are able to move from one mode to the other through intermodal integration. A process of mergers and acquisitions often accompanies this phase for the purpose of rationalization and market expansion.

- D) *Integrated demand*. The most advanced stage of extension of a distribution system involves a system fully able to answer freight mobility needs under a variety of circumstances, either predicted or unpredicted demand. As this system tends to be global, it commonly operates close to market potential. In such a setting, a distribution system expresses an integrated demand where the distribution capabilities are tuned to the demand in an interdependent system.

Each of these phases tends to be sequential and related to an historical process of transport development, reminiscent of prior conceptualizations (e.g. Taaffe, Morill and Gould, 1963) but considering the current globalization phase. For instance, up to the mid 19th century, most distribution systems were isolated and developed independently from one another. Even global maritime transport was fragmented by national flags and trading systems. As regional transport systems grew in the second half of the 19th century, they gradually interconnected, but moving from one system to the other required a form of transshipment. By the early 20th century, most national transport systems were integrated, but interconnection between modes was difficult. The next challenge resided in the development of intermodal transportation, accelerated by containerization and information technologies in the later part of the 20th century.

Consequently, the *scale effect* challenges the concept of derived demand as it appears that the most extensive the operational scale of distribution, the less derived demand applies. This is mainly due to the importance of intermediate locations regulating flows. They are in many ways more important than the origins and destinations as they tend to attract large flows. This observation is reinforced by the fact that the majority of freight flows, whatever the concerned mode, tend to agglomerate along specific high volume corridors. As geographical integration of production leads to a global convergence of production practices (global products, common standards, etc.), the functional integration of distribution has led to a local divergence in outcomes namely in terms hubs, flows and infrastructure.

2.2 Supply / Demand Relationships

Freight distribution is within a paradigm shift between “manufacture-to-supply” or inventory-based logistics (*push logistics*) to “manufacture-to-order” or replenishment-based logistics (*pull logistics*) (Figure 3). The reliance is shifting from maintaining inventories aimed at approximately satisfying the demand to a comprehensive data collection system insuring, mainly through on-demand transport, that supply matches with demand. This trend is accelerated by logistics, namely a better integration between transport modes and inventory control. Of particular relevance to the logistics industry has been the emergence of major coordinators and integrators (third and fourth-party logistics providers) that strive to improve a part of the supply chain. While a push logistics system involves a limited level of integration between suppliers, manufacturers and distributors, a pull logistics system tries to achieve a higher level of efficiency through integration. Freight flows between components of the supply chain tend to be more frequent and in smaller batches. In addition, the sharing of demand dependant data (such as sales) helps better synchronize supply with demand. Reverse logistics also tends to be better integrated in the system to achieve a higher level of customer service as well as to promote environmental strategies such as recycling.

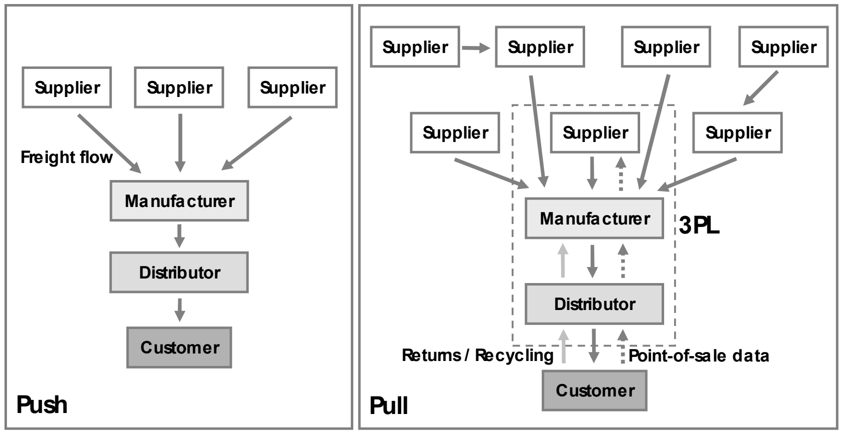

Figure 3 From Push to Pull Logistics

Derived transport demand is the outcome of a supply / demand relationship, to which transportation was bound to. However, the nature of this relationship has substantially changed along with the distribution market. Intermediate activities, such as packaging and bundling, now contribute significantly to this relationship along supply chains.

Contemporary distribution systems thus have shown a remarkable change, as they are becoming increasingly demand driven. Under such circumstances, minimal inventories are maintained and most of it is in circulation, thus the increasing importance of the transport component in distribution. The operational management of such a system relies heavily on information systems to insure that parts and / or products are delivered when required (on demand). Among the many advantages of a demand-driven system are higher inventory turnovers, better customer service, as well as increased labor productivity and capacity utilization, which should transcribe in higher incomes, returns and lower operating expenses (Lee, 2003).

Freight distribution is increasingly subject to market forces, namely with the emergence of a specialized logistics industry dominated by integrators, that synchronize mobility and offer a wide array of services. For this mobility to be synchronized, transportation cannot be solely a derived activity. A demand driven distribution system relies on a shift in the relative importance of specific logistical functions, mainly inventory, transport and information systems. This freight distribution system thus has created a paradoxical situation. The more demand-driven it is, the less the concept of derived demand applies as the relative importance of inventories is reduced while the importance of transportation *per se* increases accordingly. Another paradox involves that as transport costs are reduced, the reliance on distribution increased. The "death of distance" has been clamored many times, but it is more a misconception about the perception of transportation as an exogenous cost instead of the emerging reality that it has been internalized within supply chains. Manufacturing and mobility are much more embedded, implying that distribution is *integrated* in the process of production. Distribution then becomes concomitantly a derived and induced factor in transport demand. This is a move away from the consideration of transportation as an auxiliary economic function.

2.3 Functional Integration

The internalization of distribution is also accompanied by major changes in its operation and control. The efficiency of freight distribution is linked with the level of *functional integration* along supply chains. This efficiency is dependant not only on physical flows generated by its various functions (manufacturing, physical distribution, after-sales service...), but how well each element is linked with the other. Since transportation is a core component in this process of functional integration and economies of scale in distribution, the emergence of "megacarriers" involved in numerous segments of the transport chain can be seen as a logical process (Figure 4).

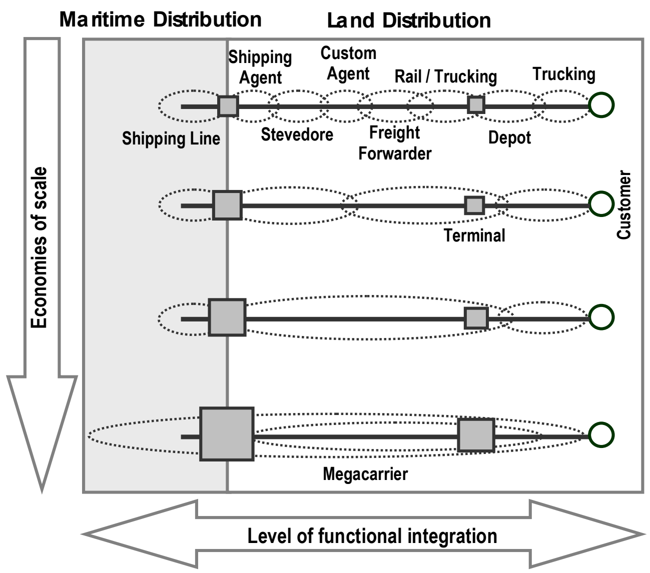

Figure 4 Functional Integration of Supply Chains
Source: adapted from Robinson, R. (2002) "Ports as Elements in Value-Driven Chain Systems: The New Paradigm", Maritime Policy and Management, Vol. 29, No. 3, pp. 241-255.

In a "push logistics" context, freight distribution was highly fragmented and was assumed by different entities ranging from maritime shipping lines, shipping and custom agents, freight forwarders and rail and trucking companies. Regulations were often preventing multimodal ownership, underlining this fragmented state. Moving freight from one part of the supply chain to the other involved additional costs and delays, either administrative or physical (namely intermodal) in nature. With an increasing level of functional integration, many intermediate steps have been removed. Mergers and acquisitions have permitted the emergence of large logistics operator that control many segments of the supply chain, a process supported by the development of economies of scale in distribution. Technology also played a significant role in this process with information technologies enabling a better *control of the process* and intermodal integration enabling a better *control of the flows*. Another significant outcome has been that maritime and land distribution systems have become closely integrated, with some transport companies involved in both. A similar process is taking place in the airline freight industry which has seen a growing level of functional integration through concentration (Bowen and Leinbach, 2004).

The control of the supply chain through functional integration challenges derived demand as the concerned actors (megacarriers) can *anticipate* and *regulate* the flows of freight. These integrators behave in a manner reflective that they are not responding to a derived demand, but in view to control their respective supply chains and answer the needs of their customers, if not often shaping them, or at least the time sequence at which they are serviced. Recent surveys (Deloitte & Touche, 2004) underline that functional integration is still in its early stages of development as current performance improvements in supply chains are focused on functions, facility, or geography, rather than a comprehensive optimization of supply chains. There is however a clear trend in that direction.

2.4 Distribution Centers

Distribution centers (DC) have become the fundamental link between production and consumption. From their conventional role as a warehouse close to final markets, DCs have evolved to provide an interface between the industrial and retail geographies of the supply chain they are involved with (Figure 5). By doing so, they have created a new geography of distribution where DCs perform numerous value-added activities, ranging from simple such as warehousing, packaging and labeling to complex such as providing some level of final assembly and taking returns.

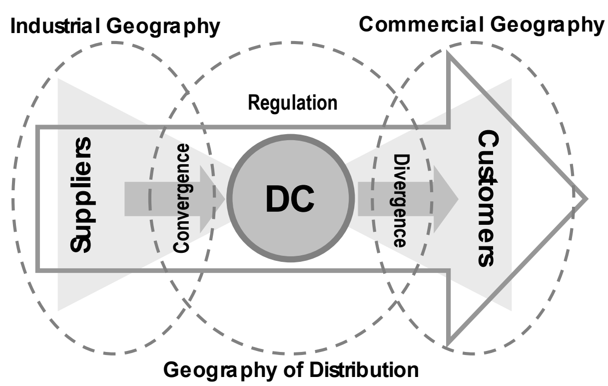

Figure 5 The Role of the Distribution Center

The concept of derived demand being challenged by a new geography of distribution as DCs act as key links in the functional integration of supply chains through processes of *convergence*, *regulation* and *divergence*. This involves new locations as well as new modes of operation, which impact on supply chains. Many activities linked with DCs have been concentrated in a limited number of facilities (often only one) having a high level of throughput and servicing extensive market areas if not the whole global market in some cases (such as electronic parts). The growing throughput of DCs is linked to a geographical convergence (from suppliers) and divergence (to customers) of vast amounts of freight flows. While manufacturing is concerned about the efficiency and reliability of its suppliers, DCs provide a crucial link to customers. The regulation function provided links manufacturing supply and demand with distributional capabilities. Several innovations have taken place in DCs making them more efficient and cost effective, namely automation, inventory control and cross-docking transfer capabilities. The location requirements of DCs have also changed to more peripheral locations where there is available land and a higher connectivity to road and/or air transport systems, with it the development of a new segment of the real estate industry (Hesse, 2004). A new geography of distribution is taking shape. Consequently, the DC can no longer be considered as a buffer in the supply chain, but as an element regulating and inducing its flows (Rodrigue, 2004).

2.5 Time Component

The emergence of time-constrained distribution systems (aka just-in-time) is mainly the results of pressures from manufacturing and retailing activities seeking to improve efficiency and productivity. The reduction of transport costs helped this process, but paradoxically, as transport costs and inventory levels dropped, the value of time increased (Figure 6).

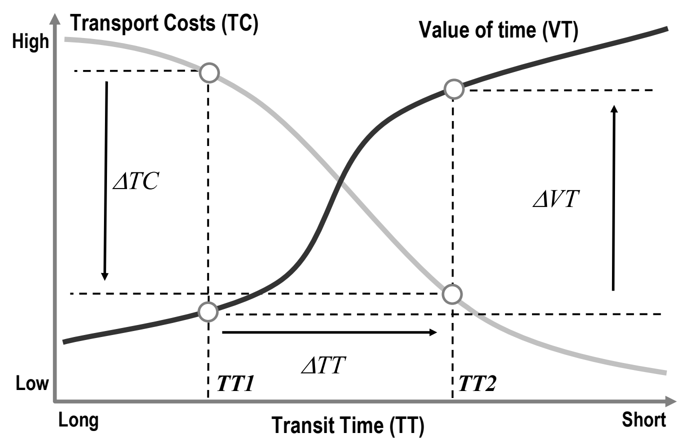

Figure 6 Transport Costs and the Value of Time

This can be explained by the fact that as the average transport costs and transit times are reduced, supply chains tend to be more synchronized with most of the inventory in circulation (Rodrigue, 1999). Under such circumstances, delays are of much more significance than before as limited inventory buffers are maintained. This factor of efficiency can also become a weakness, as it has been observed that when an element of the supply chain is shot down due to a disruptive event, it does not take long to see all other linked manufacturing and retailing activities being affected and even being shut down themselves, exacerbating the situation and even creating a “domino effect” The value of time thus increases proportionally even if the products themselves are not necessarily time-sensitive (e.g. textiles), but the supply chain they are part of is. The *certainty of time* becomes as important as the *shortness of time* in distribution (Cortright, 2001). As such, time conceptually moves from an *exogenous* (derived) to an *endogenous* component (integrated) of the transport demand. A particular challenge resides in the timing, sequence, and synchronization of freight flows, a core foundation of logistical management. Initially of most relevance for high value goods, the value of time percolates to lower value goods, especially over the retailing segment of the supply chain where many retailers apply time dependant supply practices for goods such as clothing or other basic consumer products. However, empirical evidence measuring the value of time is difficult to come by. For instance, Hummel (2001) observed at the international level that for manufactured goods each transit day is worth an average of 0.8% of the value of the good per day, the equivalent of a 16% tariff imposed on the shipment. At a smaller scale, the value of time is determinant in the efficiency in the freight distribution systems of many industrial sectors (Bergvist, 2001).

The time component remains one of the only major strategies left to achieve higher levels of productivity in freight distribution. Transit time and costs for container flows are particularly revealing (Figure 7).

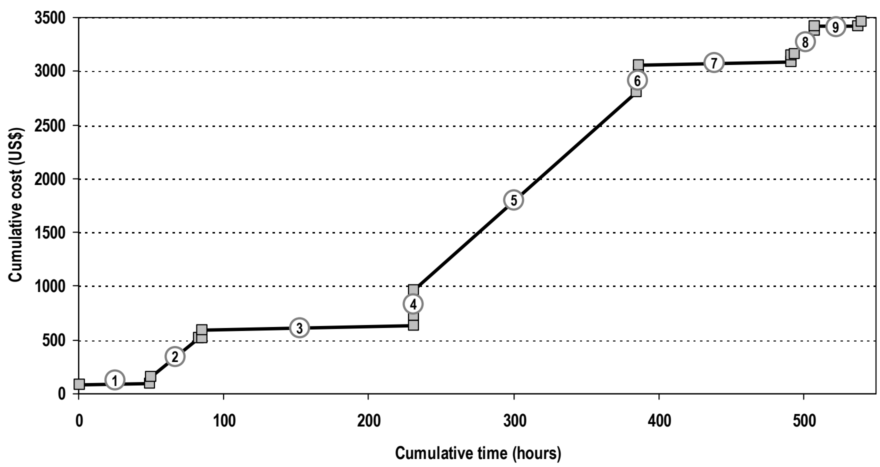

Figure 7 Cumulative Costs and Time of Moving a 40 Foot Container between the American East Coast and Western Europe
Source: Cost of Operations and Time for Shipping a 40' Container; in APEC's Congestion Points Study, Phase III, Best Practices Manual and Technical Report, Volume 2 Sea Transport, Feb. 1997, p. 105.

Moving a standard forty-footer container between the American East coast through New York and to Western Europe though Rotterdam in the late 1990s cost about $3,500 and took 540 hours (22.5 days). There is however acute imbalances between time and costs components behind such a flow (Table 2; derived from Figure 7).

Table 2 Most Significant Time and Costs Components of Moving a 40 Foot Container between the American East Coast and Western Europe

Activity	Cost	Time
1) Container waiting for pickup after stuffing	0.3%	8.8%
2) Road transport to port terminal	10.3%	6.1%
3) Waiting in stack (Port of New York)	1.1%	24.7%
4) Transfer/loading onto ship	6.8%	0%

5) Containership travel time (NY-Rotterdam)	52.6%	28.5%
6) Transfer/unloading off ship	5.5%	0%
7) Waiting in stack (Port of Rotterdam)	0.8%	19.6%
8) Road transport, port terminal to inland depot	6.3%	2.6%
9) Storage at inland depot	0%	5.5%

Cost / time components come into three major categories, including transport (2, 5 and 8), handling (4 and 6) and warehousing (1, 3, 7 and 9). Transport and handling costs have been reduced by many strategies, such as with economies of scale with larger containerships and faster and higher capacity cranes. It is unlikely that those costs can be reduced further, or in a significant manner. It is also unlikely that transit time (transport and handling) can be improved, especially transport times as containerships are not moving much faster; neither does road transportation, especially since inland road systems have become increasingly congested. The segments where the most significant improvements remain are time delays related to warehousing, which account for more than 60% of the total transit time. Stacking delays are particularly significant as just waiting at the port terminals account for 252 hours (10.5 days). Consequently the value of time represents a dominant element in improving the efficiency of freight distribution.

3. Integrated Transport Demand

3.1 Overview of the Concept

As initially argued, the elements discussed above questions the concept of derived demand, which leads to the formulation of a new paradigm to help understand contemporary freight distribution. The concept of integrated transport demand appears to be a relevant alternative to consider the shortcomings of derived demand vis-à-vis modern distribution. As such, transport activities are concomitantly planned with activities occurring at the origin, destination, and also at all intermediate stages to the extent that production, consumption and freight distribution are jointly considered. Integrated demand implicitly reflects the goals stated by supply chain management strategies where efficiency is partially derived from vertical integration along the supply chain. The main foundation of the concept is the control and anticipation of several key components of the supply chain:

- **Multi scale networks**. Intermediate locations regulating the flows of freight at different scales of the distribution system.
- **Demand**. Demand driven (*pull logistics*) distribution systems favoring a coordination of freight flows through a complex set of physical and information flows.
- **Functional integration**. A greater level of control of supply chains, especially supported by multimodal transport systems and megacarriers.
- **Distribution centers**. New locations and value added functions where distribution centers are integrated in the supply chain and regulating its flows.

- **Time component**. Increased value of time underlining the importance of supply chain synchronization.

These elements are particularly important in a highly competitive market where efficient logistics becomes a competitive factor. As such, integrated transport demand becomes a strategy to insure efficient freight distribution.

3.2 Implications for Freight Planning

Integrated transport demand implies a new geography of logistics which has implications for freight planning and forecasting models. They recognize that demand for freight transportation is derived from underlying economic activities (e.g. employment, population, income, etc.) and assume that forecasts of changes in economic variables are used to estimate the corresponding changes in freight traffic. Although this rational still holds from a macroeconomic perspective, the arguments we have provided underline that it has become increasingly difficult to tell where and how the freight will flow mainly because of the intermediate stages involved. The complex web of inter-enterprise relations, including the sub-contracting of logistical operations, has changed distribution networks and their underlying freight planning. A particular attention thus needs to be placed upon the locations regulating these flows, namely hubs and the transport corridors between them. Freight planning thus needs to pay a closer consideration to the networks and activities supporting freight distribution instead of the activities taking place at the origin and destination and of the transport network as a mere infrastructural constraint.

3.3 Assessment

The concept of integrated demand is obviously highly debatable as in spite of the growing level of integration within supply chains it can be argued that the concept of derived demand remains the same. Transport can simply be perceived as more imbedded in the process; *closely derived*. This is partially true depending on the perspective, either operational or strategic, in which freight distribution is being considered:

- **Operational perspective**. From a flow perspective, the concept of derived transport demand remains unchanged. Indeed, the fact that an interaction takes place on a transport system, with its underlying operational use of modes, terminals and distribution centers, is the outcome of a process generating a surplus at an origin (supply), which is used by a destination (demand).
- **Strategic perspective**. From a freight distribution perspective, notably when integrators (third and fourth party logistics providers) are involved, the concept of derived transport demand requires nuances as production and distribution are jointly planned. Integrated demand appears to be the emerging paradigm in global commodity chains both in terms of functional and geographical integration.

Thus, when flows in a transport system are considered, each of these interactions is the outcome of a derived demand. However, once the wider perspective of distribution is investigated, those derived flows appear to be integrated in a system of suppliers, customers and transport systems regulating these flows.

4. Conclusion: Understanding Space / Time Relationships in Supply Chains

This paper attempted to provide a conceptual background regarding changes in logistics and freight distribution. It has been underlined that both economic and transport geographies, in their conceptual representations of transportation, do not deal adequately with these issues. By considering freight transport as a derived demand, complex distributional dynamics are overlooked, especially in view of the global operational scale of distribution, the mounting importance of demand in regulating logistical flows, the growing level of functional integration of supply chains, the fundamental role of distribution centers and the rising value of time in distribution. The integrated freight transport demand argument brought forward by this paper suggests much reconsideration in the analysis of freight distribution and that a paradigm shift may be in the making, especially if transport is considered from a strategic perspective. Thus, at one scale (flows) the derived transport demand concept holds well, but at another (freight distribution) there are forces shaping a new paradigm.

For economic geography, this emerging paradigm implies that a greater importance must be placed on distribution as a factor of production and consumption as it is not a mere consequence of economic processes, but often a force actively shaping them. For transport geography, distribution should be considered as more than a space of flows, but also an economic process that adds value beyond mere transport costs. Both disciplines have diverged over the last decades and the consideration of supply chains offer a point of convergence to which economic and transport geographers can contribute. Supply chains, as both an economic and transport phenomenon, appear to be a nexus where economic and transport geographies meet.

While supply chains have been the object of substantial attention in management and engineering, many of their dimensions need to be integrated within geographical theory. Of particular interest are space / time relationships in supply chains where actors use the comparative advantages of the geography of the global economy and mitigate the corresponding transport requirements.

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