The terminalization of supply chains: reassessing the role of terminals in port/hinterland logistical relationships

Jean-Paul RODRIGUE
Department of Global Studies & Geography
Hofstra University, Hempstead, New York 11549, USA
Jean-paul.Rodrigue@Hofstra.edu

Theo NOTTEBOOM
Institute of Transport and Maritime Management Antwerp (ITMMA) – University of Antwerp
Keizerstraat 64, 2000 Antwerp
theo.notteboom@ua.ac.be

Abstract
The paper discusses how logistics service providers are using terminals in their supply chains. It argues that an increasing ‘terminalization’ of supply chains is unfolding, whereby seaport and inland terminals are taking up a more active role in supply chains by increasingly confronting market players with operational considerations such as imposing berthing windows, dwell time charges, truck slots, all this to increase throughput, optimize terminal capacity and make the best use of available land. With the development of inland terminals, a new dimension is being added: logistics players are now making best use of the free time available in seaports terminals and inland terminals, thereby optimizing the terminal buffer function. As a result, transport terminals are achieving an additional level of integration within supply chains that goes beyond their conventional transshipment role. Given increasing levels of vertical integration in the market and an increasing pressure on port capacity, a further terminalization of supply chains is likely to occur, which will strengthen the active role of terminals in logistics.

Keywords: freight distribution, port terminal, inland terminal, terminalization, supply chains
1. Introduction

Transport terminals are the main regulators of freight flows and as such considerably influence the setting and operation of supply chains in terms of location, capacity and reliability. Their function as gateways and hubs of global freight distribution is well known. Containerization has changed the function and layout of terminals. The introduction of container vessels meant larger cargo volumes per port call and shorter handling times per volume of freight. Both factors contributed to a modal separation at terminals and the setting of a significant buffer in the form of large stacking areas (figure 1). This modal separation in space was a requirement for setting up a system of indirect transshipment whereby each transport mode follows its own time schedule and operational throughput, implying a modal separation in time. Under the indirect transshipment system, the terminal stacking area functions as a buffer and temporary storage area between the deepsea operations and the land transport operations that take place later in the process (or earlier depending on the stage along the supply chain). As a consequence, and in spite of higher turnover levels, the space consumed by container terminals increased substantially. In turn, these space requirements changed the geography of ports and the migration of terminals to new peripheral sites, as outlined in port development models such as those of Bird (1980) and Hoyle (1988). These issues are well documented.

Figure 1 Modal and Temporal Separation at Freight Transport Terminals

However, advances in logistics in the last decades gave a new meaning to the temporary storage at terminals. Instead of using the stacking area as a facilitator for a smooth synchronization between transport modes, shippers and logistics service providers started to use terminals as places for the cheap storage of consignments. This change in the functional use of terminals implied that high dwell times at container yards were no longer an indication of a poor connectivity, low productivity and lack of synchronization between
maritime operations and land transport. It represents a divergence from conventional port productivity measures (Kek Choo Chung, 1993). High dwell times got increasingly associated with deliberate actions of actors in the supply chain. Additionally, in many cases the purchaser can delay payment to the vendor until final delivery even if the consignment is conveniently available at the nearby terminal. Terminals thus became buffers in supply chains, sometimes absorbing inefficiencies created elsewhere in the chain.

This paper discusses how logistics service providers are using terminals in their supply chains. It argues that an increasing ‘terminalization’ of supply chains is unfolding, whereby seaport and inland terminals are taking up a more active role in supply chains by increasingly confronting market players with operational considerations such as imposing berthing windows, dwell time charges, truck slots, all this to increase throughput, optimize terminal capacity and make the best use of available land. As a result, transport terminals are achieving an additional level of integration within supply chains that goes beyond their conventional transshipment role. Given increasing levels of vertical integration in production and distribution and an increasing pressure on port capacity, a further terminalization of supply chains is likely to occur, which will strengthen the active role of terminals in logistics.

First, this paper discusses the terminalization concept and links it to existing literature on the role of terminals. Then, it investigates the concrete unfolding of terminalization processes in supply chains. The role of deepsea terminals in shaping terminalization processes and examples of terminalization processes in Europe and North America are then presented.

2. Terminalization and the function of terminals in supply chains

A port terminal is commonly defined as a specialized facility where ocean vessels dock to discharge and load cargo. Container terminals are facilities designed to handle containers, with specialized equipment such as container cranes, straddle carriers or stacking cranes and container stacking areas. However, the above technical definition of a terminal does not portray the specific function of terminals in supply chains. Heaver (1993) argues that terminals have come to be specially designed to meet the cargo handling and throughput requirements of integrated logistic systems. Of particular relevance is Heaver’s assertion that terminals rather than ports are adversaries in the competitive struggle between ports. While terminals undeniably compete with one another, they do not compete exclusively for tangible assets such as port infrastructure. Operators are primarily competing through the provision of services that add value within the supply chains of its users. This perspective thus begs to reassess the role of terminals. Robinson (2006:54) and Robinson (2002) rightly underline that terminals are in essence through locations or elements in logistics pathways from sellers to buyers. It implies that terminals deliver value to its users (shipping lines, logistics service providers and shippers) not as individual locations but as elements in larger systems of circulation. The value creation process of a terminal is thus linked to the specific attributes of the supply chains that run through the terminal and the logistics network configuration in which the terminal plays a role.
In this paper, we introduce the concept of ‘terminalization’ of supply chains to capture the changing role of terminals as through locations in supply chains. It is worth considering to what extent terminalization is an unintended consequence of a new and more constrained context in freight distribution or simply a transitory phase in port / hinterland evolution. Initially, the term terminalization was brought forward to illustrate a new functional and operational reality of seaports where terminal operators were playing a more important role (Olivier and Slack, 2006; Slack 2007). For instance, the different strategies of global port operators, notably in terms of capital investment, have led in several cases in notable differences in terminal productivity within the same port. Here, the concept is expanded over the realm of supply chains, where two types of terminalization can be identified (Figure 2): bottleneck-derived terminalization and warehousing-derived (buffer) terminalization.

**Bottleneck-derived terminalization** encompasses a conventional perspective on the role of terminals where the terminal is the main source of delay and capacity constraint for the supply chain. It does not necessarily mean that the terminal is running close to capacity, but that operational issues (storage space, port call frequency, gate access) are imposing a more rational use of the facilities so that the performance and reliability of the terminal is maintained. This is particularly important since terminal operators must maintain a level of service to their users, particularly maritime shipping lines. In this case the supply chain adapts with volume, frequency and scheduling changes and may seek alternatives if possible.

**Warehousing-derived (buffer) terminalization** refers to an emerging trend where the function of warehousing, in whole or in part, is shifted to the terminal. The terminal becomes the main buffer instead of the distribution center, which functionally makes the terminal a component of the supply chain, no longer as a factor of delay, but as a storage unit. Even if this trend appears paradoxical vis-à-vis “just-in-time” strategies, it gives the supply chain a higher level of flexibility to lower their warehousing costs as well as to adapt to unforeseen events such as demand spikes or delays. An “inventory in transit” strategy coupled with an “inventory at terminal” one can reduce significantly warehousing requirements at distribution centers. Considering the wide variety of commodity chains, each with its own requirements in terms of origins, destinations, frequency, reliability and overall elasticity, buffer-derived terminalization can take many forms.

Historically, distribution centers were located adjacent to terminals, leading to the creation of port-industrial or rail-industrial complexes than not only encompassed heavy industrial activities but a wide range of manufacturing. The terminalization of supply chains was thus important as terminals were the core component in delays since inland freight distribution tended to be costly and unreliable for break-bulks. Containerization has broken this relevance, initially with improved intermodal efficiencies and later on with the setting of inland transport systems. Paradoxically, the terminal became less relevant as the productivity gains of containerization were absorbed by supply chains, which became structurally and spatially more flexible. This came to be known as the move from “push” (manufacture to supply) to “pull” (manufacture to order) logistics. 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 and synchronization. Freight flows between components of the supply chain
tended to be more frequent, in smaller batches and subject to tight time constraints. In addition, the sharing of demand dependant data (such as sales) helped better synchronize supply with demand. The emergence of large terminals in new manufacturing clusters, such as the Pearl River Delta, is indicative of the changes brought by the setting of global supply chains supporting global production networks.

However, due to supply chain issues, namely capacity, congestion and security, it is argued that terminalization is resurfing in a new form. The move from “push” to “pull” logistics may unfold as “hold” logistics where supply chain management places a greater emphasis to the time constraints related to terminal use. The conventional inventory in transit approach widely used for containerized modes is being complemented by buffer / hold logistics at terminals due to congestion, but also since the terminal is the convergence point – the gateway – of global freight distribution. However, it is becoming difficult for many large terminals, particularly gateway ports, to provide additional capacity because of space and environmental constraints. The capacity of inland distribution has also been a limiting factor, but the setting of inland terminals linked to gateways by high capacity corridors has provided a new dynamic as we will illustrate in the next section.

3. Unraveling terminalization processes in supply chains

Terminalization is a particularly suitable strategy for international long distance supply chains, which have become notably prevalent in the consumption goods sector, including a wide variety of products, from apparel to electronics. Figure 2 provides a schematic overview of a typical retailing supply chain where production and consumption have a substantial geographical differentiation. In the next sections we will consecutively look at how terminalization is unfolding in each of the segments of the supply chain.

Figure 2 Forces towards terminalization in a global retailing supply chain
3.1. Export flows to the gateway

The export oriented gateway in the midst of a manufacturing cluster is commonly facing capacity issues, implying some constraints in the usage of its facilities. Containerized cargo flows reach the gateway either directly from the supplier or via an intermediate export center in the port area, in a logistics zone near the gateway or in a hinterland location connected to the gateway via a multimodal transport corridor. Mainly in Pacific Asia, export centers are often used as consolidation points and container stuffing locations for non-containerized cargo. Inland connections tend to be poor and trade flows imbalanced, so distribution centers agglomerate nearby gateway facilities, which favors a fast turnover of containers. Once produced and assembled in container loads, the goal is to insure that they are shipped to the maritime segment promptly. Distribution tends to be synchronized with terminal handling capacity and availability implying that terminalization is mainly bottleneck-related at this stage.

3.2. The maritime segment

The maritime segment of the supply chain can be based on a gateway-to-gateway liner service configuration or, alternatively, might include an intermediate transshipment/interlining/relay facility. If an intermediate hub is part of the sequence, there is an opportunity to use it as a buffer and consolidation center. Intermediate hubs typically have the advantage of being lower cost locations, making them suitable to be buffers within global and long distance supply chains. Theys et al (2008) presented a generic framework on port logistics development and its interaction with hinterland regions and discussed the attractiveness of intermediate hubs in terms of logistics activities. The logistics attractiveness of ports that are heavily involved in transshipment cargo is partly determined by the structure of the hinterland markets. If a port transships cargo to smaller ports with poorly developed hinterlands then the intermediate hub will be particularly attractive for locating logistics facilities targeted to those overseas areas. When over time cargo throughput in such smaller ports increases, they might be directly served thereby undermining the logistics attractiveness of the intermediate hub. An intermediate hub can be purposely used as a buffer at locations in vicinity of large consumption markets such as in the Caribbean or the Mediterranean. This confers the potential to use a low cost storage point before entering areas with higher distribution costs. For instance, large gateways granting access to continental consumption markets (e.g. Northwest Europe, American West Coast) tend to be congested, an issue that have favored a set of inland access strategies, namely the development of inland terminals. Being less congested and closer to the distribution centers they serve, they have essentially become the buffer instead of the gateway.

3.3. Import flows to the hinterland: extended gates and the port-inland port duality

In the last fifteen years, the dynamics in logistics networks have created the right conditions for a large-scale development of inland cargo centers throughout Europe and North America. The range of functions of inland logistics centers varies from simple cargo consolidation to advanced logistics services. Many inland locations with multimodal
access have become broader logistics zones, taking a variety of functional roles based on specific customer and market requirements linked to differentiated supply chains. They not only have assumed a significant number of traditional cargo handling functions and services, but also have attracted many related services, such as distribution centers, shipping agents, trucking companies, forwarders, container repair facilities and packing firms. The concept of logistics zones in the hinterland is now well-advanced in Europe (e.g. ‘platformes logistiques’ in France, the Güterverkehrszentren (GVZ) in Germany, Interporti in Italy, Freight Villages in the UK and the Zonas de Actividades Logisticas (ZAL) in Spain). Logistics zones are usually created within the framework of regional development policies as joint initiatives by firms, intermodal operators, regional and local authorities, the central government and or the Chambers of Commerce and Industry. In some cases, they have the status of free trade zones, implying that they can be the locations where international cargo can go through customs with duties taken only when the cargo leaves the zone.

Quite a few of these logistics zones are competing with seaports as far as the location of European distribution facilities are concerned. Shortage of industrial premises, high land prices, congestion problems, the inland location of the European markets and severe environmental restrictions are some of the well-known arguments for companies not to locate in a seaport. The availability of fast, efficient and reliable intermodal connections is one of the most important prerequisites for the further development of inland terminals. Inland terminals increasingly act as extended gates of deepsea terminal facilities (Figure 2).

The interaction between seaports and inland locations leads to the development of a large logistics pole consisting of several logistics zones. Seaports are the central nodes driving the dynamics in such a large logistics pole. But at the same time seaports rely heavily on inland ports to preserve their attractiveness. To reflect the seaport-inland port duality, Notteboom & Rodrigue (2005) introduced a regionalization phase in port and port system development (see also Figure 2). Regionalization expands the hinterland reach of the port through a number of strategies linking it more closely to inland freight distribution centers. The phase of regionalization brings the perspective of port development to a higher geographical scale, i.e. beyond the port perimeter. The port regionalization phase is characterized by a strong functional interdependency and even joint development of a specific load centre and (selected) multimodal logistics platforms in its hinterland, ultimately leading to the formation of a regional load center network (figure 2). The port system consequently adapts to the imperatives of distribution systems, making regionalization a dimension of supply chain terminalization.

An important driver for the creation of regional load center networks relates to the requirements imposed by global production and consumption networks. No single locality can service efficiently the distribution requirements of a complex web of activities. Port regionalization permits the development of a distribution network that corresponds more closely to fragmented production and consumption systems. The transition towards the port regionalization phase is a gradual and market-driven process that mirrors the increased focus of market players on logistics integration. In the regionalization phase it is increasingly being acknowledged that land transport forms an important target for reducing logistics costs. The responses to these challenges go beyond the traditional
perspectives centered on the port itself. Regionalization as such provides a strategic answer to the imperatives of the inland distribution segment of the supply chain in terms of improving its efficiency, enhancing logistics integration and reducing distribution costs. With the development of inland terminals, such as satellite terminals, and broader regional load centre networks, a new dimension is being added enhancing a terminalization of supply chains: logistics players are now making best use of the free dwell time available in seaports terminals and inland terminals, thereby optimizing the terminal buffer function. Dwell times are also flexible enabling the setting of extended distribution centers that have a degree of synchronization with the gateway they are connected to. For satellite terminals in the vicinity of port terminals the degree of synchronization is high with a propensity of the extended distribution center to use dwell times at both the gateway and the satellite terminal as buffer. For inland ports, the degree of synchronization with the gateway tends to be low, but dwell times can be more flexible, also enabling the setting of extended distribution centers. The more important the customer in terms of volume, the higher its leverage with the terminal operator concerning dwell time, which is coupled with the general lower level of congestion of inland terminals. As a result transport terminals are achieving an additional level of integration within supply chains that goes beyond their conventional transshipment role (Figure 3).

Figure 3: Inland Terminals and Terminalization of Supply Chains

Port regionalization and the associated creation of inland cargo centers enable to partially circumscribe local constraints of seaports by externalizing them. Ports, especially large gateways, are facing a wide array of local constraints that impair their growth and efficiency. The lack of available land for expansion is among one of the most acute problems, an issue exacerbated by the deepwater requirements for handling larger ships. Increased port traffic may also lead to diseconomies as local road and rail systems are heavily burdened. Environmental constraints and local opposition to port development are
also of significance. As discussed before, this places pressures to lower free dwell time, often forcing freight forwarders to readjust their distribution strategies.

However, the possibilities of deploying inland cargo centers to solve the problems in seaports have their limits. First of all, there is the market potential needed to set up successful inland cargo centers. The profitability of an inland container terminal typically depends on two factors, namely its throughput and the size of its service area (Rabobank, 2000). The size of the service area has a large impact on the competitiveness of an inland terminal. In case the inland terminal is located in the vicinity of the seaport, the service area of the inland port (the market threshold) often covers a range of 10 km or less around the terminal, making the last trucking leg short and time responsive. Far away from the seaports (>300 km), service areas of inland terminals in some cases stretch up to a range of 60 km. Larger service areas imply high haul costs (pre- and end-haulage), which seriously hampers a terminal’s ability to attract new business, confer longer delivery times and increase the risk of competition with other inland terminals. All this impedes the acquisition of possible new customers. The expected terminal profitability is highest for terminals with a high throughput and a small service area.

Secondly, also inland ports are increasingly facing environmental regulations and a lack of spare capacity. This results in longer waiting times on terminals, which in turn leads to a reduced operational efficiency of inland vessels and crews. Still, numerous inland ports have spare capacity, resulting in the need for either higher charges per cargo unit or increased public financial support. Many inland cargo centers are forced to find a trade-off between proximity to the economic centers (services areas) on the one hand and land availability and public support on the other hand. Similar to the situation in seaports, inland cargo centers must demonstrate a high level of environmental performance and compliance in order to ensure community support.

3.4. Import flows to the hinterland: towards an extended DC

The import distribution segment of a typical retail supply chain is characterized by a multitude of routing options. The import flows across markets such as in Europe and North America are being redesigned to respond to varying customer and product service level requirements. A generic distribution structure does not exist. Companies can opt for direct delivery without going through a distribution center, distribution through a main distribution center (MDC, e.g. one serving the whole of Europe), distribution through a group of national or regional DCs (NDC/RDC) or a tiered structure in which one MDC and several RDCs are combined to form a comprehensive multi-layered distribution network.

The choice between the various distribution formulas depends on a multitude of factors. Kuipers and Eenhuizen (2004) identified a set of important logistics characteristics that can have an impact on the choice of distribution structures and on whether or not to locate logistics/distribution activities in a port. These characteristics relate to the value-density expressed in value per cubic meter, the needs in terms of delivery frequency, the perceived economies of scale and scope in production, country-specific product or packaging requirements, the share of transport costs in total distribution costs, the share of distribution costs in total production costs and the technological dynamism related to the
product. On top of this, the specific geographical and economic characteristics of the production and consumption markets will have an impact on the chosen distribution formula. In the fresh food industry for example, worldwide or main distribution centers are unusual because the type of product (mostly perishables) dictates a local distribution structure. In the pharmaceuticals industry, main distribution centers are common but regional or local distribution centers are not present, because the pharmaceutical products are often manufactured in one central plant and delivery times are not very critical (hospitals often have own inventories). However, in the high tech spare parts industry, all of the distribution center functions can be present because spare parts need to be delivered within a few hours and high tech spare parts are usually very expensive (which would require centralized distribution structures). At present, the network structures have become more complex as various forms of smaller local warehouses, ‘merge in transit’ concepts or ‘cross docking’ facilities have been introduced to guarantee a high level of service, frequency of delivery and distribution cost control. Companies today often opt for a hybrid distribution structure of centralized and local distribution facilities. For instance, they use an MDC for medium- and slow-moving products and RDCs for fast-moving products. These RDCs typically function as rapid fulfillment centers rather than holding inventories. The classical or multi-country distribution structures are being replaced by merge-in-transit, cross-docking or other fluid logistics structures.

The increasing differentiation of supply chains and related logistics networks, in response to specific customer and market requirements, is having an impact on the specific role of seaport and inland terminals. Just like other market players, terminal operators are trying to capture value and revenue. Where possible and desired, they are teaming up with shippers and logistics service providers to create value through developing concepts to streamline and synchronize supply chains. A concrete outcome of this development on the inland segment of the supply chain relates to the role of inland terminals as extended distribution centers (Figure 2). Terminalization is trickling down inland, conferring the benefits of a location close to the distribution center (and of final markets) and of a higher likelihood that the consignment will be held at the terminal and made available “on call”. The broadening of the DC functions to include a nearby inland terminal also makes it possible to arrange direct delivery of full container loads without physically passing the cargo through the DC (see also figure 3).

Table 1 summarizes the main dimensions of the terminalization concept discussed so far, particularly over the issues of scale, mode and actors as they pertain to extended gate and the extended distribution center. For the extended gate, it commonly takes the form of a satellite terminal when in proximity to a port terminal or an inland port (terminal) when linked to long distance corridors. The associated inland freight distribution remains the realm of rail or barge services and act as intermodal or transmodal nodes managed by transport and terminal operators. For the extended distribution center, it either relies on gateway synchronization when linked to a port terminal and to a joint synchronization to the inland terminal and its related corridor when located inland. When linked with intermodal activities, they perform a wide variety of transport functions such as deliveries and the repositioning of empty containers, but when solely linked with road, they mainly act as points for merge in transit or cross-docking. The relationships extended distribution centers establish with terminals is intricate, particularly with the usage of dwell times as a buffer in freight distribution (figure 3).
Table 1: Main Dimensions of Terminalization

<table>
<thead>
<tr>
<th>Scale</th>
<th>Mode</th>
<th>Actors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Distance</td>
<td>Long Distance</td>
<td>Road</td>
</tr>
<tr>
<td>Rail / Barge</td>
<td>Mode</td>
<td>Transport and terminal operators</td>
</tr>
<tr>
<td>Road</td>
<td>Distribution centers</td>
<td></td>
</tr>
<tr>
<td>Extended Gate</td>
<td>Satellite terminals</td>
<td>Dominant (initiator)</td>
</tr>
<tr>
<td>Inland terminals with corridors</td>
<td>Limited (initiator)</td>
<td></td>
</tr>
<tr>
<td>Intermodal or transmodal</td>
<td>Limited (initiator)</td>
<td></td>
</tr>
<tr>
<td>Merge in transit / Cross-docking</td>
<td>Facilitator</td>
<td></td>
</tr>
<tr>
<td>Extended Distribution Center</td>
<td>High level of gateway synchronization</td>
<td>Dominant (initiator)</td>
</tr>
<tr>
<td>High inland port synchronization (corridor dependent)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Terminalization and Operational Strategies at Deepsea Terminals

As outlined previously, logistics players are now making best use of the free time available in deepsea terminals and inland terminals, thereby optimizing the terminal buffer function. In principle, this trend has been facilitated by the pricing strategies of the terminal operators: free time on the deepsea terminals has a tendency to decrease and higher charges apply to containers that stay on the terminal for a longer period of time. However, not in all ports these charging systems have been effective in lowering dwell times. Hence, the increasing differentiation of supply chains and advances in distribution structures made quite a few chain managers less susceptible to variations in dwell time strategies of terminal operators. Dwell time charges typically remain rather low compared to the total logistics costs of the goods. Many receivers of the goods might therefore opt for cheap storage at the terminal instead of at their own warehouse or factory premises, provided this solution adds value to the supply chain. An alternative strategy consists in transferring the temporary storage function to other nodes in the container network, primarily inland terminals and satellite ports (the extended gate).

In European main ports the average dwell time on deepsea container terminals ranges from four to more than seven days (table 2), with most terminals offering a free storage time of around seven days (Dekker, 2005; Merckx, 2006). There is a particular disconnect between import and export dwell times which is indicative that importers of containerized foreign goods are using dwell times for their inland distribution strategies. High dwell times are less of a concern when ample stacking capacity is available. However, with concerns about container terminal capacity shortages in Europe and North America, terminal operators have come to realize that a generous free storage time could seriously reduce yard capacity as well as undermine the efficiency of hinterland access. For instance, the port of Los Angeles reduced in 2005 free dwelling time by one day to four days for imports and six days for exports. This difference reflects the imbalanced container flows handled by the gateway and forces customers to move their freight inland to help free strained inbound terminal capacity. The plan for 2006 was to reduce free dwell time requirements by one additional day, again as an attempt to free terminal capacity. However, this measure was abandoned, mainly due to pressures from the port’s
customers. Such constraints would have been difficult to reconcile with well established supply chain practices.

Table 2: Average dwell times at major European container terminals (in days)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Bremen</th>
<th>Hamburg</th>
<th>Rotterdam</th>
<th>Antwerp</th>
<th>La Spezia</th>
<th>Gioia Tauro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Import dwell vessel – truck</td>
<td>6.4</td>
<td>6.4</td>
<td>6.4</td>
<td>6.4</td>
<td>7.4</td>
<td>7.4</td>
</tr>
<tr>
<td>Export dwell truck – vessel</td>
<td>4.6</td>
<td>4.6</td>
<td>4.6</td>
<td>4.6</td>
<td>5.6</td>
<td>5.6</td>
</tr>
<tr>
<td>Import dwell vessel – train</td>
<td>6.5</td>
<td>6.5</td>
<td>6.5</td>
<td>6.5</td>
<td>7.5</td>
<td>7.5</td>
</tr>
<tr>
<td>Export dwell train – vessel</td>
<td>4.7</td>
<td>4.7</td>
<td>4.7</td>
<td>4.7</td>
<td>5.7</td>
<td>5.7</td>
</tr>
<tr>
<td>Import dwell vessel – barge</td>
<td>4.1</td>
<td>4.1</td>
<td>4.1</td>
<td>4.1</td>
<td>5.1</td>
<td>5.1</td>
</tr>
<tr>
<td>Export dwell barge – vessel</td>
<td>4.3</td>
<td>4.3</td>
<td>4.3</td>
<td>4.3</td>
<td>5.3</td>
<td>5.3</td>
</tr>
<tr>
<td>Transshipment dwell</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5.3</td>
</tr>
</tbody>
</table>

Source: Dekker (2005)

It is very likely terminals will take up a more active role in supply chains in the future by increasingly confronting market players with operational considerations through imposing berthing windows, dwell time charges, truck slots, etc., all this to increase throughput, optimize terminal capacity and make the best use of the available land. This will enhance a further terminalization of supply chains. The more terminals become relatively scarce or capacity constrained, the stronger the trend towards a more active role by terminal operators. Many have very limited options for terminal expansion, particularly if they are high volume and well established gateways.

5. Terminalization in practice

The remainder of this paper discusses some recent terminalization initiatives. This section contains two North-American cases (i.e. transloading at US West Coast ports and the role of inland hub Chicago) and two European cases. The European cases all relate to the Rhine-Scheldt Delta, i.e. the Extended Distribution Center of JVC Belgium and the Extended Gate strategy of terminal operator ECT in Rotterdam. The Rhine-Scheldt delta area accommodates a large concentration of seaports with a total maritime throughput of 710 million tons (18% of total port throughput in the European Union) and a container throughput of 18.7 million TEU in 2006 (about 23% of the European total). The seaports in this region, in particular the main ports of Rotterdam and Antwerp, have become the main drivers of a large logistics pole covering the Benelux, northern France and western Germany. The existing geographical concentration of logistics sites has stimulated the development of inland terminals in these areas.

5.1. The extended DC system of JVC Belgium

JVC Belgium was set up in 1999 and is responsible for the European distribution of the products of Japanese electronics producer JVC. The European Distribution Centre is located in Boom, halfway between Antwerp and Brussels in Belgium. JVC Belgium uses inland barges to transport the containers with imported electronics (mostly with an Asian
origin) to the EDC in Boom. The containers are handled at the inland terminal TCT Belgium, part of ECT/Hutchison and situated along the Scheldt-Brussels Canal. The terminal maintains a daily barge connection to Rotterdam and three daily sailings to Antwerp. Two elements make this an interesting case and a good example of a streamlined supply system: the nature of the agreements with the deepsea shipping lines and the way JVC Belgium deals with transit and dwell times.

Virtually all the containers from the Far East are discharged in Rotterdam as it features as first port of call in many liner services on the Far East/ North Europe trade. As of December 2007, Rotterdam acted as first port of call on 10 of the 32 services on this trade route. The port of call is of limited relevance as the first and only priority to JVC Belgium is the uninterrupted delivery of containers to the EDC in Boom. Over the years, JVC has developed a simple and effective system for the transport of containers between Rotterdam and Boom. All deliveries take place by barge via the inland terminal of TCT Belgium in nearby Willebroek.

In early 2005, JVC Belgium abandoned the traditional system of submitting transport orders to the deepsea carriers. Instead of giving shipping lines a separate transport order for each container, the company now follows the four day rule: each container discharged in Rotterdam should be at TCT Belgium within three days. This implies that the logistics planning system behind JVC Belgium does no longer consider the total transit time from Asia to Europe (and associated problems with delayed containers), but only the transit time from the port of Rotterdam to its distribution center. JVC keeps a close eye on the seven shipping lines with which they do business. They especially monitor the compliance to the four-day rule.

Every morning TCT Belgium informs JVC about the number of containers that are waiting at the inland terminal or will be arriving later that day. JVC picks the containers they like to have in their warehouse that day and these are subsequently delivered by truck to the warehouse between 8 and 11am. Trucks take empties on the way back to the inland terminal facility. In the afternoon, the truck bays at the EDC are solely used for supplying the regional distribution centers in the European Union.

The warehouse management system of JVC considers full containers stacked at TCT Belgium to be in stock like any other inventory within the walls of the warehouse. Having stock in two different places and two different forms (containerized and in racks) offers advantages. If a full container load of a specific product needs to be delivered to a regional distribution centre somewhere in Europe, JVC might leave the stock in the warehouse and send directly a full container stationed at TCT Belgium, since it has to be moved anyway.

The streamlined supply system of JVC Belgium makes optimal use of the free storage time at the deepsea terminal in Rotterdam and at the inland terminal. Free time in Rotterdam is limited to around 5 days, while free time at TCT Belgium amounts to 21 days. By imposing the four-day rule to shipping lines, JVC Belgium guarantees the dwell time at the deepsea terminal never exceeds the free time. The free storage period at TCT Belgium is long enough for the rather fast moving consumer goods JVC is involved in. In other words, JVC has successfully externalized a significant share of its warehousing costs through an optimal combination of deepsea and inland terminals.
5.2. The extended gate TCT Venlo

Inland terminals can be incorporated as ‘extended gates’ to seaport terminals and as such can help reducing container dwell times on seaport terminals. In late 2007, an extended gate in the hinterland of the Rhine Scheldt Delta was initiated by ECT Delta Terminal in Rotterdam, the shipping line APL, APL Logistics and the forwarder DHL. After arrival at the deepsea terminal, containers are directly moved by train to TCT Venlo, an inland rail terminal on the Dutch-German border operated by ECT. Customs considers TCT Venlo as an extension of the ECT Delta Terminal, so custom clearance can be done inland. Well before the vessel arrives in Rotterdam, APL informs ECT which containers are bound for the Venlo region. ECT remains responsible en route between the deepsea terminal and TCT Venlo. The inland terminal has a bonded warehouse C license, implying APL does not have to draw up a customs document for the follow-up declaration for transport to TCT Venlo. Containers which have arrived at the rail terminal can be entered in the warehouse management systems of the customers.

APL Logistics initially aimed for a similar solution in Germany, but the cross-border character of such an arrangement and the accompanying differences in customs regulations between the Netherlands and Germany posed major obstacles. This explains why the companies finally opted for an inland terminal in the Netherlands.

TCT Venlo is an example of the active strategy of HPH-owned ECT of acquiring key inland terminals acting as extended gates to its deepsea terminals. This strategy also includes the DeCeTe terminal in Duisburg (Germany) and TCT Belgium in Willebroek (Belgium). ECT in Rotterdam is not the only deepsea terminal operator developing an active extended gate policy (Notteboom, 2008). The door-to-door philosophy of other companies such as APM Terminals, DP world and Eurogate has transformed these terminal operators into logistics organizations and or organizers/operators of inland services. Maersk Line wants to push containers into the hinterland supported by its terminal branch APM Terminals and its rail branch European Rail Shuttle (ERS). DP World is working in partnership with CMA CGM to streamline intermodal operations on the Seine and Rhône axes, while the large terminals of Antwerp Gateway (open since 2005) and London Gateway (future) are both linked to inland centers. DP World has set up Hintermodal in joint venture with the intermodal transport organizer Shipit to give concrete content to the concept of ‘terminal operator haulage’ from the Antwerp Gateway terminal to the hinterland. The terminal operator haulage concept is aimed at a more active involvement of the terminal operator in hinterland connections by establishing closer relationships with shipping lines and inland operators.

Terminal operators can play an instrumental role in bringing together intermodal volumes of competing lines and as such create a basis for improved or even new intermodal services. Terminal operators in Europe are expected to increase their influence throughout supply chains by engaging into inland transport. They seem to do so mainly by incorporating inland terminals as extended gates to seaport terminals and by introducing an integrated terminal operator haulage concept for the customers. The advantages of the extended gate system are substantial: customers can have their containers available in close proximity to their customer base, while the deepsea terminal operator faces less pressure on the deep-sea terminals due to shorter dwell times and can guarantee a better
planning and utilization of the rail and barge shuttles. However, the success of both extended gates and terminal operator haulage largely depends on the transparency of the goods and information flows. Unfortunately, terminal operators often lack information on the onward inland transport segment for containers that are discharged at the terminal. A close coordination with shipping lines, forwarders and shippers is needed to maximize the possibilities for the development of integrated bundling concepts to the hinterland.

Also, deepsea shipping lines are developing hub-concepts in the hinterland of the Rhine-Scheldt Delta ports in order to cope with terminal congestion, the growing problem of imbalances and the need to reposition (empty) containers. Inland terminals are responding to this need by jointly developing regional services (e.g. setting up a central organization responsible for empty containers). Contrary to the Rotterdam-Antwerp inter-port market where barge container transport is ‘dominated’ by the deepsea shipping lines (carrier haulage), the inland market is still dominated by large shippers (merchant haulage).

5.3. Extended gate operations: transloading at the San Pedro Bay Ports

The San Pedro Bay Ports – Los Angeles and Long Beach – are the main gateways of the North American West Coast and handled about 60% of all the TEU of that maritime façade in 2005 and 29% of all North American containerized volume. They also handled about 13% of the value ($258.9 billion) of all international trade handled by American modal gateways, air (airports), land (ports of entry) and maritime (ports) combined. Even if under the jurisdiction of two port authorities, they are functionally a single port. In spite of an average annual traffic growth of 19% since 1990, from 3.7 million TEU to 15.7 million TEU in 2006, the terminal facilities remain essentially the same. There are limited options for expansion and terminal operations are increasingly facing constraining environmental regulations (e.g. truck idling at the gates). One approach to rising congestion has been the reduction of free dwell times by one day in 2005 in an attempt to address terminal capacity issues, particularly for imports.

A serious operational constraint facing West Coast ports involves imbalanced container flows reflecting imbalanced trade patterns with Pacific Asia. Both ports export a much greater quantity of empty containers than loaded. For instance, while the Port of Los Angeles exported about 1.2 million TEU of loaded containers in 2006, it exported 2.3 million TEU of empties. A large quantity of maritime containers thus leaves the United States empty to be shipped across the Pacific and are then brought back loaded with goods. Since maritime containers shipped inland are most likely to come back empty, an additional inland leg would exacerbate the problem. It is thus not surprising that maritime shipping companies are reluctant to have maritime containers going far inland because of empty repositioning.

The optimal size of the North American intermodal load unit is 53 feet, which is the largest load permitted on the interstate highway system. Having 40 foot containers moving inland can be perceived as a suboptimal use of existing rail and road capacity. The outcome of such constraints has been the setting of transloading facilities in the vicinity of the San Pedro Bay ports where the contents of about three maritime containers (40 footers) are transferred into two domestic containers (53 footers). Then, the domestic
containers are carried to rail terminals and shipped to inland destinations. Empty maritime containers are returned to the port terminals and put back on maritime shipping routes. Consignments bound to the regional markets are shipped directly from the port facility. About 25% of all international cargo to be moved by rail is transloaded in domestic containers, which is a substantial volume. The transloading of containers represents a unique form of terminalization where the terminals become an interface between the operational characteristics of the international and continental freight distribution systems (Figure 4).

Figure 4: The Extended Gate of the Ports of Los Angeles / Long Beach: Inland Traffic Share by Mode

Source: Port of Long Beach (2005)

About one third of all the long distance freight carried out of the San Pedro Bay ports is transloaded into domestic containers. Another third is carried through the Alameda Corridor, a 20-mile-long rail high capacity freight expressway linking the port cluster to the transcontinental rail terminals near downtown Los Angeles. Since coming online in 2003, the number of trains going through the corridor has grown relatively on par with the containerized traffic at the port cluster. Since empty container exports have accounted for a substantial share of the recent growth of port traffic, empty containers being transited at a discount also account for a significant share of the corridor’s traffic growth. The Alameda freight corridor appears to be a phase of inertia as users are reluctant to abandon existing modal and freight distribution practices. A significant factor impeding its growth is the transloading function assumed by the nearby distribution centers, an indication that
the terminalization of the concerned continental supply chains cannot be easily by-passed, even with alternative inland distribution opportunities.

5.4. Chicago: North America’s Nexus

Terminalization has moved far inland in North America. After more than two decades in the setting of long distance containerized rail corridors (commonly labeled as landbridges), North American freight distribution is facing acute inland capacity problems at its chokepoints (Rodrique, 2007). This situation is exacerbated by the realities of ownership fragmentations of rail networks where different parts of the system are serviced by seven major rail operators. Three major components can be identified; the Western United States, the Eastern United States and the Canadian system, which functionally can be considered a North American system since it links the three major maritime facades; the East Coast, the West Coast and the Gulf of Mexico (Figure 5). They all connect in Chicago, the most important inland terminals complex in North America, which accounts for 50% of American rail freight volume – about 14 million TEU were handled by the rail terminals in 2004.

Intermodal trains on the Western American system have an average length of 164 cars (about 650 TEU of doublestack containers) while intermodal trains on the Eastern system have an average length of 110 cars (440 TEU), which underlines differences in the operational characteristics between the systems. About 70% of the containerized traffic entering Chicago by rail has a final destination that is more than 480 kilometers away, which makes rail the preferable alternative, but also causes serious transmodal (rail to rail) problems. The terminals of each rail operator are located in different parts of the metropolitan area, so transmodal movements are assumed by trucks or rail switch carriers. From a supply chain perspective this causes additional delays and unreliability in deliveries. Many distribution centers servicing the East Coast have located inland (e.g. Pennsylvania and upstate New York) to have a better level of truck access to the rail terminals at Chicago. So, instead of another rail segment between Chicago and East Coast destinations, in many cases containers are transloaded at Chicago and carried by truck directly to inland distribution centers. This bottleneck form of terminalization thus had a substantial impact in the geography and operations of North American supply chains.

---

1 BNSF - Burlington Northern and Santa Fe, CN - Canadian National, CP - Canadian Pacific, CSX Transportation, NS - Norfolk Southern, KCS - Kansas City Southern and UP - Union Pacific.
6. Conclusions

After half a century of containerization the transport terminal is no longer a passive element within supply chains, imposing a given set of conventional constraints in terms of capacity, efficiency and reliability. Terminals, both as constraints and buffers, are becoming more embedded within supply chain practices which, as discussed in this paper, can take many forms. The increasing differentiation of supply chains and related logistics network structures, in response to customer and market requirements, is driving the logistic relationship between ports and inland terminals. In response, terminal operators and logistics service providers are rethinking their strategies to capture revenue and profits and add value to the customer, without neglecting operational considerations linked to terminals. On the one hand, several logistics service providers and shippers are actively using terminals as an extended component of their distribution centers, which led to the emergence of extended distribution centers. On the other hand, terminal operators are also reacting to the changes in supply chain management practices by imposing restrictions in terms of dwell time and conditions to terminal access. Inland terminals are increasingly incorporated as extended gates to seaport terminals and as such can help reducing container dwell times at seaport terminals by transferring it inland.
The emergence of inland terminals can be seen as a compromise where both actors – operators and users – find an alternative to their constraints, leading to the setting of extended gates and extended distribution centers as components of port regionalization strategies. Although empirical evidence underlines that terminalization is the result of unintended consequences and specific customer and market needs, it appears to be a distinct phase in the evolution of global supply chains. It is thus a long term trend reflecting the adaptation of global supply chains to the functional reality of transport terminals. An enduring growth of global container traffic will force new distribution strategies in which transport terminals, from offshore hubs, gateways and inland ports, are likely to play a greater role.

This paper conceptualized the changing role of terminals in supply chains by introducing the terminalization concept. It does not assume to provide all answers to the practical implications of observed terminalization processes. The paper is aimed at triggering further research on the extent and attributes of successful terminalization strategies by market players. A major field for further study relate to the geographical and functional differences in terminalization strategies according to different supply chains and commodity flows. This paper portrayed terminalization as a generic tendency driving the port-hinterland logistical relationship. However, each supply chain involves different market and freight distribution strategies which result in different forms of terminal use and hinterland operations. Therefore, the contribution of terminalization processes in the further integration of the chains might differ among supply chains. Also, the role of market players in shaping terminalization processes (both bottleneck-derived and warehousing-derived) might be different depending on the specificities of the supply chains under consideration.

References

Bird, J., 1980, Seaports and seaport terminals, London, Hutchinson University Library


Hoyle, B., 1988, Development at the port-city interface, Revitalising the waterfront: international dimensions of dockland redevelopment, Hoyle, B.S., Pinder, D.A. and Husain, H.S. (Eds.), Belhaven Press, London, 4-19

Kek Choo Chung, 1993, Port Performance Indicators, The World Bank, Transportation, Water and Urban Development Department, No. PS-6,


Merckx, F., 2006, The impact of dwell times on container terminal capacity, in: Notteboom, T. (ed.), Ports are more than piers, De Lloyd, Antwerp, 399-422


Rabobank, 2000, Waterlogistiek: Vaart in de ruimtelijke ontwikkeling van logistieke dienstverlening, Rabobank, Utrecht (in Dutch)


