

Detours in Supply, Logistics and Freight Transport Chains

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Abstract

From the perspective of a transport service buyer and at the abstraction level of material flows, all transports travel directly from product supplier to customer. In reality the directness of transport services depends on factors such as geography, available infrastructure, temporary conditions, shippers' qualitative preferences, possibilities for consolidation and access to return flows. This paper examines detours by structuring and elaborating upon the causes of freight transport detours and analyzing their effect.

Detours are looked from supply chain, logistics and freight transport perspectives. Freight transport detours are divided into physical, political, commercial, operational and non-planned causes. The first two stipulate the environment in which transport service providers decide upon detours. Operational causes are subject to internal decision making whereas commercial and non-planned causes are both external and internal to transport service providers.

Keywords: Detour, distance, efficiency, freight transport.

Introduction

Very few, if any, freight transport services are performed directly between the consignor and the consignee. Impedence due to geography, infrastructure, congestion and weather conditions are common reasons for not electing for the shortest path. Geographical theory deals well with detours imposed by physical conditions, as exemplified by the detour index which is simply the ratio of transport distance over the Cartesian distance. Operational measures to consolidate goods in terminals and through routing, to capture backhaul opportunities, to utilize intermodal transportation and to route for lower fuel, infrastructure and transport services costs also imply detours. Furthermore, regulation adds distance with cabotage rules, subsidies to certain services, variations in infrastructure quality and charging, restrictions to few border crossings or ports of entry, zones or paths with forbidden transit and limited driving hours.

It is acknowledged that using the theoretically shortest distance is not an aim *per se* and there is often a perfectly rational reason behind a detouring decision. An indirect path that appears irrational

from a geographical (distance-based) standpoint could from a supply chain management standpoint be more effective. Analyzing the causes of detours and to elaborate on a categorization of the different causes of this theoretical inefficiency of freight transport services remains a relevant approach to understand the relationships between supply chain management, logistics, freight transport and geography. Such an analysis has been done for passenger transport (see, e.g. Héran, 2009; Witlox, 2007) but not to a great extent for freight transport, although it is a common component in research addressing network configurations (see, e.g., and Kreutzberger, 2004; Liu *et al.*, 2003; Woxenius, 2007) and sustainability (see, e.g., Browne and Allen, 1998; Leonardi and Baumgartner, 2004; van Wee *et al.*, 2005). There is also a nuance to be brought forward between detours and delays. While a *detour* is a deviation from an optimal (often Cartesian) path, a *delay* is time added to the journey irrespective of if the path is optimal or not.

Detours and delays have far reaching implications for transport planners since they represent a dimension that conventionally was not effectively considered in the analysis of transport investments. For instance, an origin-destination (O-D) matrix tries to capture the demand, but if much of the freight is directed through indirect links in the network, then a whole new layer of interactions between intermediary locations has to be considered.

The purpose of this conceptual article is to look at the causes of detours and delays in freight transport services and to qualitatively analyze these effects. It seeks to expand the concept of intermediacy (Fleming and Hayuth, 1994), particularly how freight distribution influence routing through intermediate locations. It is primarily based upon an overview of the causes for detours and a discussion about their effects, based upon empirical evidence. Although delays and detours that are imposed by circumstances outside the control of transport operators are discussed, the primary focus of the paper is how detours are voluntarily used to manage freight distribution systems.

Supply, logistics and freight transport chains

Detours are universally present in transport chains but are obviously also present in supply chains and logistics chains. There are strong dependencies between the different types of detours since shipper preferences regarding mode, transport time, or consignment size affect the transport service providers' and transport operators' ability of finding direct paths. The focus in this article is on freight transport detours; but further analysis requires a clear view of the scope of supply chains, logistics chains and transport chains.

The logistics and marketing literature is abundant with more or less distinct definitions of the terms supply chain management, logistics and transport. The terms have evolved over the years (see, e.g., Hesse and Rodrigue, 2004; Klaus, 2009) and the often non-stringent use has made them rather blunt conceptions. Consequently, many authors find reasons for at least making operational or contextual definitions. In a physical product setting, the different types of chains can be explained in the following way (Figure 1):

- *A supply chain* focuses upon a **product** and extends back over the different actors, activities and resources required for making it available at the place of consumption. It encompasses a set of logistics and transport chains linking activities from basic extraction of

raw materials to retailing (final consumption). It is rare that a whole supply chain will be managed by a single provider but it remains a functional entity.

- A *logistics chain* focuses upon an **item** or article and extends from when the item number is created (manufactured or received from a supplier) until it is dissolved (item consumed, becoming a part of another item or being split into several items). For instance, a logistics chain could include a product that has been assembled into a final good, brought to a distribution center to be sorted and temporarily stored and delivered to a retail store.
- A *transport chain* focuses upon a **consignment** and extends over movement, physical handling and activities directly related to transport such as dispatch, reception, transport planning and control. For long distance interactions, a transport chain can involve a sequence of modes and terminals.

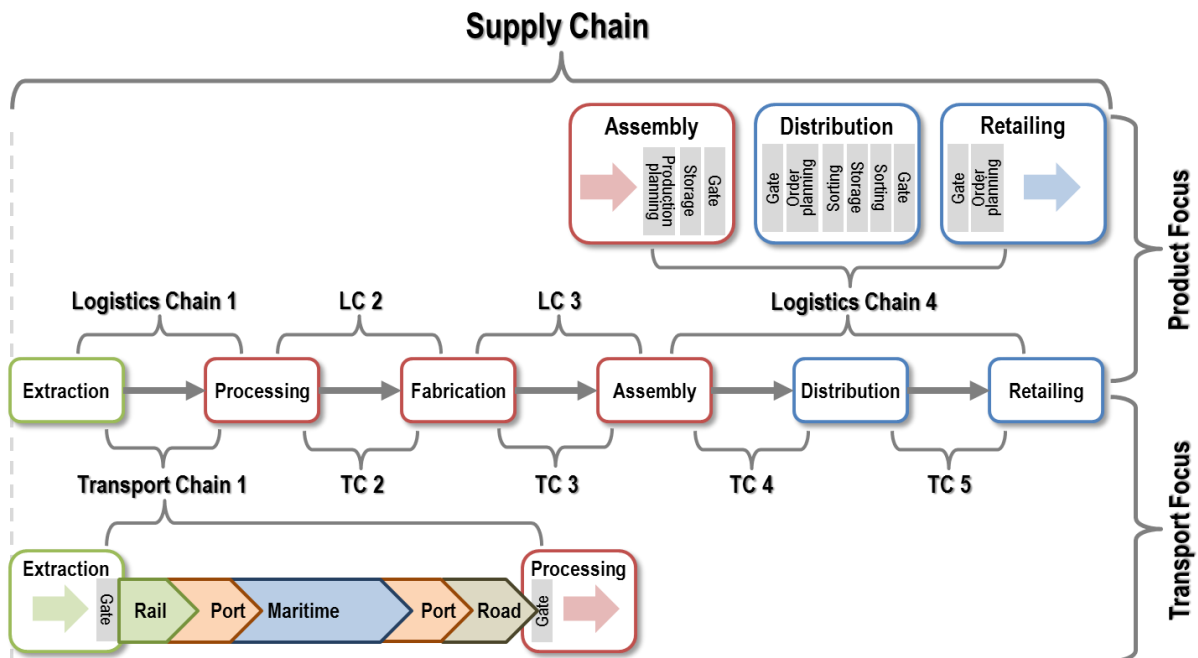


Figure 1. The scope of a supply chain, logistics chains and transport chains.

On Figure 1 the transport chains partly overlap the consignors and the consignees, thus including dispatching and reception activities at the gate, often referred to as floor-to-floor rather than door-to-door (consignments actually have to be physically loaded or unloaded within the facility). Transshipment and consolidation terminals are parts of transport chains while warehouses and distribution centers are not. The reason for this is that the consignee of the shipment is known in the former case and the goods are cross-docked, not stored, or just stored temporarily for capacity bridging or co-ordination reasons. Hence, transshipment and consolidation terminals belong to the transport service provider (TSP) domain while warehouses belong to the transport service buyer (TSB) domain. Warehouses and distribution centers are embedded in a logistics chain as long as the item number is not changed.

The design of supply, logistics and freight transport chains developed over the years, as did the division of labor. This implies that the provision of a product to a consumer might be stable regarding the source of raw material and components, but the configuration of production determines how the supply chain is divided into logistics and transport chains. For instance, a common strategy of “big box” retailers has been to take a higher level of control over the logistics chain leading to final consumption (e.g. Logistics Chain 4 on Figure 1), particularly since this chain tends to be dominantly multinational. Previous freight transport chains are thus divided into several transport chains by the addition of transforming or stocking activities, reshaping the pattern of supply chains and logistics chains.

Analyzing the causes of detours also requires rather strict definitions of the role of actors for all three types of chains. For transport chains the industrial organization differs significantly between different types of transport services depending on the character of the demand, modes involved, regulations, levels of vertical and horizontal integration, etc. Table 1 proposes a taxonomy of the actors involved in transport chains.

Table 1. Taxonomy of transport chain actors.

Abstract terms	Generic actor names	Roles	Actor group names used
Origin/source	Consignor	Send goods	(Product) Supplier
Destination/sink	Consignee	Receive goods	(Product) Customer
Management	Transport co-ordinator	Co-ordinate transport services	Forwarder, Third party logistics provider, Agent
Link operator	Transport operator	Move goods	Ship owner/Shipping line, Airline, Road haulier, Rail operator
Node operator	Terminal operator	Tranship, consolidate goods	Port, Airport, Intermodal terminal operator, Consolidation terminal operator

Source: Adapted from Ramstedt and Woxenius, 2006.

The generic terms TSB and TSP are used for denoting the *roles* at the demand and supply sides of the market for transport services. However, Table 1 does not define the business relationships between the actors, i.e., who acts as TSB and who acts as TSP. The consignor, the consignee or someone appointed by them can take on the TSB role and the TSP role can be directly played by a transport co-ordinator or a transport operator. The amount of transport on one’s own account is diminishing, but large parts of the transport market involve only two parties, for instance a road hauler transporting clothes from a retailer’s distribution center to its stores or a rail operator moving iron ore from a mine to a port owned by the mining company. Still, there are often hierarchies of companies on either side of the TSB-TSP interface.

Detours in Supply Chains and Logistics Chains

Supply Chains

Supply chains are not *per se* prone to detours as they represent functional sequences. It is rare that a supply chain falls under the control of a single enterprise, so supply chain management is an amalgamation of sequences, some better integrated than others. Globalization and outsourcing to distant locations have functionally extended supply chains through more complex logistics chains and longer

transport chains. There is a propensity to confuse detours in logistics chains with detours in transport chains and the focus is on products and production systems including several manufacturing stages. Detours in supply chains stem from strategic decisions regarding supply chain configuration.

Discussing detours in relation to distant sourcing makes sense only if the real supply chains are contrasted against a world where supply chains are centrally designed aiming at minimizing transportation. Measuring the amount of detours opens questions of which options to compare. The actual supply chain could be matched against one using the closest potential supplier of equivalent material or components, one using the closest suitable production unit or even one based on shortest route of the raw material used in the final product. This underlines that “detours” in supply chains are essentially delays, and the matter becomes how some delays involving higher lead time and more inventory in transit can be accommodated by distribution. Acknowledging the benefits of applying market forces rather than centrally managed optimization, much of the debate is less relevant in a detour context and relates more to a general discussion on sourcing practices, transport distances and their respective energy efficiencies.

Nevertheless, the design of supply chains affects the levels of logistics chains and transport chains and is the root cause of many transport detours. The supply of efficient and cheap transport services has, on the other hand, facilitated the design of geographically-extended supply chains (see, e.g., Hesse and Rodrigue, 2004; Rodrigue, 2006) and information systems have assisted with the possibilities to control them (Lasserre, 2004). Long-distance trade in raw materials and finished products has an ancient history, but the substantial increase in total transport distance is mainly caused by offshoring of the intermediary manufacturing stages (see, e.g., Woxenius, 2006).

The utilization of cheap labor is the traditional motive used to extend supply chains, but economies of scale in manufacturing, patents and competition between supply chains with mutually exclusive partners add to transport distances. The issue is complex, particularly for supply chain managers trying to combine strategies of being green, lean and global (Mollenkopf *et al.*, 2010). On a political scale, customs tariffs, tax incentives, compensatory purchasing or foreign aid and distant sourcing due to embargoes or, to a diminishing extent, lack of trade agreements with closer trading partners add to detours. In the case of raw materials, an increased element of geopolitical considerations can be observed as the Chinese sourcing strategies in Africa and South America underline.

Examples like the well-travelled yogurt pot (Böge, 1995) are striking but often taken out of a proper economic, supply chain and transport efficiency context. A paradox is also that the ecological footprint often decreases by distance when consolidation or shifting transport modes becomes economically viable. Contemporary supply chain management has often led to surprising results in logistics and transport chains, with Figure 2 depicting a particularly eloquent example.

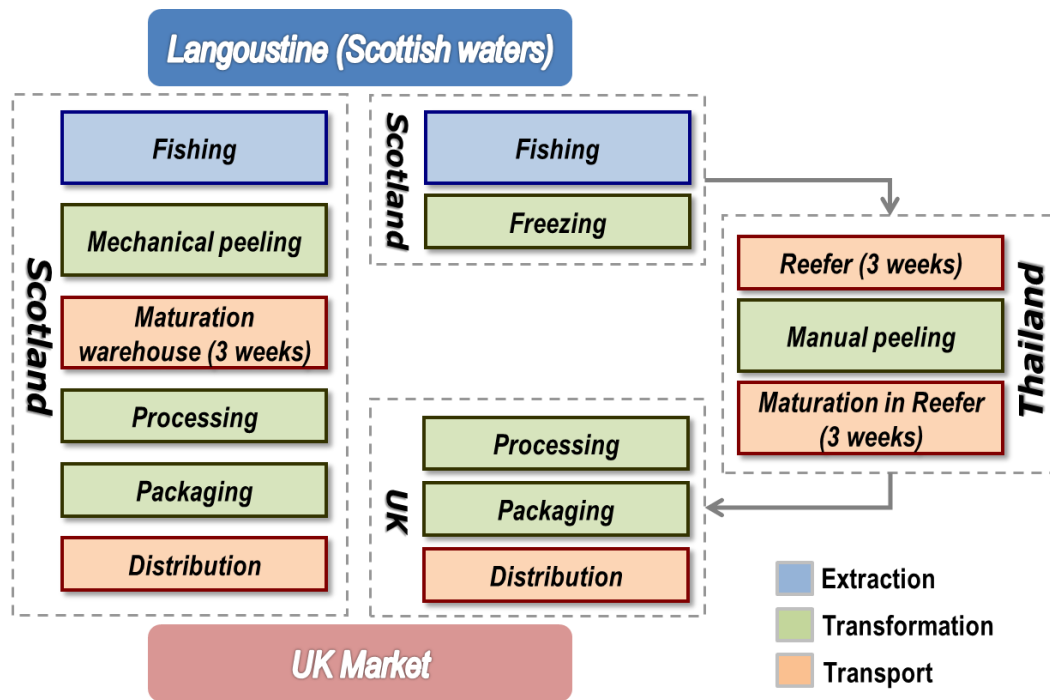


Figure 2. Containerization, cold chains and the flexibility of supply chains.

Globalization and more reliable cold chains have significant impacts on commodity chains by expanding the options available for each sequence of the supply chain. Conventionally, langoustines were fished off the coast of Scotland, brought to a nearby processing plant where they were mechanically peeled. After a maturation period of about three weeks in cold storage, the langoustine meat was then processed, packed and then distributed to the main United Kingdom market.

By using the cold chain technology at the global level, it becomes possible to relocate part of the process to a lower cost location. In the above case, after freezing the langoustines are placed in ISO reefers and shipped by containership to Thailand, which takes about three weeks. Since the containerized trade between Europe and Asia is imbalanced, the cold chain benefits from a significant discount on the UK - Thailand transport chain, in the range of 50%. In Thailand, the Langoustines are manually peeled, which improves the quality of the product as well as the yield. Then, the peeled langoustines are shipped back to the UK. Since the maturation process takes about three weeks, the reefer acts as a transport unit as well as a maturation warehouse, conferring additional economies since no more warehousing space is required for that process. The final stages, processing and packaging are taking place in the UK market.

Logistics Chains

Freight distribution is a market servicing activity, implying that the nature and structure of the market will have an important impact on the manner it is serviced. The movement and storage of items between manufacturing stages and the distribution of finished products to consumers overlap the scope of supply chains. Detours in logistics chains are affected by decisions by TSBs rather than by TSPs. They are sensitive to two related variables defining the level of service performed by a logistics chain composed of a set of distribution centers; the *distance to customers*, which defines the market size as well as the delivery and return distance and the *lead time*, which is the time it takes for a distribution center to deliver the goods once an order has been placed.

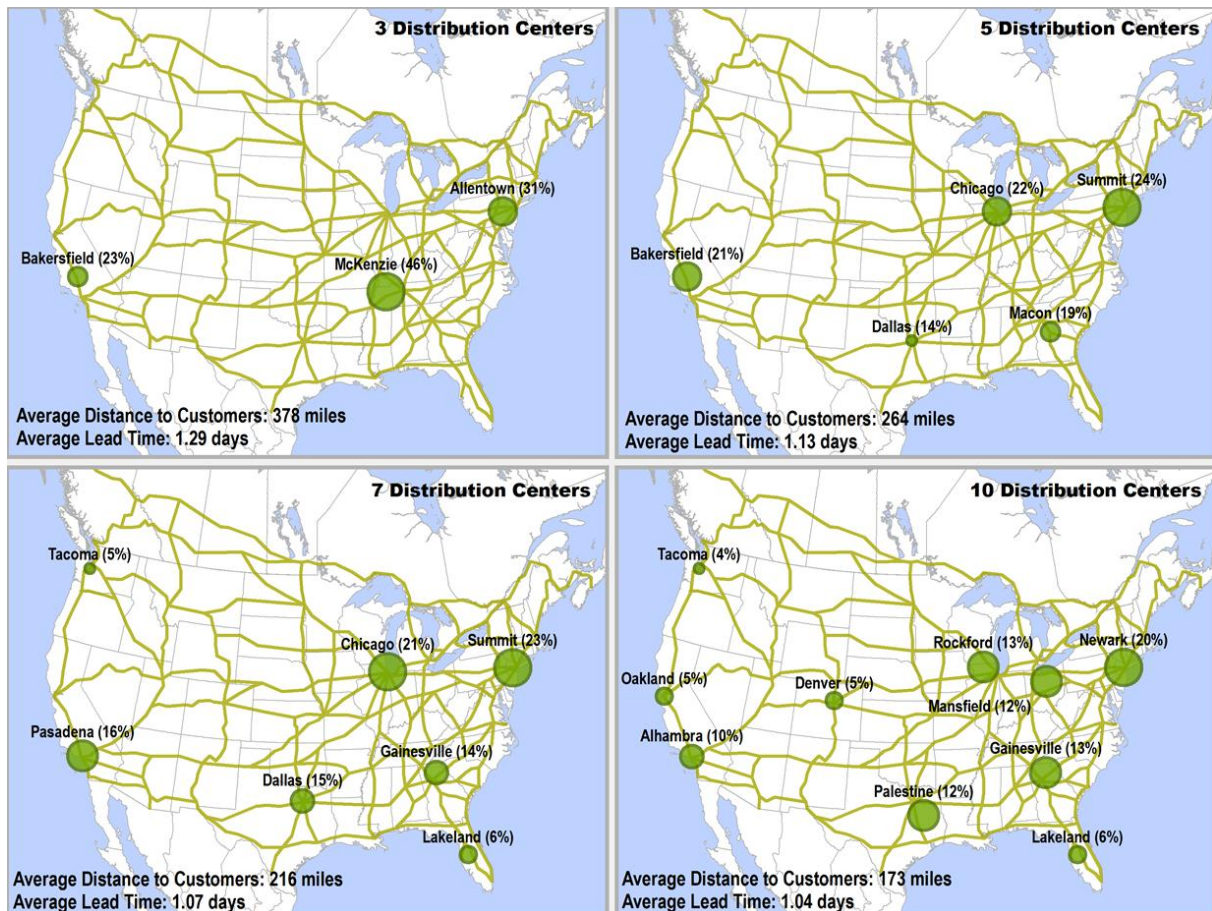


Figure 3. Optimal location and throughput by number of freight distribution centers. Source: Adapted from Chicago Consulting (2010).

Figure 3 depicts four optimal scenarios in the location of distribution centers within the United States, based upon the number of distribution centers where each scenario is linked with a level of detour. It assumes two basic assumptions. The first is that the market potential is directly related to the population. The second is that deliveries are done by truck using the highway network. For three distribution centers, the optimal locations would be Allentown, McKenzie and Bakersfield handling respectively 31%, 46% and 23% of the total throughput and with an average lead time of 1.29 days. The throughput is simply a function of the total population within their respective market areas. The other three maps depict the improvements in terms of lead time and average distance to customers if additional distribution centers are considered (a total of 5, 7 and 10 distribution centers). Roughly, after 6 distribution centers, there are limited marginal improvements in lead time.

Frequency of service is an important variable that influences the suitable number of distribution centers servicing a supply chain and the level of detour. A low frequency level tends to require less distribution centers than a high frequency level. A low number of distribution centers also imply longer distances for empty returns. The issue can be regarded as most intense in the field of transport of food. The successive reduction of distribution centers and the resulting logistics detours are of particular interest.

The inter-organizational design of distribution chains has a huge impact on item detours. Decisions on who and how many layers that keep stock, sometimes referred to as the handling factor (Sanchez-

Rodrigues *et al.*, 2010), is one example affecting detours of items but the decisions can also reduce the number of transport chains involved in a logistics chain.

Another example of the fine line between logistics and transport chains regards postponement. Long transport distances through maritime shipping imply long lead times but their effect can be decreased by sending a consignment in roughly the right direction and then fine-tune the final destination when the final consignee becomes known. Crude oil shipments from the Middle East can shift owners several times in transit but the principle only results in detours when the final destination is decided after the potential routes diverge. A logistics chain is transformed into a transport chain when the consignee is known.

Another inter-organizational example is the use of vendor-managed inventory (e.g., Disney *et al.* 2003). The principle can be used for delivering batches equaling the full capacity of a vehicle or vessel but also as delivery of stand-by goods filling up unused capacity when delivering other consignments. The former case leaves a back-haul problem and the latter case a slight detour.

The factors contributing to detours on a logistics chain also include insufficient planning and unforeseen events (Sanchez-Rodrigues *et al.*, 2010), the use of exclusive agents for some markets and preferred ports of entry for imports.

Detours in Freight Transport Chains

The detours in freight transport chains are here structured along the root causes for detour decisions with a rough division between causes internal and external to TSPs.

Physical causes

The first set of reasons for detours is the most obvious as it reflects the physical possibilities and restrictions for transport operations. This stipulates the range of available modes and their routing options.

Geography and topography could be argued to affect air transport the least. Availability of airports is, however, a strong restriction so the combination of air and surface modes implies detours and often substantial ones for shorter transport services. For surface modes geography and topography can imply both short-cuts and detours for sea, inland waterways, rail and road traffic, respectively.

Geography and topography are generally static, but seasonal and long-time *climate conditions* imply changing conditions for transportation. One example is that climate change seems to foster interests in the use of the Northern Sea Route saving, for instance, 40% of the distance between Yokohama and Rotterdam (Liu and Kronbak, 2010) during parts of the year. Another example is ice in archipelagos that prevents shipping, forces detours around thicker ice or restriction to ice-broken fairways. For road transport, on the other hand, ice can open up for shortcuts. Passability in mountainous areas is often also subject to seasonal changes. Also, infrastructure passability is subject to temporal restrictions, for instance diversions around links closed for maintenance or for clearing up after accidents.

Detouring to avoid *temporary and local weather conditions* is common for air and sea transport but particularly wind and snow affect also road and rail. Routing around bad weather in shipping is often

caused by concerns for ship and cargo safety, but increasingly also for saving fuel and prolonging the structural lifetime of ships.

Geography and topography could be regarded as the most decisive; these factors also give the conditions for the *directness and quality of infrastructure*. On a larger scale, the quality of land transport infrastructure implies detours when consignments are routed to follow main arteries. On a minor scale, all roads, railway tracks and inland waterways wind through the landscape. The division of the rail network into a passenger network and a freight network implies detours since paths assigned to the other application are not open. For air and sea, transport chain detours attributed to infrastructure are defined by node location, accessibility and equipment rather than link configuration and quality. Examples of restrictions were abundant in the early days of containerisation and more recently when ship sizes grew rapidly and fewer ports were properly equipped for handling post-panamax vessels. Regarding node location, Medda and Carbonaro (2007) identified the deviation from the Suez-Gibraltar route as a decisive factor for the competitiveness of Mediterranean transshipment ports, but Rodrigue and Notteboom (2010) underlined that shipping companies are willing to deviate further if inland cargo can also be found to complement the footloose transshipment cargo (Figure 4).



Figure 4. Deviation from the main shipping route of Mediterranean container ports. Source: Rodrigue and Notteboom, 2010.

In the Caribbean, which is also an active transshipment market, the port of Cartagena, Columbia has seen an impressive growth of transshipment traffic in spite of not being particularly advantageous in terms of deviation. As opposed to other Caribbean transshipment hubs, it offers significant inland traffic.

Political Causes

The second category of detours is caused by political decisions and is therefore external to the TSPs. On a large scale, the division of the world into economic regions and states contributes to transport chain detours. Trade agreements and custom tariffs contribute primarily to supply chain and logistics chain detours but the *channeling of international consignments* through certain border crossings, ports and airports imply transport chain detours. Cabotage rules, security and customs inspection restrictions are common reasons for additional distances. A particular example is the U.S. Department of Homeland Security's Container Security Initiative imposing restrictions on which ports containers are allowed to be loaded before the final sea leg to the United States. With less than 50 ports cleared for shipping directly to the United States, detours are inevitable. Yet, this observation must be nuanced by a growing level of concentration along American container ports.

In addition, the absence of political control can lead to detours through *banned links*. Navigation around the piracy prone Gulf of Aden might be the currently most debated example, but war zones or conflict areas also contribute as do lack of transit rights in national air space, waters or on land infrastructure.

Nationally different rules for size and weight of vehicles and vessels, night-time driving and emission standards also make certain routes unattractive for transport operators. The tradition of limiting the size of trucks allowed in Switzerland has in practice meant banned routes for road haulers, which often has been solved by detouring through France or Austria on routes between Germany and Italy.

However caused by nature, the decisions on *temporarily closed links* due to volcanic ash clouds in Europe in 2010 were compounded by air safety regulations, which in retrospect have been debated. This unforeseen event resulted mostly in delays, but also forced airplanes to take detours around the ash cloud or by using longer routes by other modes.

On the national or local level, *selective road and street restrictions* prevent the use of the shortest paths for certain vehicles regarding size and weight but also emission standards. It is also common to restrict when specific vehicle types can access city streets. Furthermore, there is regulation giving detours for specific types of consignments. Hazardous cargo is particularly subject to restrictions regarding time to use sensitive links such as ferries, tunnels and city streets.

Commercial Causes

It could be argued that TSBs' preferences only regard service attributes, not the content. With such a view, detouring decisions would be subject to physical and political causes but otherwise left to TSPs' discretion as long as the agreed quality performance is met. There are, however, numerous examples of *TSBs specifying the route*. Preferences for customs clearance at certain ports specializing in the particular commodity is one and preventing TSPs from mixing with competitors' consignments is another that might cause detours. Commercial reasons for detouring are consequently regarded as partly external and partly internal to TSPs.

Competition between firms is an obvious reason for supply chains being designed with longer transport distances than if they were optimized solely with operations research tools. Transport chains are accordingly affected by *competition* between transport co-coordinators, transport operators and terminal operators. One example is that routing detours increase with the number of competitors serving a less-than-truckload market.

Ownership or control of a physical network can be detour factors. In North America, rail operators own both the network and the rolling equipment. While the network they control is extensive, they do not cover the whole North American market and do not have intermodal terminals at all major markets within the regions they serve. This has favored interlining, either by trucks or switch carriers, at hubs such as Chicago and Memphis (Rodrigue, 2008), imposing delays on transcontinental traffic and even a switch to trucking for the last segment of the trip.

Differences in factor prices, such as for fuel and infrastructure use, also cause detours, although international harmonization attempts are in place to decrease such inefficiencies. One example is that Luxembourg has been forced to raise fuel taxes by the European Commission, reducing the incentives for road haulers to route through Luxembourg for cheap fuel. Another example is that the introduction of the selective German highway charge, the MAUT, included close monitoring of the extent to which road haulers circumvented the fees by detouring on minor roads. Another large scale example is the substantial growth in the use of the all-water route through the Panama Canal for containerized traffic bound to the American East Coast. Accessing the East Coast and the Midwest from East Asia is subject to a range of routing options. While in 2000 intermodal (landbridge) accounted for 82% of TEUs between Northeast Asia and the East Coast, it was reduced to 55% in 2007 (Panama Canal Authority, 2009). The cost structure of the transport chain is an important determinant in the comparative advantages of respective routing options, including the landbridge, the usage of the Suez Canal, or the all-water route through the Panama Canal. Depending on the supply chain, the detour option is preferred to the direct landbridge connection.

Operational Causes

The directness of transport services depends on the economy, the demand for transport quality as well as possibilities for consolidation and finding return flows. A number of parameters and their effects can be distinguished:

- consignment size—the closer to the full capacity of a vehicle or vessel, the more direct
- transport distance—the shorter, the more direct
- transport time demand—the more particular, the more direct
- product characteristics—the more particular, the more direct
- availability of other goods along the route—the lesser the availability, the more direct

Of the factors mentioned in the list above, consignment size is particularly conclusive for transport chains which are combined by a vehicle or vessel schedule. Detours are inevitable when consignments are smaller than economically feasible for direct traffic. A main divider between transport chain designs is whether the cargo stays on the vehicle or vessel along the whole route or if it is consolidated with other goods. The number of consignors and consignees included in a route has, in turn, great influence on if the transport is outsourced and if so who takes on the TSB and TSP roles and the degree of influence the TSB has on the routing.

When terminals such as consolidation terminals, intermodal terminals, airports, and transshipment ports are used, different vehicles and vessels are used for different links in the network. *Consolidation network operation* is an evident reason for consignment detours. The objective of such networks is not to minimize consignment distance but rather to minimize costs within the restrictions set by

TSBs' qualitative demand and physical, political and commercial issues. The level of detours differs widely between different network configurations and is well captured in literature (for a review see, e.g., Woxenius, 2007). Particularly, hub-and-spoke networks show a large amount of detours for consignments and passengers (see, e.g., Alderighi *et al.*, 2007).

The subject of when the consignments stay at vehicles and vessels during *route collection and distribution* has also attracted much attention, primarily in the field of operations research. The principles are the same for the capillary parts of consolidation networks where smaller vehicles are used for local pick-ups and deliveries in a sequential manner, for part load services or container shipping strings where a few locations in each end of a long link are connected. Particularly the first consignment in a pick-up route and the last in a distribution route experience long detours.

The trans-oceanic container pendulum routes between Asia and Europe typically connecting about ten ports actually do not add much to the detours caused by geography since ports are selected more or less along the route and with limited deviation. Still, if a maritime shipping company decides to drop a port out of a pendulum route, detours for freight bound to the port's hinterland are immediately imposed. For transatlantic and transpacific pendulum routes, detours can be more substantial as the North American and Pacific Asian maritime ranges are latitudinal and the choice of first or last port call along a range having a significant impact on the detour on cargo bound to or coming from other ports along the range.

The issue of online shopping vs. conventional shopping is an example where routing involves transport chain detours. Edwards *et al.* (2010) show that online shopping and detours are not strictly correlated, but a reduced transport distance often includes shorter detours with increased drop-off density. These observations are in accordance with Boyer *et al.* (2009) who analyzed the effect of customer density for e-commerce in the United States. Co-location of freight terminals and warehouses in suburban areas (Cidell, 2010) might increase the drop-off density and thus decrease detours.

Boyer *et al.* (2009) also investigated the effect of delivery *time windows*, a well-known contributor of routing inefficiencies. Sommar and Woxenius (2007) found that many Swedish part load trucking routes were initially carefully planned based on the TSB's demands but time window promises prevented them from adjusting the route to an efficient one when the customer base changed. Time windows correspond to the agreements with TSBs, but regularly appearing congestion on individual links has a similar effect for routing.

Another cause of detours is *intermodal transport* where intermodal routing can be treated as just a subset of consolidation network operations. Its objective is rather to use more efficient traffic modes than minimizing detours. Terminals for shifting traffic modes are not necessarily located along the most direct route and diversions can be significant. An important factor when analyzing the competitiveness of intermodal transport is the total intermodal distance compared to single mode transport chains (Sommar and Woxenius, 2007).

Repositioning of empty resources to access the next scheduled transport assignment implies detours that are difficult to allocate to individual consignments. Repositioning adds to the difference between the straight and effective route for consignments if the repositioning is part of route optimization. Shifts in the production factor costs occur over time and if the time-dependent labor cost be-

comes cheaper in relation to the distance cost there will be more occasions when it is profitable to let a driver wait for a back-haul or to match a time window thus reducing the total travelled distance. The opposite (more detours) is perhaps more likely when the traffic work savings from consolidation more often offset the extra terminal labor costs.

Vehicles and vessels are not the only resources in which repositioning cause diversions. The most salient example remains empty containers (Figure 5).

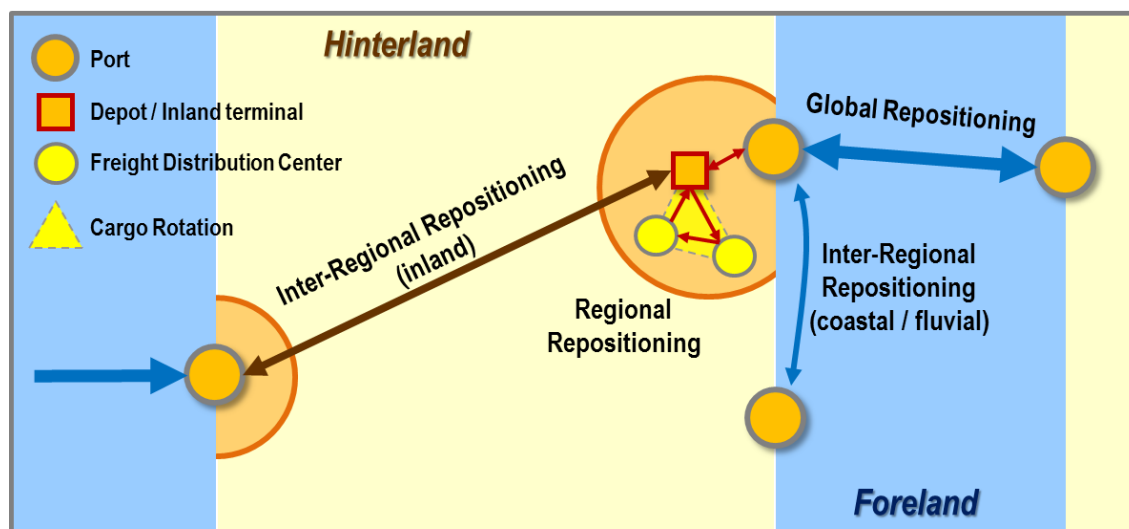


Figure 5. Geographical levels of empty container repositioning. Source: Adapted from Boilé *et al.* (2008)

The repositioning of empty containers takes place at three geographical levels, each involving a growing level of detour; global, inter-regional and regional. Global repositioning involves the resolution of trans-oceanic trade imbalances from surplus (import-oriented) to deficit (export-oriented) areas. For inter-regional movements, containers are repositioned within continents using rail or short sea shipping. They concern connections between inland terminals and ports. Regional repositioning mainly concerns drayage operations between empty container depots or inland terminals and major freight distribution centers. A common detour mechanism concerns cargo rotation where an inbound container is emptied at its consignee, moved back to the terminal or to the empty container depot and then picked up to be brought to an exporter. Due to different supply chains and time windows, it is very rare that a container is directly repositioned from a consignee to a consignor.

Non-planned Causes

The performance of all transport systems are subject to its level of robustness, that is, how well the existing transport chains capture the risks during transit and the systems' ability to adjust to changing conditions. In addition to unforeseen conditions, there are numerous examples of internally and externally induced diversions. Common examples are *excessively rigid planning* (Naim *et al.*, 2006), a lack of information about the passability of individual links, strikes, as well as individuals' failure to adhere to the given route orders. Drivers might, for instance, *disobey routing orders* and travel extra mileage to combine business and a personal convenience. The extent of the resulting detours relies heavily on the pre-warning time, the urgency of the transport and the length of the detouring options at hand.

However, monitoring employees is a difficult objective; increasing general efficiency, employee safety and preventing theft are the prime reasons. Following route suggestions from the GPS device potentially saves a great deal of distance, but GPS devices also add to detours when set to minimize travel time, for instance, by suggesting longer but faster diversions around congested links.

Conclusions

Detour and delays are unavoidable in supply, logistics and transport chains with each involving a specific array of considerations. This paper underlines that while several types of detours and delays are unforeseen and must be accommodated, in several instances they are effectively used as a freight distribution strategy. Detour decisions particularly belong to freight forwarders and transport operators (Table 2).

Table 2. Influence of nature and actor groups on the causes of transport chain detours.

Cause of detour	Nature	Society	TSB	TC	TO	Individuals
Physical causes						
Geography and topography	x					
Climate conditions	x					
Local weather conditions	x					
Directness and quality of infrastructure	x	x				
Political causes						
Channeling international consignments		x	x			
Banned links		x				
Temporarily closed links		x				
Selective road and street restrictions		x				
Commercial causes						
TSBs specifying the route			x			
Competition				x	x	
Ownership or control of a physical network				x	x	
Differences in factor prices		x	x	x	x	
Operational causes						
Consolidation network operation				x		
Route collection and distribution				x	x	
Time windows			x			
Intermodal transport				x	x	
Repositioning of empty resources				x	x	
Non-planned						
Excessively rigid planning			x	x	x	
Disobeying routing orders				x	x	x

Abbreviations: TSB=Transport service buyer; TC=Transport co-ordinator, TO=Transport operator.

The design of transportation services in freight distribution is thus not solely a network optimization strategy, as globalization and supply chain management offer opportunities to “manipulate” flows by using routing and delays for consolidation, economies of scale, reliability or a more convenient time window.

Further work is needed to shed more light on the issue. This includes additional empirical evidence of the different types of detours and delays, quantifying the actual and relative detours for transport services and analyzing the difference between the transport work required by shippers and the transport work reported by the transport operators. For instance, the emerging practice of slow steaming in maritime shipping, a decision from transport operators (ship owners) will impose delays

on maritime routes and a potential reconsideration of the associated supply chain management. Detours and delays must thus be seen no longer solely as a transport constraint but as effective strategies to manage globally-oriented supply chains.

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