CHAPITRE 8

Strategies and future development of transport corridors

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Biographie

Theo Notteboom *est le président de ITMMA (un institut de l'Université d'Anvers), professeur à l'Université d'Anvers, un professeur à temps partiel à l'Académie Maritime d'Anvers, professeur invité à Dalian Maritime University en Chine et World Maritime University en Suède et ancien titulaire de la chaire MPA à Nanyang Technological University à Singapour. Il est également président de l'Association internationale des économistes maritimes (IAME), co-directeur de l'initiative PortEconomics.eu et président du conseil d'administration de l'Institut belge des organisateurs de transport (IBOT-BITO), un institut du gouvernement fédéral belge. Il a publié de nombreux ouvrages sur l'économie portuaire et maritime et contribué à plus de 200 conférences académiques et d'affaires partout dans le monde. Il a reçu six prix pour son travail académique.*

Theo Notteboom est un expert invité régulier de l'OCDE, l'organisation européenne des ports maritimes (ESPO) et d'autres organisations de premier plan dans le domaine. Il est également Associate Editor de Maritime Policy and Management et membre des comités de rédaction de quatre autres journaux académiques dans le domaine.

Introduction

The previous chapters discussed various aspects linked to the development and governance of transport corridors. These corridors have become primary structuring elements in transportation networks and modern supply chain thinking. The observed increased relevance and importance of the transport corridor concept leaves us with a number of questions regarding their future development potential and role. In this chapter we present some ideas on the future development challenges of transport corridors in terms of governance, inter-corridor competition and coordination and the linking of sea-based networks to hinterland-based corridors. More in particular, we provide input to feed the discussion on which practices in corridor management are to be expected in the future, how strategies of the various actors involved in transport corridors are likely to evolve and what the future reality of corridors will look like. This chapter does not portray to provide definite answers to the above questions. Instead, we identify and assess key developments and their impact on the future of transport corridors.

A multi-layer approach to corridors

In order to grasp the future development of transport corridors, it is useful to place transport corridors in a four-layered perspective ranging from a spatial perspective to a more functional perspective (see figure 1). We particularly focus on port-related corridors linking seaports to inland locations and markets.

- The **locational layer** relates to the geographical location of the transport nodes and corridors vis-à-vis the economic space and forms a basic element for the intrinsic accessibility of the nodes such as seaports. For gateway ports, a good location is a necessary condition for attaining a high intrinsic accessibility to a vast hinterland, which often builds upon the centrality of the port region. It becomes a sufficient condition when the favorable geographical location is valorized by means of the provision of efficient infrastructures and transport services, typically embodied by transport corridors.

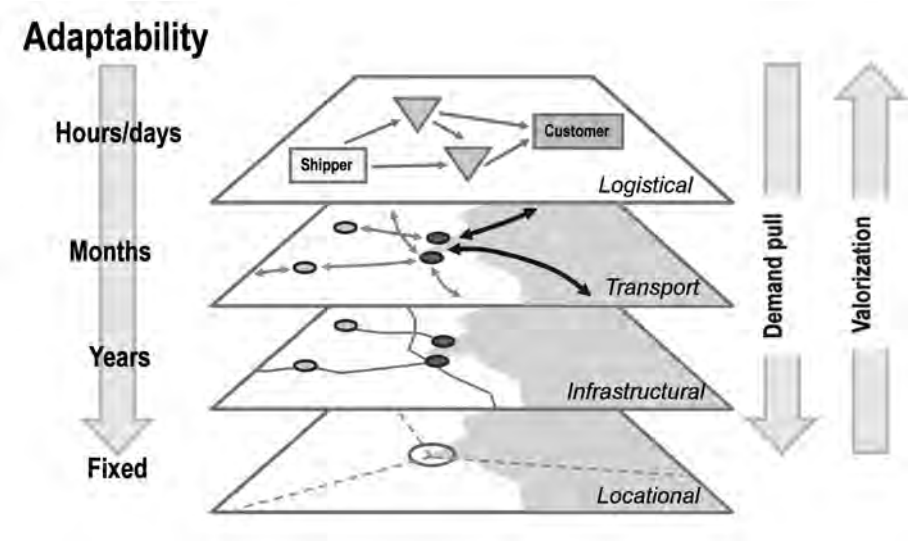
- The **infrastructural layer** involves the provision and exploitation of basic infrastructure for both links and nodes in the transport system. This is where the intrinsic accessibility is valorized since a port site has little meaning unless capital investment in inland transport infrastructure (c.q. transport corridors) is provided.

- The **transport layer** involves the operation of transport services on the transport corridors between the port and other nodes within the intermodal transport system and the transshipment operations in the nodes of the system. It is a matter of volume and capacity.

- The **logistical layer** involves the organization of transport chains and their integration in supply chains. This layer is mostly managerial with a decision making process in terms of the allocation of modes and the booking of transshipment facilities.

In the remainder of this chapter we will use the multi-layer diagram to discuss the future challenges and opportunities for transport corridors.

Figure 1 : A multi-layer approach to port-hinterland dynamics



Source: Notteboom & Rodrigue (2007)

A growing pressure on the infrastructural responsiveness of transport corridors

How uncertainty leads to a lower infrastructural responsiveness

A first challenge to the future development and management of transport corridors relates to the danger of growing temporal mismatches between the four layers in terms of responsiveness and adaptability.

The upward arrow in figure 1 depicts that each layer valorizes the lower layers. The downward arrow represents the demand pull exerted from the higher levels towards more basic layers. In a demand-driven market environment the infrastructural layer serves the transport and logistical layers. The more fundamental the layer is, the lower the adaptability (expressed in time) in facing market changes.

For instance, the planning and construction of major corridor infrastructures (e.g. a new railway link) typically takes many years. The duration of the planning and implementation of shuttle trains on specific railway corridors (transport level) usually varies between a few months up to one year. At the logistical level, freight forwarders and multimodal transport operators (MTOs) are able to respond almost instantly to variations in the market by modifying the supply chain design, i.e. the routing of the goods through the transport system. As adaptable as they may be, they are still dependent on the existing capacity, but their decisions are often indications of the inefficiencies of the other layers and potential adjustments to be made.

The differences in responsiveness on the proposed levels lead to considerable time lags between proposed structural changes on the logistical and the transport level and the necessary infrastructural adaptations needed to meet these changes adequately. This observation partly explains both the existing undercapacity (congestion) and/or overcapacity situations at the level of transport corridors and seaport systems. Strong traffic generating regions are typically confronted with an elevated demand pull for infrastructural capacity and the stretching of existing corridor capacity *via* advanced traffic management systems and the implementation of effective cargo bundling and cargo coordination systems. While measures to optimize the use of existing capacity are obviously the right way to go, there are limits to the 'stretching' of the use of existing capacities.

A market-oriented corridor strategy starts with an efficient planning of transport corridor infrastructure. A high adaptability and responsiveness of the corridor infrastructure requires reliable forecasts on future transport demand, so that infrastructure development anticipates (and not follows) the evolution in demand. However, the crisis of late 2008 introduced a high level of volatility in worldwide traffic flows, emanating in an increasing level of uncertainty regarding transport volumes, also on transport corridors. The growing uncertainty has made an end to the common practice in forecasting to extrapolate exponential growth for the next fifteen to twenty years resulting in phenomenal traffic levels. It has also forced forecasters to follow a bottom-up approach starting from the physical cargo flows that trade will be able to generate and the inevitable shifts in cargo types, routes and packaging.

Partly driven by high growth figures in international and intra-regional trade, a supply push policy under the motto 'build it and they will come' has dominated infrastructure development in developed economies for many years. In the last couple of years such a policy does no longer guarantee success as the crisis has somewhat eased the pressure on transport infrastructure capacity. Traffic uncertainty not only challenges an effective capacity utilization of existing transport infrastructures, but also makes it more difficult to plan ahead using forecasts on future cargo flows. Uncertainty on future flows lowers the responsiveness of cor-

ridor infrastructure to changes in the logistics market, particularly when logistics companies (logistical level) and transport operators (transport level) are developing lean and agile strategies to deal with a fast changing market environment.

Given an increased level of uncertainty, transport corridor project appraisal and evaluation procedures are expected to attach more and more attention to quality management. Quality tests can take various forms ranging from assessing compliance to the guidelines on project appraisal to the evaluation of the basic scenarios and forecasts used. Governments departments and agencies involved in corridor development are increasingly encouraged to consider establishing formal evaluation or assessment units and formalizing access to internal and external auditors. There is an increasing trend in dealing with systematic optimism in project evaluation (Flyvbjerg, 2002). Optimism bias has played a major role in e.g. the underestimation of construction costs or the overrating of indirect benefits of a project. Sensitivity analyses are now broadly used to test assumptions about operating costs and expected benefits. Project proposals will increasingly be reviewed more than once in terms of impact of risks, uncertainties and inherent biases.

More stringent appraisal and evaluation procedures are a must since a poor responsiveness of corridor infrastructure development to the demand at the transport and logistical layers leads to negative effects on market players. Infrastructure investments not valorized by market players have to be avoided. But even sound investments in new corridor infrastructures can have a negative impact on existing networks. The rents on earlier investments by transport operators can be undermined by (1) under-investments in infrastructure, (2) 'supply push' infrastructure investments in other places aimed at redistributing flows across a continent. Regarding point (1), scarcity in markets can lead to more efficient use of resources, which is a good thing. But accepting a continuous high level of scarcity as the 'new normal' might in the longer term have adverse effects on the whole logistics system and eventually also on global production and consumption networks. Therefore, it is a joint responsibility of infrastructure managers, policy makers and other stakeholders to foster transport infrastructures and the broader networks of which they are part and to safeguard their future development potential. With respect to point (2) it is important to underline an 'unnatural' rebalancing of flows due to government policy can undermine the success of existing transport corridors as the redistribution of flows puts a downward pressure on the scale and frequencies in existing intermodal shuttle networks and thus makes these networks less successful.

As the dynamics in the economic system are high, long delays in the realization of physical corridor infrastructures could ultimately lead to a misallocation of means. Hence, user requirements and market conditions might change considerably in the time-span between the planning phase and the actual realization of a trans-

port corridor infrastructure. So, an infrastructure investment which at the time of its conception seemed feasible and market-driven, could end up as an investment in the wrong place, at the wrong time, for the wrong market and using the wrong technology. Such missteps can have serious impacts on markets in terms of pricing, user costs and competition levels.

The role of government and the financing of transport corridor development

Not only uncertainty regarding future transport demand is increasingly affecting the responsiveness of corridor development to market evolutions. Transport corridor infrastructure around the world has traditionally benefited from public investments by government agencies at various geographical scales (supranational, national, regional and local). Many governments now want to decrease or curb their financial participation in corridor development projects as they face declining available funds, partly as a result of the government debt crisis that has affected a large number of western countries. Given rising budget constraints, procurement routes are increasingly considered, including the role of the private sector in the financing of the project (public-private partnerships). This trend poses great challenges to the transport project appraisal procedures as potential partnering arrangements and its implications on costs and benefits sharing should be identified early in the process.

Other parties are getting involved in the financing and management of corridors not only because of budgetary constraints at a government level, but also because of strategic interests. A good example is the Alameda corridor on the West coast of the US which opened in 2002. The project was built by the Alameda Corridor Transportation Authority (ACTA), a joint powers authority formed by the cities and Ports of Long Beach and Los Angeles. The Governing Board includes two representatives from each port; a member of each city council, and a representative of the Los Angeles County Metropolitan Transportation Authority. The Alameda Corridor Operating Committee oversees operations and is comprised of one representative each from the Port of Long Beach, Port of Los Angeles, Burlington Northern Santa Fe Railway and Union Pacific Railroad (see www.acta.org). The dedicated freight rail line Betuweroute in the Netherlands towards Germany provides a good European example. In 2010, rail traffic on the 120 km stretch between Kijfhoek and Zevenaar increased by almost 80% to 17,600 trains. The Betuweroute is managed by Keyrail. The shareholders of Keyrail are Prorail (50% - Prorail is the rail infrastructure manager in the Netherlands), Rotterdam Port Authority (35%) and Amsterdam Port Authority (15%). Public port authorities have thus secured a shareholding in the corridor infrastructure manager Keyrail and have taken part in the financing.

The possible reduced budgets allocated to transport corridors do not necessarily imply a government retreat in corridor policy. It merely has created a shift

in attention. Also in the future, the public sector has its role to play in a market-oriented corridor strategy. A rationale for government intervention emerges when, in certain circumstances, the competitive market mechanism 'fails' (Notteboom and Winkelmans, 2001). Three important circumstances in which the market will fail in its allocative role are when increasing returns to scale exist in the provision of services and when externalities and public goods exist. Public goods may be defined as `those goods and services that could probably never be supplied sufficiently or satisfactorily by a competitive industry, or might not be supplied by them at all. [..] It concerns communal or non-rival consumption where it is impossible to exclude anyone on the basis of non-payment' (Suykens and Van de Voorde, 1998, p.256). In this sense, there might be good reasons to accept government intervention as corridors can comply to the characteristics of a public good, e.g. when they generate time benefits to all categories of merchandise. In such cases no cost recovery is required: it concerns a public investment in a public good. Other arguments for having public sector involvement in efficiency-oriented transport corridors include the issue of property rights (e.g. in case of expropriation of sites for corridor development) and the need for integrated planning.

When it comes to corridor development, public policy stakeholders do not only include government departments responsible for transport and economic affairs on a local, regional, national and supranational level. Hence, the scarcity of resources such as land and nature will continue to increase the impact and involvement of environmental departments and spatial planning authorities on decision processes. The potential overlap in jurisdiction between the various geographical levels in corridor strategy is another issue that needs careful deliberation. A vague demarcation of jurisdiction or bad co-ordination among the various levels can have a detrimental impact on corridor development processes, in particular when a court contests the validity of earlier (political) decisions because of procedural errors with respect to public policy making.

Public policy stakeholders typically follow a political management system based on the principle of distributional equity. This political factor could make that corridors are not always developed where they are needed or where they make most sense from a market-oriented perspective. The organization structure in a political system is often based on the administrative heritage and on structural shocks caused by powerful individuals or pressure groups. Also the (public) managing bodies of nodes along a corridor (such as port authorities or inland port authorities) partly rely on political organizations for their survival, as nodes and corridors ports are often considered to be strategic assets in the process of community welfare creation and appropriate tools for achieving a higher distributional equity. An ever greater challenge for the future is for technocratic corridor and transport node organizations and governance frameworks to work constructively with political managers by forming alliances of effective operating organizations.

Stakeholders' involvement and responsiveness of corridor infrastructure

The dynamics of investments in transport corridor infrastructure are not taking place in a vacuum, but are articulated by the strategic and operational decisions of the stakeholders involved. The interest in stakeholder approaches to strategic management is growing around the world (Mills and Weinstein, 2000). Consultation is important.

At the level of transport corridor governance, the need for a single point of coordination will continue to grow in the future given the diversity of stakeholders and the large number of government agencies that oversee different activities within a corridor. This coordination requires a public-private partnership to address a wide range of problems including investment in infrastructure, regulation of transport and trade, facilitating the improvement in private sector transport and logistics. Therefore, in recent years several corridor-based organizations have emerged to help coordinate development projects and to gather support from major stakeholders. Good examples include Canada's Asia-Pacific Gateway and Corridor Initiative, where the setting of transport corridors is an official Federal Government policy, and the Trans-European Transport Network (TEN-T) coordinated by the European Union.

Streamlining the involvement of community stakeholders is a painstaking process. Stakeholder relations management (SRM) aims at holding the balance between various groups and taking due note of their rights (Argenti, 1997). However, this does not imply that all stakeholders should be equally involved in all processes and decisions. Decision-making procedures on transport infrastructures (including corridors) in France and the United Kingdom explicitly include public hearings. Formal processes typically describe how and when consultation of stakeholders should take place. It is expected that government departments will continue to play a key role in deciding about the role attributed to each stakeholder in the corridor development and management process by implicitly classifying stakeholders based on their involvement in the process/decision and their possible impact on the process/decision (Notteboom and Winkelmans, 2003).

In search of routing flexibility and scale

Flexibility as a major consideration in corridor development

Transport corridors typically depend on the bundling of line infrastructures and transport operations in view of offering an intermodal transport connection between seaports and one or more inland centres. A transport corridor is very of-

ten viewed as a point-to-point connection. In reality, individual transport corridors are mostly part of extensive transport and logistics networks consisting of a range of corridors, each with specific characteristics in terms of scale, transport modes used, price and service quality. The future development of transport corridors will therefore have to be assessed ever more from a network perspective.

The logistics actors and transport operators have designed more complex networks that need a high level of reliability. The current development and expansion of global supply chains and the associated intermodal transport systems relies on the synchronization of different geographical scales. The efficiency of transport systems can be seriously hampered if shipments would significantly be delayed, although having low transport costs. In view of reducing the risk of major disruptions, logistics players tend to opt for a flexible network design offering various routing alternatives. This 'not all eggs in one basket' approach implies a specific port-corridor combination rarely finds itself in a position where the market will forgive major flaws in system performance.

As such, routing flexibility has become one of the major considerations for corridor development. Hinterland regions are fuelling this process as they recognize that it is in their interest not to depend on one corridor leading to one gateway port but to establish a set of efficient corridors to more than one gateway. The linking up to more gateways implies more routing options and flexibility for shippers and logistics service providers who want to set up business in these regions. A transport network that guarantees routing flexibility will allow for a higher responsiveness of infrastructure networks to continuous changes in routing decisions of market players. Infrastructural corridor developments can thus multiply the routing options available between specific inland regions and overseas regions.

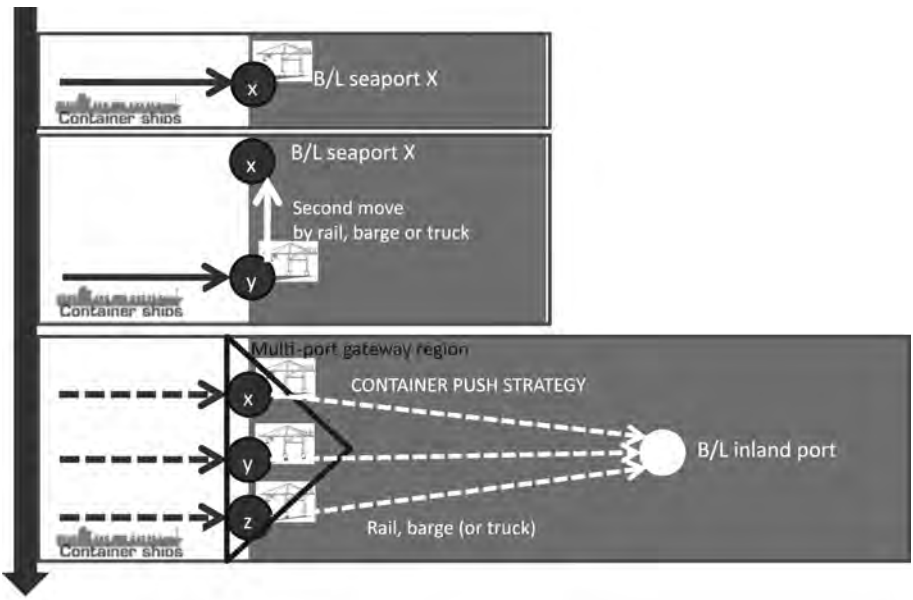
Routing flexibility as part of carriers' and terminal operators' strategies

The search for routing flexibility *via* the use of multiple corridors is also fuelled by the strategies of a number of shipping lines and global terminal operators who have come to understand that landside operations are key to a successful integration along the supply chain. In order to streamline the inland distribution system, shipping lines and alliances between them seek to increase the percentage of carrier haulage on the European continent. The share of carrier haulage presently is about 30% on an average, but large differences can be observed among routes and regions: the UK is a typical example of a strong carrier base, while merchant haulage remains dominant in the Benelux and in particular Switzerland.

A number of larger shipping lines such as Maersk Line and MSC are developing hub-concepts in the European hinterland. Inland terminals and rail and barge services are combined to push import containers from the ocean terminal to an

inland location, from where final delivery to the receiver will be initiated at a later stage. This "push" strategy (see figure 2) is initiated by the shipping line, yet prioritized based on the required delivery date. Export containers are pushed from an inland location to the ocean terminal, initiated by the shipping line, yet prioritized based on available inland transport capacity and the estimated time of arrival (ETA) of the mother vessel.

Figure 2. Evolving role of shipping lines in the hinterland: towards a 'push' strategy



Source: Notteboom and Vonck (2011)

Some terminal operators in Europe are also increasing 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 (Rodrigue and Notteboom, 2009 and Notteboom, 2009a). For example, container terminal operator ECT in Rotterdam (part of Hutchison Ports Holding) follows an active strategy of acquiring key inland terminals acting as extended gates to its deepsea terminals. Through 'European Gateway Services', ECT offers shipping lines, forwarders, transport companies and shippers a variety of services to facilitate the optimal flow of containers between the deep-sea terminals in Rotterdam and the direct European hinterland. ECT bundles cargo, which allows

for highly frequent inland barge and rail connections to various logistics hotspots in the European hinterland. Maersk Line wants to push containers into the hinterland supported by its terminal sister APM Terminals and its rail branch European Rail Shuttle (ERS). DP World uses the concept of 'terminal operator haulage' to streamline intermodal operations on the Seine and Rhône axes, while the large terminals of Antwerp Gateway (open since 2005) and London Gateway (open since 2012) are both linked to inland centres.

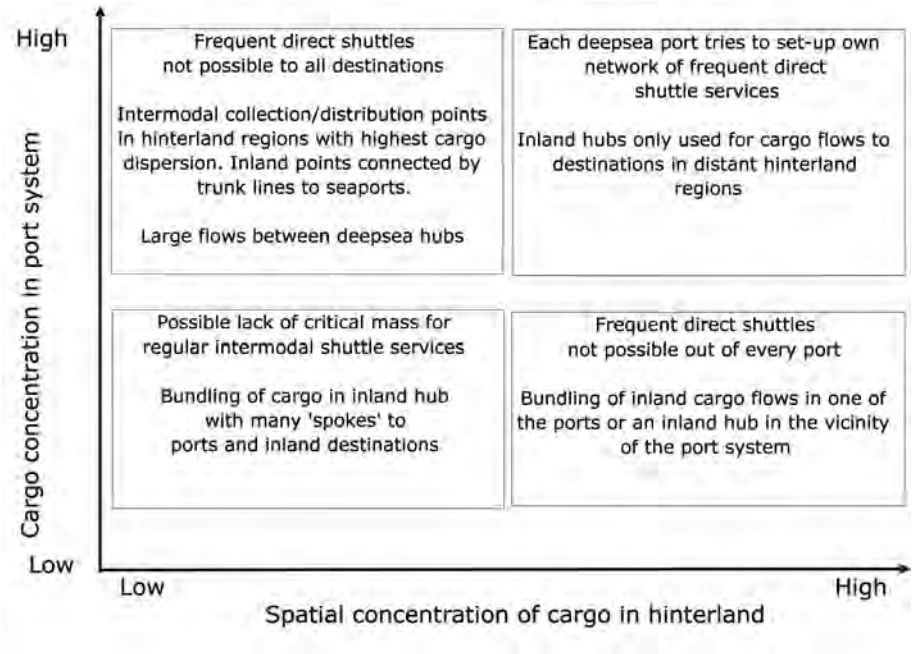
The advantages of the above solutions are substantial: customers can have their containers available in close proximity to their customer base, while the deepsea terminal operator faces less pressure on the deep-sea terminals due to shorter dwell times and can guarantee a better planning and utilization of the rail and barge shuttles. 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. We argue that 'extended gate' and 'terminal operator haulage' strategies will increasingly evolve from point-to-point services (i.e. from a seaport to an inland port and vice versa) to network services which rely on routing flexibility offered *via* multiple inter-linked corridors.

The balance between routing flexibility and scale

The ambition of market players to attain a greater routing flexibility can have its costs. The more cargo flows are dispersed over a large number of (competing) corridors, the lower the chance of realizing economies of scale and massification of flows on each of these corridors. A lack of scale increases the transport cost per unit carried and or could lead to a significant reduction in the service frequency of intermodal shuttles. A high level of cargo deconcentration can even prevent intermodal transport from developing due to a lack of critical mass for frequent intermodal shuttles. Market players are thus challenge to find a balance between routing flexibility and scale when developing a corridor network strategy.

More than ever, the feasibility and success of large-scale corridor development will partly depend on the changing relation between cargo concentration levels in port systems and in the hinterland. Hence, the possibility of bundling container traffic on corridors partly depends on the level of cargo concentration in the port system and on the dispersion level of maritime cargo volumes in the hinterland (figure 3).

Figure 3: Inland service configuration as a function of the level of cargo concentration in port systems and in the hinterland



Source: based on Notteboom (2009b)

A certain level of traffic concentration in a limited number of seaports is required in order to allow a virtuous cycle of modal shifts from road haulage to high-volume transport modes and corridors. Extensive cargo concentration on a few trunk lines opens possibilities to economies of scale in inland shuttles (through the deployment of longer trains or larger inland barges) but even more likely to higher frequencies. Most large container ports in Europe are witnessing such a virtuous cycle: the availability of cargo makes it possible to build an extensive network of intermodal hinterland services and this in itself attracts even more cargo (partly triggered by economies of scale and density). But even port systems with a low degree of concentration have embraced intermodal transport as maritime container traffic has increased sufficiently in the last decades to allow the operation of frequent inland shuttles to destinations in the immediate hinterland. As such, a low level of cargo concentration in a port system can still be beneficial to the development of intermodal services on corridors if it goes hand in hand with substantial cargo volumes per port or if inland hubs are in place where outgoing container flows of the individual seaports can be bundled.

Dense networks of direct shuttles to nearby destinations are more and more complemented by indirect inland services to more distant destinations built around

one or more inland hubs. This is a trend that is taking place in quite a number of ports. Some European examples: Marseille is using Lyon to connect to more Northern destinations. Also Barcelona sees Lyon as an important inland turntable. The Benelux ports are using inland hubs in Germany and Hungary (cf. Sopron) to connect to Central and Eastern Europe. Hamburg strongly relies on rail services to Prague to connect to further destinations in Central Europe.

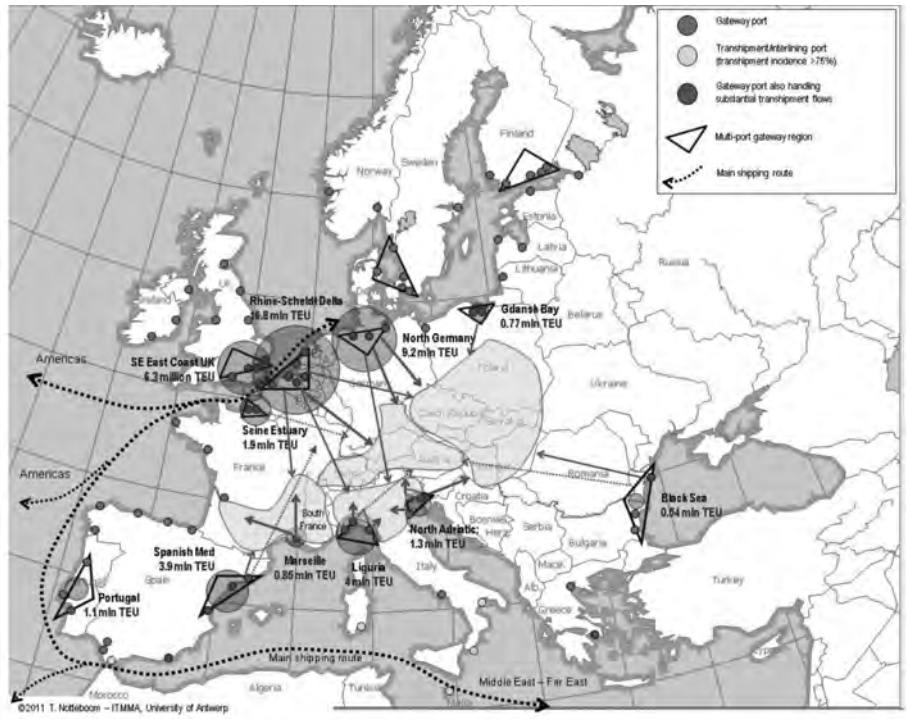
Smaller ports and new terminals find themselves confronted with a vicious circle in the organization of hinterland transportation along corridors. The small-scale container volumes do not allow to install frequent block and shuttle trains to the more distant hinterlands. Because of the inability to serve a substantial hinterland, the major shipping lines do not include these ports in their liner services. One way for smaller container ports to escape this vicious circle is by seeking connection to the extensive hinterland networks of the larger ports through the installation of shuttle services either (a) to rail platforms in the big container ports or (b) to master rail hubs in the hinterland. Numerous hub-and-spoke railway networks have emerged since the 1990s, thereby allowing higher service frequencies and the inclusion of smaller container ports in the network. However, European rail liberalization has partly contributed to a recent decline of many of the hub-and-spoke networks. A further decline of hub-and-spoke rail networks in Europe could seriously affect the future growth potential of smaller and new ports as they would remain confronted with the vicious circle effect.

An increasing focus on multi-port gateway regions to combine scale and routing flexibility

In view of reconciling the need for routing flexibility and the benefits of scale, we expect that multi-port gateway regions (see Notteboom, 2010 for terminology) will take up a more prominent role in the future as places where corridors start or end. The multi-port gateway region level is highly relevant and supported by the liner shipping networks as developed by shipping lines (see earlier figure 2) and the communality in hinterland connectivity issues among ports of the same multi-port gateway region.

Throughout Europe, port authorities and or regional governments are taking initiatives to strengthen synergies at the level of multi-port gateway regions. A good example is the creation of the North Adriatic Ports Association (NAPA) which envisages close cooperation between the port authorities of Venice, Ravenna, Trieste, Rijeka and Koper, particularly in promoting the port region to develop into a major gateway to central Europe and parts of the 'blue banana' hinterland. NAPA has developed an active lobbying at the European level in view of establishing large-scale corridor infrastructure to the hinterland. NAPA, just like most other multi-port gateway regions in Europe, offers routing flexibility to customers as it involves several gateways linked to multiple inland corridors.

Figure 4. Gateway traffic (inland traffic excl. sea-sea transhipment) in major multi-port gateway regions in Europe (TEU – figures 2008)



Source: own compilation

The prime European multi-port gateway region in Europe in volume terms is the Rhine-Scheldt Delta. The region does not only offer routing flexibility, but can also capitalize on its unrivalled scale in terms of the volumes (i.e. 16.8 million TEU of inland container flows, see figure 4), connectivity and frequencies in maritime and land transport services. This seemingly paradoxical and quite unique combination of network flexibility on the one hand and concentration and bundling of flows on the other enhances network complexity and challenges corridor governance.

The position of each of the ports in the same multi-port gateway region is not only determined by its own weaknesses and strengths but also by the way the ports succeed in valorizing existing synergies between the ports of that gateway region. The bundling of cargo along multiple corridors towards the hinterland by joint services or by using inland hubs as bundling points within rail and barge networks can serve synergy creation between ports of the same multi-port gateway region. The bundling of cargo allows the ports to gather critical mass to access regions in the more distant hinterland using shuttle services that meet customer requirements in terms of frequency. Coordination and collective actions between

ports and market players is essential to meet the objective of increasing the share of intermodal solutions and to bundle cargo on corridors.

Transport corridors have enabled individual ports and multi-port gateway regions to increase the inland penetration of their intermodal offer so as to increase the capture area. Transport corridor formation is now allowing seaports to access formerly captive hinterlands of other ports. Particularly in Europe, an increasing number of ports gain direct hinterland access to the 'blue banana' area. This development has broadened container port competition and altered spatial hierarchy, in the sense that the container ports of one multi-port gateway region are increasingly facing competition from container ports in other European port ranges particularly for cargo related to the four shaded hinterland areas in figure 4. These contestable hinterlands are increasingly being served not only by the ports of one gateway region, but by several multi-port gateway regions. The rise of economic centers in Eastern and Central Europe creates opportunities for different multi-port gateway regions and standalone gateways to develop water-based and land-based transport corridors to these areas. Examples are the Black Sea port region/Constantza as a new eastern gateway region to Europe and the port regions near the Gdansk Bay and the North Adriatic. The linking up of inland regions to more gateways implies more routing options and flexibility for shippers and logistics service providers who want to set up business in the region. The performance profile of each of the corridors in terms of infrastructure provision (capacity), transport operations (price and quality of the shuttle services) and the associated logistical control (i.e. the management in a supply chain context) is a key attribute for this kind of competitive play among various multi-port gateway regions.

In Europe, existing transport corridors by rail, road and inland navigation between the core of the EU, the Baltic, the Mediterranean, East and Central Europe and third countries are likely to grow in importance, whereas a number of new corridors will emerge to deal with growing transport volumes between Member States. The development of these corridors is enhanced by EU policy on the creation of the Trans-European Transport Network (TEN-T) and initiatives of rail operators, megacarriers and other market players to extend their European transport networks. RailNetEurope (RNE), which groups the rail infrastructure managers in Europe, has developed corridor management along a set of European rail corridors in view of planning international train paths and of shaping corridor infrastructure capacity according to market requirements. Six European Railway Traffic Management System (ERTMS) Corridors exist. Each ERTMS-corridor is corresponding to a freight corridor. For example, corridor A corresponds to the Rotterdam-Genoa rail link while Corridor C concerns the connection Antwerp-Basel-Lyon. The European Commission is also working on the creation of a number of international freight-oriented corridors. The ultimate goal is at least one corridor in each EU Member State by late 2012. The governance structures established for the

ERTMS-corridors will form the basis of the governance structures to be established for the majority of the Rail Freight Corridors. Each Rail Freight Corridor is a "single entity", a One-Stop-Shop (OSS), but several possibilities are open for its setting-up or designation.

Corridors are also found in the inland waterway infrastructure network. The main axes include (a) the Rhine and its tributary rivers (Main, Neckar, Mosel), (b) the river system in the Benelux and northern France, including main canals such as the Albert Canal between Antwerp and Liège, (c) the Rhône-Saône basin, (d) the Northern network around the Elbe and Weser and associated canals, (e) the Rhine-Main-Danube linking the Alpine Region to the Black Sea. The Seine-Nord project is among the most significant infrastructure projects with potentially structural effects on port competition and cargo routing in the Benelux and Northern France. In eastern Europe ships have the possibility to reach the Danube from the Rhine, opening up the larger industrial areas in Austria, the Czech Republic, Hungary, Croatia, Serbia, Romania and Bulgaria. *via* the Elbe and the Oder the industrial areas in Austria, Germany, Poland and the Czech Republic are within reach. For this region an impressive attempt to improve the network is the connection of these two waterways (Elbe and Oder with the Danube) in order to create a new trans-European shipping lane. Other countries in Europe which boast inland shipping are Italy, Finland, Sweden, Russia and Ukraine. However these pertain to isolated national waterways networks which (except maritime) have no connection with the European network.

Routing flexibility on an intercontinental scale

The search for routing flexibility is also increasingly felt at a more global level. Long-distance maritime corridors have become the main arteries of world trade and this is not expected to change in the future. Strategic points along maritime corridors such as the Panama Canal, Suez Canal, the Straits of Malacca and the Straits of Gibraltar function as important turntables in extensive hub-and-spoke and relay/interlining activities. Total container volumes through the Suez Canal reached an estimated 33 million TEU in 2010 compared to 20 million in 2004. Nearly 93% of these container flows are related to the Europe-Asia trade routes. Many of the world's larger ports can be found near these key locations: e.g. Port Said and Damietta near Suez Canal, Algeciras and Tanger Med near the Straits of Gibraltar and Singapore and Tanjung Pelepas near the Straits of Malacca. Shipping lines have designed liner services with slow steaming large vessels connecting a limited number of global ports on each side of the trade routes. Maersk Line, MSC and CMA-CGM are among the truly global liner operators, with a strong presence also in secondary routes. The networks are based on traffic circulation through a network of specific hubs. However, shipping lines do not necessarily opt for the same hubs. There is an upper limit to the concentration of flows in only a few hubs as shipping lines have commercial reasons for not

bundling all their cargo in one port (i.e. not all eggs in one basket). For instance, Maersk Line and MSC did not opt for one European turntable, but several major hubs.

The opening of new larger Panama Canal locks in 2014 (allowing container vessels of up to 14,000 TEU) opens opportunities for shipping lines to reintroduce equatorial round-the-world container services. Furthermore, the almost monopolistic position of the Suez route on many trade routes is being scrutinized by rising security concerns caused by piracy acts, high Suez Canal charges and an ever-changing geography in world trade patterns. The Cape route could in the long run serve as an alternative to the Suez option on trades between Asia and South America, Asia and West Africa and South America and East Africa (Notteboom, 2012). The flows related to the first two trade lanes now typically pass through the Suez Canal and are interlined in hubs such as Algeciras, Tanger Med or even in more northern ports such as Rotterdam (Maersk Line) and Antwerp (MSC). The expected emergence of the Cape route should be seen as the embodiment of a promising development of south-south trade volumes between Asia, Sub-Saharan Africa and South America.

A number of other routing alternatives are being planned or are in operation to accommodate part of the trade volumes between Europe and Asia (figure 5), but their market shares are expected to remain low compared to the Suez route. First there is the Northern Sea Route (NSR), a set of all-water shipping lanes between the Atlantic Ocean and the Pacific Ocean along the Russian coast of Siberia and the Far East. Future ice cap reductions would open new possibilities for commercial shipping on this route. In cost terms the route today is still less favorable due to the need for ice-classed ships and ice breaker assistance, non-regularity of the liner services, slower sailing speeds, navigation difficulties and Russian transit fees. Secondly, North South land corridors could develop as land bridges from the Persian Gulf *via* Iran to Russia. Third, the east-west rail corridors, a set of railway lines connecting East Asia and the western part of Russia with the Eastern part of Russia, are becoming more commercially interesting. The main arteries are the Trans-Siberian Railway, the Trans-Manchurian Railway, the Trans-Mongolian Railway and the Baikal Amur Mainline (BAM – opened in 1991). The 'Trans-Siberian in Seven Days' program sets a target speed of 1,500 km a day by 2015. Rail land bridges in principle offer lead time advantages to shippers, but capacities remain low compared to container liner services.

Figure 5: **In search of routing flexibility: the main routing alternatives between East Asia and Northern Europe**

Source: based on Notteboom (2012)

Port regionalization and the growing importance of inland ports and logistics zones

Corridor development enhances the location of logistics sites in inland ports and along the axes between seaports and inland ports. In the last fifteen years, the dynamics in logistics networks have created the right conditions for a large-scale development of freight villages and inland or dry ports. Many inland locations with multimodal access have become broader logistics zones. Not only have they assumed a significant number of traditional cargo handling functions and services, but they also attracted many related services. 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, national, regional and or local authorities, and or the Chambers of Commerce and Industry.

It is expected that the role of inland logistics zones will increase further in the future, partly as a result of a slow, market-driven process. But also national, regional and/or local authorities try to direct this process by means of offering financial incentives. Quite a few of these logistics zones are competing with seaports for what the location of European distribution facilities and value added logistics (VAL) 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 new interactions between seaports and inland locations lead to the development of a large logistics pool consisting of several logistics zones. This trend goes beyond the narrow geographical limits of the port, thereby confirming the need for an increasing focus on the notion of the borderless mainport (Van Klink, 1995) and on port regionalization as the newest phase in the functional development of load centres and port systems (Notteboom and Rodrigue, 2005). Regionalization expands the hinterland reach of the port through a number of strategies linking it more closely to inland freight distribution centres. 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 centre network or logistics pole. The port system consequently adapts to the imperatives of distribution systems as supply chain management strategies finally permeate to transport operations and transport infrastructure.

The port regionalization process is increasingly dependent on innovative forms of coordination and cooperation between transport operators, logistics service providers and other transport nodes. The dynamics in contemporary port-hinterland relationships and corridor development is thus not taking place in a vacuum, but is articulated by the joint strategic and operational decisions of the actors involved. This need for coordination is also rooted in the belief that the private interests of individual companies will not lead to the creation of efficient and extensive pan-European intermodal networks. Companies cannot be expected to be the promoters of an intermodal network system that leads to higher efficiency at the macro-level rather than the level of the firm.

Against this background, port authorities are expected to take up an ever more active role as facilitators in shaping efficient hinterland networks and corridors. Port authorities can add value by setting up task forces together with various stakeholders (carriers, shippers, transport operators, labor and government bodies) to identify and address issues affecting logistics performance. These issues can relate to the bundling of rail and barge container flows in the port area and the development of rail and barge shuttles. Ports such as Rotterdam, Barcelona, Le Havre, Marseille and more recently also Antwerp and Lisbon have become more active in establishing formal links with inland ports. An example is the cooperation between Le Havre, Rouen and the inland port of Paris in the context of the “Haropa” initiative. The Port of Rotterdam has launched the ‘Container Transferium’ concept to support further growth of container activity in Rotterdam by transferring cargo to barges and is involved in the expansion of the Wanssum container terminal (North Limburg) and the terminal in Alphen a/d Rijn, which is being built for use by Heineken, among others. The Port Authority is advancing cooperation with the nearby smaller ports of Dordrecht and Moerdijk. The Antwerp Port Authority participates in the Beverdonk Container Terminal, situated about 50 km east of the port, and is involved in the development of the Trilogiport

site in Liège, a new terminal and logistics area located along the Albert Canal. The port authority of Lisbon participated in the development of Puerta del Atlantico, a logistics platform in Mostoles in the outskirts of Madrid. The Barcelona port authority started in the early 2000s with the Terminal Maritima concept which involves joint partnerships to set up dry ports/logistics zones in the hinterland. The portfolio includes tmT (Toulouse), tmZ (Zaragozza), tmM (Madrid) and new projects in Perpignan, Montpellier and Lyon. The port of Marseille supported the development of Lyon as an intermodal satellite of Marseille. The port authority is one of the shareholders in the Société d'économie mixte founded in 1997. Co-operation with inland ports mainly focuses on traffic management, land issuing, hinterland connections and services, environmental protection and research & development (R&D). Large seaports generally have a broad financial base to engage in a well-balanced port networking strategy, although substantial differences exist even among the largest container ports.

In the future a further integration of intermodal transport and supply chain management will undoubtedly lead to new value-added services in inland locations. This will enhance the provision of logistics services at key transfer points and the organization of distribution patterns around such nodes. The availability of fast, efficient and reliable intermodal connections is one of the most important prerequisites for the further logistical development of inland terminals.

New factors in routing decisions

A last major facet of future transport corridors relates to the factors driving routing decisions by economic actors. We argue that out-of-the pocket costs do not fully explain the routing decisions of the future. Connectivity *via* liner services and connectivity *via* rail or barge (where available) remain important factors for route decisions, since they imply higher frequencies and a better connectivity. Moreover, the rising concerns on capacity shortages in corridors and nodes which emerged in the early 2000s made supply chain managers base their port and modal choice decisions increasingly on reliability and capacity considerations next to pure cost considerations. While concerns over congestion have eased significantly due to the economic crisis and the associated drop in volumes, freight transportation still is the most volatile and costly component of many firms' supply chain and logistics operations. Also managers still have to deal with reliability issues in the transport system and face strong rising oil prices, complex security issues, and labour and equipment imbalances. Each of these problems adds risk to the supply chain. These sorts of problems have not disappeared despite the economic slowdown. Managers in the logistics industry are spending more and more of their time handling freight transport missteps and crises.

Table 1. Index comparison among gateway regions in Europe with respect to emissions of CO2 on specific origin-destination relations

C02 emissions (index)	Gateway region					
Route + inland mode	Rhine-Scheldt Delta	Helgoland Bay	Black Sea	Spanish Med	South France	North Adriatic
Shangai - Frankfurt by truck	103	106	132	115	105	100
Shangai - Lyon by rail	125	132	128	106	100	107
Santos - Budapest by truck	129	121	124	150	132	100
Santos - Strasbourg by rail	100	107	158	109	103	122
New-York - Munich by truck	100	100	181	135	120	105
New-York - Budapest by rail	101	100	135	137	126	115

Source: Notteboom (2009b)

A last cost dimension concerns the external costs (congestion, traffic safety and environmental damage) generated by transport corridors. When major differences exist in external costs between corridors or when these external costs are not internalized in a balanced way, the resulting market imperfections might enhance modal choices that deviate from a situation in which external costs are more balanced and equally internalized in the generalized logistics costs. Table 1 depicts the results of a simulation exercise with respect to emissions of CO_2. The case study considers fifteen origin-destination relations transiting *via* six gateway regions in Europe. All inland destinations are major economic centres in mainland Europe: Frankfurt, Lyon, Budapest, Strasbourg and Munich. Both the rail and truck options are included in the analysis. An index of 100 indicates the gateway region that has the lowest emission level on the specific origin-destination relation. The results show that, for the given inland destinations, the North Adriatic has the most favourable results on most relations with the Far East. The Rhine-Scheldt Delta, closely followed by the Helgoland Bay, shows the most favourable outcomes on most links with North-America.

As companies are adopting a more 'green' management approach, environmental effects linked to transport corridors are increasingly becoming an important decision factor in the routing of goods. Environmental concerns linked to corridors are mounting, so corridor managers are challenged to adopt a more 'green' corridor management in view of safeguarding their 'license to operate' and increasing their economic and environmental competitiveness. One of the key elements of effective environmental management of corridors relates to an environmental management system which documents the management of environmental impact

processes and continuous improvement (for example, environmental risk assessment and management actions to address those risks). As transport corridors are vulnerable to claims of environmental damage and to deflect such claims, corridor managers need quantifiable and detailed information on the impacts of their operations on the adjacent environment through environmental reporting and monitoring. Community consultation also forms a key component of environmental management. Land use strategies should identify plans for areas of future corridor development and strategies to conserve and protect areas of conservation value (for example, buffers and wildlife corridors). When corridor development leads to natural damage, questions to consider during the restoration process of environmental assets should include 'what is to be restored?', 'how much restoration is required to compensate for the loss? ', 'do the benefits to be obtained from the restoration justify the costs?' and 'who pays or how can the costs be shared out equitably ?'. This is a real concern as mitigation and compensation measures when developing transport corridors commonly add between 10% and 20% to the cost of the project and this share is expected to increase in the future.

Conclusions

Transport corridors have become structuring elements in modern transport and logistics systems. In this chapter we pointed to a number of key issues in the future development potential and role of transport corridors in terms of governance, inter-corridor competition and coordination and the linking of maritime networks to inland corridors.

At the infrastructural level, we expect a growing uncertainty regarding future transport demand volumes combined with a lower feasibility of a 'build it and they will come' approach to infrastructure development. Developers and managing bodies of transport corridors are increasingly challenged to anticipate future demand in view of guaranteeing a high responsiveness vis-à-vis market evolutions at the transport and logistical layers. It is a joint responsibility of infrastructure managers, policy makers and other stakeholders to design high-quality appraisal and evaluation procedures for transport corridor infrastructure.

As many governments face declining available funds, the role of the private sector and more autonomous public companies in the financing of the project (public-private partnerships) is expected to increase. Next to the provision of public goods, governments will most likely focus more on the regulatory setting for transport corridors including market functioning, property rights, environmental regulation and spatial planning. Technocratic corridor organizations and governance

frameworks increasingly have to deal with political forces (such as the push for distributional equity) and with the need for streamlining the involvement of community stakeholders.

Routing flexibility at an intra-regional and intercontinental scale is one of the major considerations for future corridor development. The concept of routing flexibility corresponds to the ambitions of logistics market players to secure a high supply chain resilience by not putting all eggs in one basket. This demands a network perspective on transport corridor development and a further coordination and synchronization of various maritime and land-based infrastructures and transport services. In view of reconciling the need for routing flexibility and the benefits of scale, we expect that multi-port gateway regions will take up a more prominent role in the future as places where corridors start or end.

The role of inland logistics zones and dry ports is expected to increase in the future in line with port regionalization processes and the evolving hinterland strategies of market players. More innovative forms of coordination and cooperation between transport operators, logistics service providers and other transport nodes will emerge with port authorities taking up an ever more active role as facilitators in shaping efficient hinterland networks and corridors.

Transport corridors have to take into account the rebalancing of factors affecting routing decisions. While out-of-the pocket costs remain important, decision makers are more and more guided by connectivity, reliability and capacity considerations, security and energy concerns, and the environmental footprint. As such, corridor managers are challenged to combine market-oriented corridor operations with a more ‘green’ management.

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