Assessing the strategic role of inland ports in urban freight policy: an application of the Port Hinterland Impact matrix (PHI) to the port of Brussels

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Assessing the strategic role of inland ports in urban freight policy: an application of the Port Hinterland Impact matrix (PHI) to the port of Brussels

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Abstract

This research benefits the strategic governance of inland ports located within urban areas by analysing the logistical dedicatedness and the geographic reach of economic activities that take place within a specific inland port. We find that the port under consideration faces challenges of retaining relatively new traffic categories (e.g. pallets) characterised by a high potential for transport mode substitution, whilst the more traditional traffic categories (e.g. construction materials) show higher levels of logistical dedicatedness to the port. The latter do so, while generating negative local externalities. As a result, this assessment and application of the PHI matrix serves the creation of crucial strategic insights that allow policy makers to improve their urban freight policy and the role of inland ports therein. Furthermore, these insights allow for the identification of key stakeholders with whom strategic objectives can or cannot be easily aligned in the context of urban logistics.

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Introduction

The Port Hinterland Impact matrix (PHI) (Haezendonck et al., 2014) was first designed and applied in the seaport setting. The framework allowed seaport managers to evaluate port strengths and weaknesses in terms of the potential for transport mode substitution, i.e. asset specificity and geographical impact of the trade flows generated at the port. These strategic assessments serve to direct the (often) demanding relationship(s) between ports and their (hinterland) stakeholders (Haezendonck et al., 2014). The latter is due to the economic geography of port impacts, their increased spatially dispersion, in turn imposing new contractual challenges on ports and on the various economic actors in the hinterland with whom contractual relationships need to be crafted and fine-tuned.

This chapter extends the application developed by Haezendonck et al. (2014) and applies the PHI matrix within the inland port setting, and more particularly in the context of *intra muros* urban inland ports. By capturing and disseminating strategic insights the application of the matrix stands to aid inland port governance, as these types of ports are often confronted with urban stakeholders that place societal pressures on the economic activity generated in the port, hence impacting the licenses to grow and operate. Consequently, generating crucial insights into the impact of port operations and activity allows inland ports to differentiate their strategic direction as well as their communication strategy both in terms of their direct environment and their broader surroundings.

The operationalisation of the matrix in the inland setting gauges the necessity that contractual port stakeholders perceive in terms of their economic activities taking place in a particular inland port. Geographic reach on the other hand, serves as an indication of distance, and highlights the potential for both the geographical impact of freight distribution facilitated by an inland port as well as the challenges faced by port stakeholders in the port's hinterland. Local impacts for instance, highlight the need for port operations within an urban region, as access to a market or distance to a market may be crucial for the stakeholders under consideration.

Authors such as Notteboom and Rodrigue (2005) state that the study of inland ports and their geographical reach is of great importance, as the sustainable development and growth of port gateways and the ability of inland regions to compete in international trade is highly dependent on the efficient and durable functioning of inland ports (Veenstra et al., 2012; Dooms et al., 2013; Petit and Beresford, 2009; Monios, 2011; Ng et al, 2013). This as the result of the development of enhanced intermodal transport and the promotion of 'green logistics' (Macharis et al., 2010). Which, in the vision of Veenstra et al. (2012), is the result of further sea- and inland port interdependence under the influence of congestion found in several of the transport modes typically associated with freight transport in urban areas (Veenstra et al., 2012; Wan et al., 2013; Lu and Yan, 2014).

As a consequence, by applying the PHI matrix in this particular inland port setting, insight is gained into the relation metropolitan ports (Dooms et al., 2013) have in their direct hinterland and often-urban surroundings. The research hereby answers the call of both academics as well as professionals in tackling growing concerns that highlight the role of inland ports in terms of both positive as well as negative externalities, associated with port operations in urban areas and the associated pressures and perceptions presented by port stakeholders (Pellegram, 2001; Priemus, 1999; Dooms, 2010; Daamen and Vries, 2013).

Research perspective and framework

1. Inland ports and their urban environments

The inland port concept has gone through substantial re-evaluations over the last decades, starting with Leitner and Harrison (2001) who were amongst the first to offer a methodological classification of inland ports.

In its broadest sense, the term inland port has been used to indicate a (non) waterway-based port, not located at the seaside. In recent years however, scholars and practitioners have come to see inland ports as integral parts of global supply chains, where a cluster of distribution and logistics activities may take place (Leitner and Harrison, 2001; Rodrigue et al., 2010). As such, these ports, located further from the maritime access points, often serve as a direct link between seaport corridors and the larger hinterland. The facilities offered by inland ports have the advantage of reducing the demand on restricted seaport capacity, offering shippers the ability to connect to modern distribution centres that are located farther away from the maritime access point and closer to the hinterland (Rahimi et al., 2008). More detailed conceptualisations of the inland port concept tend to diverge or try to encompass several definitions under the same umbrella, hence generating some debate on the actual state, nature, function(s) and the role(s) these ports play as links in today's global supply chains.

Authors such as Roso et al. (2009, 2010) focus on the 'dry port' concept, which therefore excludes the water-based component that typifies several real-life examples of inland ports (Roso et al., 2009; Roso and Lumsden, 2010). Ng and Gujar (2009) highlight the spatial characteristics of inland transport hubs and state that dry ports, in many ways perform many of the same functions as seaports, with several particular differences (Ng and Gujar, 2009; Ng et al., 2013). Cullinane et al. (2012) also explore the dry port concept and find that the initial conceptualisation of a dry port as a seaport owned entity with little or no private involvement is no longer completely valid, and that many examples of show that current dry ports fulfil crucial roles in terms of intermodal transport and in accommodating current challenges in world trade (Cullinane et al., 2012).

This vision is shared by Rodrigue et al. (2010), who posit that three main criteria come into play when assessing the concept of an inland port: containerisation, the presence of a dedicated link and the introduction of massification (Rodrigue et al., 2010). As such, inland ports, in the criteria presented by Rodrigue et al. (2010) are characterised by their ability or function to facilitate value-adding activities and their scale enhancing function in terms of inland distribution, whilst operating in the presence of dedicated links to other larger ports or corridors.

That which differentiates an inland port from a seaport is the fact that the seaport is seen as an obligatory step in the maritime/ land interface, whilst an inland port is only one of the options available for freight distribution. As such, shipping freight to and through an inland port is seen as an option that is to be chosen when favourable economic and environmental conditions arise (Rodrigue et al., 2010; Dooms, 2010; Slack, 1999). Furthermore, in terms of their functionality, inland ports often function as anchoring mechanisms and serve more than mere economic objectives. They affect the wider urban economy and community and in effect serve not only private sector objectives, but also function as a governance tool in the context of urban or metropolitan policy-making (Rahimi et al., 2008). The ownership structure of inland ports, furthermore ranges from purely privatised to fully subsidized entities that can have a very dedicated connection to specific metropolitan areas or on the contrary, serve just one single customer (Rodrigue et al., 2010; Rodrigue, 2013).

The main question therefore, is how inland ports can sustain their viability, as added value that is created in the fore- or hinterland, can be shifted from the main port or hinterland to the inland port and vice-versa. This whilst inland ports are also facing the inherent trade-off between economic growth and the depletion of scarce resources. As these dynamics undoubtedly influence stakeholder perceptions this in turn directly or indirectly influence port authority decision-making and strategic manoeuvrability and increases the need inland ports have for accurate information on the logistical dedicatedness of the economic activities taking place in the port and the impact these activities have within the wider region (Aerts et al., 2015; Charlier, 2011; Dooms, 2010; Haezendonck et al., 2014).

2. Towards a governance tool for non- and contractual inland port relations

In 2004, Hesse and Rodrigue argued that the literature in geography research did not place sufficient attention on the movement of goods and the distribution of freight. The argumentation stated that insufficient understanding about how freight distribution works, meant that value chain analysis, logistics interdependencies and logistics principles and requirements would be overlooked when analysing the organisational or locational decision-making of firms. As such, these authors have called for the evaluation of how the physical space is interwoven with informational structures, social systems of production and local interaction. Hence highlighting the interrelation between locational elements and organisational decision-making (Hesse and Rodrigue, 2004). In this sense, the authors suggested to focus on the improvement of knowledge on the volume, composition and dynamics of physical distribution at different geographical levels. Consequently, creating a need for the further analysis of interactions of geographical systems of production (firms) and systems of consumption (urban regions) (Hesse and Rodrigue, 2004).

Assessing the geographical impact as well as the decision-making process of firms, directly related to their locational or geographical preferences, as is done in this chapter, therefore aids in elucidating the position of the port authority within its direct inland/urban environment. At the same time, this also provides insight into the locational decision-making processes that influence key stakeholders. As such, the port authority in this case, The Port of Brussels, serves as the focal entity that links up the local and regional system of consumption, namely the Brussels Capital Region (BCR, containing 19 municipalities and approx. 1,2 million inhabitants) and Brussels Metropolitan Region (BMR, containing around 2,5 million inhabitants, integrating the municipalities of the larger metropolitan area) with the geographical systems of production, namely the firms and other stakeholders active within the port. Port stakeholders, whilst having their own strategic considerations, depend on their core business and perceive the necessity of handling freight at the inland port in light of the trade policy and business opportunities that are facilitated at the port. Transport and supply chain operators for instance, seek to take advantage of economies of scale and co-location, when locating some or all of their economic activities within the port.

At the public side, through the ownership structure of the port, i.e. fully owned by The Brussels-Capital Region, the City of Brussels, and several of the municipalities of Brussels, the port authority is also influenced by public policies that seek to leverage the port as a means for revenue stream generation. And, more importantly, the PA seeks to leverage the associated rents and taxes generated through these economic activities for the improvement of the urban area (Rodrigue et al., 2010; Rahimi et al., 2008).

Hence, applying the PHI matrix to the case under consideration, allows us to improve our understanding of the reasoning behind why certain stakeholders choose to do some or all of their business in the port (highlighting the logistical dedicatedness of these activities, i.e. the asset specificity of the activities), at the same time, providing strategic information on the geographical reach of these activities, hence highlighting the connection between locational elements and their importance in terms of both decision making at the port authority, as well as the port stakeholder level.

Research method

For the application of the Port Hinterland Impact matrix to the inland port setting, an explorative approach into the workings of the Port of Brussels was applied. Located in the centre of Europe and Belgium, The Port of Brussels handled a total of 6.6 million tonnes of cargo in 2013 (Port of Brussels, 2013). This means that the port is defined as a small port authority (PA) (Verhoeven, 2010), although for inland ports, it ranks as one of the larger European inland ports. In 2013, the PA noted a total of 11,450 vessels and 50,000 passengers passing through the port (Port of Brussels, 2013).

The application of the Port Hinterland Impact matrix to the Port of Brussels was done using a cascade. First, percentages were calculated per region and traffic category, by asking the port's main contractual stakeholders to provide exact figures, or alternatively, estimates of the geographical impact of their activities. The four possible options that were given to these stakeholders are in order: (i) within the port, (ii) within the Brussels Capital Region (BCR), (iii) in the Brussels Metropolitan Region (BMR), (iv) in Belgium and abroad. The various applications of the PHI concept in Haezendonck et al. (2014) have shown that the definitions of the geographical layers of the matrix vary in function of certain size, market and geographical conditions. Hence, four geographical dimensions are established for the regional aspect (the horizontal axis in the matrix) and were developed in close collaboration with port experts and stakeholders. A greater regional scope involves greater logistical complexity and more complicated regulations on the one hand, and growing competition over this area in the hinterland with other ports or transport modes, on the other hand.

Secondly, the traffic categories were assigned to the classes of the vertical dimension, i.e. the logistical dedicatedness of their operations to the port. Hereto, contractual port stakeholders (essentially tenants and cargo owners) were asked to indicate the extent to which their economic activities are bound to the Port of Brussels. The division used to make this assessment is based on four categories, ranging from a weak to a very strong commitment to the Port of Brussels. The stronger the traffic is bound to the current port, the better for the port as this means that the companies active in this traffic category will suffer a high cost of substitution if they want to change locations or transportation mode. Consequently, the intention of moving the business to another region/port, or transport mode, is smaller when the logistic dedicatedness is strong and vice versa (see below).

In order to gather the necessary input for the construction of the PHI-matrix, the research team drew from existing freight market studies and policy documents on the port and wider urban level, the master plan of the port of Brussels, as well as from 20 face-to-face in-depth interviews that were conducted with experts from the companies active in and around the port during a 2-month period in 2014. The companies selected for each traffic category either represent a combination of several of the larger players in each traffic category or are the main entities active in a traffic category in the port. During a 6-month research period (January – June 2014), an expert committee was established to validate the approach and intermediate results of the research. These experts included, yet were not limited to, the port's director of marketing and development, a commercial manager, a manager of development, two statisticians, policy experts, an independent transport expert, an expert from the Minister of the Brussels Region's cabinet responsible for the port, and an expert from the Regional Mobility Agency.

To identify the traffic categories and subcategories of traffic flows found at the port, data was used on current traffic flows of the port of Brussels (of the year 2011), combined with potential developments as specified in the Master Plan of the Port of Brussels, established in 2012. The data were validated through expert consultation, and during the expert committee meetings. Through the interviews with managers of firms active in the port area, the findings were validated once more.

With regard to the potential future traffic categories, no time series on traffic evolution were available as there were no projects with sufficient maturity. For these categories a bottom-up approach is applied, using recent feasibility studies as well as face-to-face interviews with experts from both existing tenants interested in developing these new traffics as well as logistics providers currently operating these traffics in similar environments.

Results

The analysis of the results will focus on three distinct categories of traffic, as suggested above:

- 'Traditional traffic categories', i.e. larger, dominating traffics within the traffic portfolio of the port, which have been present in the port for several decades and show a mature growth. Typically, this concerns construction materials, petroleum products and material recycling.

- 'New traffic categories', i.e. more recently developed traffics with a smaller share within the traffic portfolio of the port but showing relatively high growth potential. These include containers, pallets and ro-ro traffic. Here the port either has already substantially developed the flow of goods (containers), ran successful pilot projects (pallets) or is in the process of leasing land (ro-ro second hand cars).

- 'Potential traffic linked to urban logistics', i.e. traffic volume currently mainly using road transport from and to the urban region, but with proven potential for modal shift to either water or rail transport. Here, the port authority is committed to improve the logistical connections of these urban logistics centres in order to achieve a modal split and contribute to the increase of pallets, containers and other innovative forms of intermodal transport.

1. Traditional traffic categories

1.1 Origin and destination of the traffic

The origin of the raw materials for the concrete that is produced in the port of Brussels originates either from Belgium (70%), or abroad (30%). This can be seen in figures 2 and 3. The destination for this traffic lies mainly within the borders of the Brussels Capital Region (BCR): 33% is for inside the port and 63% is destined for Brussels. The remaining 3% knows its destination within the Brussels Metropolitan Region (BMR). Hence, concrete, as a traffic category, does not have a wide geographical spread in terms of outbound traffic, especially when compared to the geographical distribution of this category's incoming traffic. It does however mean that the generated traffic serves a market directly connected to the Brussels capital and port area. This means that the traffic is most likely to be logistically highly dedicated to the port, as its activities serve the direct market.

Most (99%) of the raw construction materials that are handled in the port of Brussels originate from the broader Belgian region (24%) and or come from abroad (75%). The main countries from which construction materials are imported are Germany, Britain, and the Netherlands. The remaining minor part originates from within the Brussels Metropolitan Region (BMR) and is actually a part of the recycled material that is recuperated from building sites in the city. Of the outgoing traffic 7% is destined for inside the port, 23% within the BCR, 40% within the BMR and 30% for within Belgium. Hence the market that is served through the economic activities that take place in the port of Brussels in handling construction materials is broader than the market for concrete, even though the centre of gravity does lie within the Brussels Capital region. This indicates that the activities that are performed within the port serve the direct port region, demonstrating a dedicated logistical operation.

The food products traffic is characterised by a port-hinterland connection that mainly serves Belgium and the region outside Belgium. The main countries that supply the nutritional resources and the markets that are served with the products treated at the port of Brussels are, besides Belgium, the Netherlands, Germany and France. The incoming traffic on the geographical dimension can be divided according to three modes: 85% of traffic comes via inland shipping (barge / coaster), 8% comes by train and 7% is moved using road transportation. The other share, a very small proportion of the incoming traffic has its origin in the BMR (<3%) and comprises wheat, supplied by truck. Analogously, the traffic has a small share of its customers within this geographical dimension of the BMR: 5% of the traffic (flower) is supplied to bakeries and industrial customers (in bulk or bags) via road transport. The outgoing nutritional flour and the by-products of the milling process (short flour pellets, bantams and middlings), represent 22% and 73% of the nutritional products that leave the port by barge. Hence the economic activity that is generated within the port has little direct economic impact within the direct urban surroundings. However, it should be mentioned that there is only one major player in this category.

The liquid bulk that is handled within the port of Brussels is dissimilar in its origin and its destination. Relating to where the traffic originates, the results indicate that three quarters of the traffic come from abroad (the trade of oil and petroleum products with the Netherlands is quite important), and only 25% comes from within Belgium. The incoming traffic is entirely done by barge. Three quarters of the outgoing traffic in petroleum stays within the BMR with 25% that is destined for the BCR. The remaining 25% goes to other regions, but still stays within Belgium. Consequently, the fact that this traffic mainly impacts the direct Brussels region is mainly due to the presence of the customers of the companies (essentially petrol service stations) in the direct vicinity of the port. The main player active in this traffic category supplies its customers throughout Brussels, both in the city centre and within a radius of approximately 40 km around the centre. The second largest player active in this traffic category also supplies in Anderlecht (in the south part of BCR). This implies that for these categories, the port is an indispensable part of the supply chain.

The recycled materials that are handled in the Port of Brussels overwhelmingly come from the BCR (80%). The rest either comes from within the BMR (10%) or from within Belgium (9%). Only a tiny fraction of the recycled materials comes from inside the boundaries of the port itself. Approximately 98% of recyclable materials have a destination in Belgium (77%) or abroad (21%). The latter is the result of higher processing costs associated with recycling installations that are located in densely populated areas. Processing is therefore very expensive in Brussels. Also, for demolition and processing of aggregates, ultimately a large part of the goods is shipped to destinations outside Brussels and possibly even abroad (the Netherlands, India and China). This category illustrates a remarkable situation, compared to the forgoing categories as a reverse situation is observed. In this case the port's position is not linked to the demand side of the market, but rather to the supply of materials sourced in the immediate environment of the port.

1.2 Logistical dedicatedness of traffic flows

The concrete-traffic category show a strong connection to the port. This is explained by the location of the port and its short distance to the market. Time is very significant in this category, as there are stringent quality standards in place, regulating the transport time for ready to use/mixed concrete. The traffic class construction material equally has a strong to very strong connection to the port of Brussels. For the companies that are active in this field, the delivery time and hence the distance to the market serves as a very important factor in the selection criteria used to select a suited production location. Inland waterways and barge-based shipping allow these companies to be less dependent on road transportation and hence to become less exposed to the heavy congestion that typifies the road traffic in Brussels. There is also the added benefit that arises from having multiple and similar players present at the same location, thereby making the individual supply chains more robust (through reciprocal activities in times of need) and even allowing for the division of larger shipments into smaller mutual deliveries.

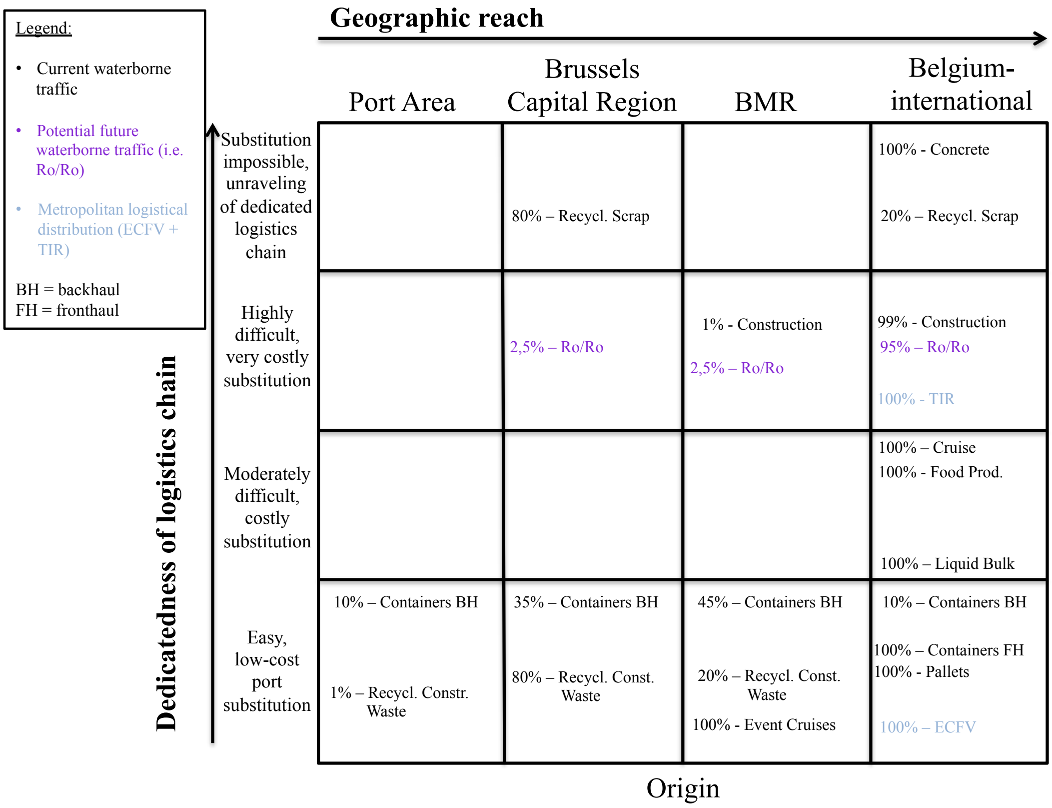
The food products category is only moderately dependent on the port of Brussels. This is however related to the extent of its use of the inland waterway. There is only one large multinational active in this category, which therefore is responsible for 100% of the nutritional traffic in the port. Originally the company was located in the port due to the flourmills that were situated along the waterfront and were used in order to process the grain. The fact that the company still uses the waterway, for almost half of its traffic, is indicative of a degree of logistical boundedness. However, based on interviews and input retrieved through interactions with port experts, it was confirmed that the activities could certainly be performed elsewhere, given that the current production process is no longer dependent on the waterway.

The petroleum traffic is moderately connected to the port because the traffic mainly concerns a trade flow to third parties. It is an automated flow where handling of the product is not labour intensive, and only serves as one link in a very long supply chain. This would imply that the logistical connectedness of this particular traffic category to the port of Brussels is rather weak, as the value-added services could take place elsewhere.

Advantageous to the location of the port of Brussels is the time to the market and the diversification in terms of deposits and possible starting points to supply the product to the wider Brussels region. Without the port of Brussels serving its role in this particular logistics chain, this would mean an additional 200 trucks added daily to the already heavily congested Brussels region.

Recycled materials show a weak logistics connection to the port as the traffic is generated as a result of the port's concession policy. One of the companies using a concession is required to achieve a traffic volume of 150,000 tons/year. Hence this company is forced to create traffic through the waterway. If the use of the waterway is not facilitated by concessions, then the cost of additional transport is sufficient to undermine the viability of this approach. The cost of post-transport (after the waterborne part of the journey) can play a crucial role here in the profitability of the overall transport or logistics chain. For another company active in this traffic category, there is a very strong commitment to the logistic location of the port of Brussels, given that all raw materials are obtained within the Brussels Region.

Figure 1. Port of Brussels PHI Matrix: Traffic Origins



Source: author

Figure 2. Port of Brussels PHI Matrix: Traffic Destinations

Legend:

- Current waterborne traffic
- Potential future waterborne traffic (i.e. Ro/Ro)
- Metropolitan logistical distribution (ECFV + TIR)

BH = backhaul
FH = fronthaul

Geographic reach →

Dedicatedness of logistics chain	Port Area	Brussels Capital Region	BMR	Belgium-international
Substitution impossible, unraveling of dedicated logistics chain	33% - Concrete	63% - Concrete	3% - Concrete	100% – Recycl. Scrap
Highly difficult, very costly substitution	7% - Construction Mat.	23% - Construction Mat. 20% - TIR	40% Construction Mat.	30% - Construction Mat. 100% – Ro/Ro 80% - TIR
Moderately difficult, costly substitution		100% - Cruise 2,5 % - Alimentation 25% – Liquid Bulk	2,5% - Alimentation 50% - Liquid Bulk	95 % - Alimentation 25% – Liquid Bulk
Easy, low-cost port substitution	100% - Event Cruises	50% – Containers FH 70% - Palets 12% – ECFV	50% – Containers FH 30% - Palets 5% – Recycl. Constr. Waste	100% – Containers BH 95% - Recycl. Constr. Waste 88% – ECFV

Destination

Source: author

For these traditional traffic categories, the results consequently indicate that the traffic for most categories provides a high added value and is closely tied to the port. The traffic makes use of the waterway and offers growth prospects. Consequently, it is extremely important to anchor these activities at their current location, given the positive impact on economic and environmental issues at regional level, i.e. less road congestion and sufficient supply for the related markets in the metropolitan region.

2 New traffic categories

2.1 Origin and destination of the traffic

For containers, the traffic movement is split between the backhaul (from the hinterland to the terminal) and front haul (from the terminal to the hinterland). This breakdown is also presented in figures 2 and 3. Back haul containers predominantly originate from Brussels and the surrounding region (35% of the Brussels-Capital Region and 45% from Brussels Metropolitan Region) and their destination is exclusively (100%) Belgium, the traffic goes to and passes through the Port of Antwerp. Front haul containers exclusively (100%) originate from Belgium, and their destination is the Brussels Metropolitan Region. This indicates that companies that are active in this region have a use for cargo that is shipped by container.

The most frequently used mode of transport to the port of Brussels, for the container traffic category, is inland shipping via barges (99%). Only in emergencies are containers shipped to the port of Brussels, by truck. The "last mile" for containers to their final destination in Brussels is usually done by truck. Afterwards, the containers that come back (90% of cases) are shipped via inland waterway on the Antwerp-Brussels axis.

Pallets are seen as a new traffic category for the port of Brussels. The pallets are formed and originate from the port of Antwerp and other distribution centres in Belgium. From these distribution centres, the pallets are shipped by barge to reach the hinterland. For the port of Brussels, the pallets that are shipped in through the port are destined to reach the region in and around the Brussels: the bulk of this traffic category (+/- 70%) is destined for the BCR, the remaining portion (+/- 30%) is destined for the BMR and reaches its destination by truck.

Ro-Ro traffic has been identified in the port master plan, as a very promising future traffic category. Given the historical presence of a large second-hand car-trading hub in the Brussels Region. This hub focuses on the export of second hand cars to West and Central Africa through the port of Antwerp. Currently these second-hand cars are transported by road from an economic cluster near the canal to the Port of Antwerp.

For the second-hand car traffic, the results indicate that only a small percentage of these cars originates from the BCR or the BMR (both less than 5%), and less than a fifth (15%) comes from the rest of Belgium. The largest suppliers of the cars are located abroad, France, Switzerland, Germany or Italy are seen as the main suppliers for this cargo stream. The cars are gathered in the trading hub near the canal and are 100% bound for an abroad destination. The cargo is brought to the port of Brussels by truck and leaves the port by truck. Hence, providing a location near the port for this traffic category and allowing for cargo consolidation on barges may prove to be both lucrative as well as ecologically justifiable.

For reasons of chapter length, we exclude the discussion of the river cruise traffic here. A full version of the analysis is however available upon request.

2.2 Logistical dedicatedness of the new traffic flows

Container traffic has a very strong connectedness to the port of Brussels, given the existing subsidy framework. It is quite clear that without subsidies the long-term survival of the container terminal located at the port of Brussels would be nearly impossible. The cost of a substitute location for this traffic category is relatively low as it can be switched to road transport fairly easily.

Ro-ro is characterized by a strong logistical connectedness to the Brussels Capital Region, given the closeness of the sales system, the administrative services (highly specialized, dedicated maritime agencies located in Brussels) and the involvement of the current vendors/shippers in Brussels. The results therefore indicate that the necessary conditions are created to improve both the economic profile as well as the environmental profile of these economic activities, through the creation of a network of trade platforms for urban distribution and expansion/development of additional logistics zones in the vicinity of the waterway.

For reasons of chapter length, we exclude the discussion of the river cruise traffic here. A full version of the analysis is however available upon request.

3 Potential future traffic categories linked to urban / metropolitan distribution

3.1 The European Centre for Fruit and Vegetables (ECFV)

The European Centre for Fruit and Vegetables has a weak logistical connection to the port of Brussels and is characterized by an inbound cargo stream entirely originating from abroad (100%). In terms of the traffic's destination, the results indicate that this is mainly the Belgian market (78%) or a destination somewhere abroad (10%). The rest of the fresh fruit and vegetables are sold in the region in and around Brussels (ca. 12%).

The centre trades 600,000 tons of fresh fruit and vegetables annually. The produce is not stored on location; the centre serves as market place or trading spot for perishable products. Moreover, there are no Belgian products for sale and 75% of the 600,000 tons, or 450,000 tons, comes from within the wider European Union or European region.

In terms of modal split approximately 90% of the volume initially enters Europe by sea in the ports of Antwerp, Zeebrugge, Rotterdam, Bremerhaven and Marseilles, and the loads are further transported by truck to the ECFV. Other volumes are transported by air and then by truck: this is the case for goods that are more time sensitive (e.g. beans from Kenya). Due to the fact that the cargo is shipped by plane, the parcels themselves consist of smaller quantities of 3, 4 or 5 tons. Ultimately, all inbound traffic enters the ECFV by road. The same goes for all outgoing traffic. None of the traffic neither coming nor going to and from the ECFV is transported by waterway through the port of Brussels. Road transport is preferred as waterway-based transports are too expensive and take more time than shipping the goods by road from the origin, or from a seaport or airport.

The ECFV, in relation the Port of Brussels, knows a weak logistical connectedness, as there is a real chance that the centre is going to move to a new location. The city of Brussels owns the land on which the ECFV is located, and the land is at the ECFV's disposal through a contractual agreement in the form of a lease. This lease is valid for 50 years and was signed in 1978. The centre's future is under discussion, with respondents indicating that the ECFV might not remain at the current location.

3.2 TIR centre: International Road Transport centre

The TIR centre has a strong logistical connection to the port of Brussels. The majority of the companies that are active in the centre use it for the storage of their goods in order to efficiently serve their local market (Brussels). Most of these companies have their headquarters elsewhere in Belgium. Consequently, as the centre's name implies, all incoming and outgoing traffic is transported by road. In the past, tests were conducted in order to supply cargo via inland waterway, yet the costs and time needed for this type of transportation were assessed as too high and too long respectively.

The largest user's customers are mainly situated in Zellik (in BMR), Louvain-la-Neuve (close to BMR) and Antwerp (outside BMR). Other companies active in the centre are mainly local companies, with customers in and around BCR. The results indicate that the TIR centre is not going to move. The main advantages of the current location are that it is located close to the centre of the urban region and is relatively close to the highway access.

4 Overall results and main implications

Overall the results indicate that the inland port under consideration faces challenges of retaining relatively new traffic categories with a high identified potential for green urban logistics (e.g. pallets, containers), due to low levels of logistical dedicatedness, as a result of a high potential for transport mode substitution.

In contrast, the more traditional traffic categories present at the inland port (e.g. construction materials or petroleum products) show higher levels of logistical dedicatedness and boundedness to the port. The fact that these more traditional traffic categories show higher levels of logistical dedicatedness to the port, offers continuous benefits in environmental terms for the broader metropolitan region, as the reduction of inbound road traffic lowers the congestion in the Brussels urban region. Yet, at a more local level, the traditional traffic categories also face challenges from infrastructure developers and leisure developments that seek to use the waterway for their economic exploitation.

The new traffic categories show lower levels of logistical dedicatedness to the port and are less focussed on the direct or local environment of the port. They make more use of road transportation, thereby being less oriented towards the integration of intermodality and green logistics. Furthermore, the mere logistical operations at the waterside of these new traffic categories offer relatively low added value and employment potential, if these are not linked to value added logistics (VAL) further down the chain (Langenus et al., 2015). However, also here lies an important environmental benefit, and further innovation potential (e.g. use of electrical vehicles for urban distribution).

Conclusion

This chapter applies the Port Hinterland Impact (PHI) matrix developed for seaports (Haezendonck et al., 2014) in the inland port setting, in order to add a geographical or spatial dimension to the socio-economic impact of the Port of Brussels. By using this assessment method of inland port functioning, insights are gained into the regional distribution of the port traffic, for the inland port under consideration. The analysis focuses on the logistical dedicatedness, as an expression of asset specificity and geographic reach, as an indication of distance and potential challenges for contractual port stakeholders.

The results indicate that the more traditional traffic categories tend to show higher levels of logistical dedicatedness to the port, vis-à-vis the newer and more innovative traffic categories often linked to new, sustainable forms of waterborne transport (e.g. containers, pallets and other smaller units than containers). In terms of geographical reach, the traffic flows also differ, as the more traditional traffic categories have a substantial impact in the direct vicinity of the port and the urban region, whilst newer traffic categories tend to reach further, beyond the direct port area and the Brussels Capital region. As a result, in contracting terms, differentiation is needed in order to strategically support and position these traffic categories based on their impact in the urban region (or beyond). The stakeholders that are part of the more traditional traffic categories stand to gain if they cooperate with the port authority in order to address local externalities that affect the strategic manoeuvrability of the port, as license to operate issues often arise due to dust, smells, noise and security concerns related to these operations. The fact that these stakeholders have a clear interest in co-developing strategies and thereby aiding the strategic objectives of the port, is a crucial insight, gained through the application of the PHI matrix.

In developing and consolidating newer traffic categories, stakeholders need to be included that are currently situated outside the direct vicinity of the port, yet stand to benefit from inland port use, in turn affecting the strategic position of the inland port. An increased critical mass, as well as increased employment, economic activity and revenues, will further the strategic objectives of the port substantially. Towards third party stakeholders, or those not directly involved in the creation of economic activity within the port, such as local communities and environmental interest groups, the application of the PHI matrix and the resulting findings stand to illustrate the importance of certain traffic categories and the impact both locally, regionally as well as nationally created by these port operations. Thereby clearly illustrating the strategic use and position of the Port of Brussels. The combined insights, gathered through the application of the PHI matrix to this inland port setting, therefore allow the port to improve its port governance in relation to the internal, external, direct and indirect port stakeholders in the context of urban logistics and freight policy.

Discussion and future research

Inland ports tend to be smaller in scale, when compared to seaports; this calls for a more detailed analysis of the activities that take place in such ports. This research therefore provides a very detailed description of the different traffic categories and their impact. This in turn also relates to the different functions of inland ports, which complicates matters further, e.g. as multimodal platforms for both location of urban production (sometimes even strongly export oriented), urban distribution, and leisure and tourism activities. This research has established the Port of Brussels as a metropolitan inland port. As a result, future research may want to apply the PHI matrix to other types of inland ports, in order to address potential differences that are to be found in the comparison of metropolitan (i.e.

more urban logistics oriented, with the associated stakeholder pressures) and industrial inland ports (i.e. more production/manufacturing oriented, located somewhat outside urban regions) and also do so in a more longitudinal manner.

Furthermore, added research in the strand of strategic port governance and the spatial impact of ports, stands to elucidate the different scale types needed to measure and compare different types of ports. For instance, the previous research performed by Haezendonck et al 2014, indicated that a particular scale was developed in order to assess the geographical impact of seaports. In this chapter, similarly a scale was developed to assess the impact of an urban/metropolitan inland port. Consequently, by addressing this issue further, and by adding additional insights based on the application of the PHI matrix to different cases, grounded theory will be able to develop that will allow for standardised scales to be used depending on the types of ports that are studied. Researchers are therefore encouraged to apply the PHI matrix to different ports, and the urban regions within these are located, in order to aid the development of a more standardised strategic knowledge capturing approach.

Bibliography

Aerts, G., Dooms, M., & Haezendonck, E. (2015). Stakeholder management practices found in landlord seaport authorities in Flanders: an inside-out perspective. *International Journal for Shipping and Transport Logistics , forthcoming*, 1-24.

Carbone, V., & De Martino, M. (2003). The changing role of ports in supply-chain management: an empirical analysis. *Maritime Policy & Management , 30* (4), 305-320.

Charlier, J. (2011). Hinterlands, port regionalisation and extended gateways: The case of Belgium and Northern France. In P. Hall, R. McCalla, Slack, & B. Slack, *Integrating Seaports and Trade Corridors.* Surrey, UK: Ashgate.

Cullinane, K., Bergqvist, R., & Wilmsmeier, G. (2012). The dry port concept - Theory and practice. *Maritime Economics & Logistics , 14*, 1-13.

Daamen, T. A., & Vries, I. (2013). Governing the European port-city interface: institutional impacts on spatial projects between city and port. *Journal of Transport Geography , 27*, 4-13.

Dooms, M. (2010). *Crafting the integrative value proposition for large scale transport infrastructure hubs.* Vrije Universiteit Brussel. Brussel: VUBPRESS.

Dooms, M., Haezendonck, E., & Valaert, T. (2013). Dynamic green portfolio analysis for inland ports: An empirical analysis on Western Europe. *Research in Transportation Business & Management , 8*, 171-185.

Haezendonck, E., Dooms, M., & Verbeke, A. (2014). A new governance perspective on port–hinterland relationships: The Port Hinterland Impact (PHI) matrix. *Maritime Economics & Logistics , 16*, 229-249.

Hesse, M., & Rodrigue, J.-P. (2004). The transport geography of logistics and freight distribution. *Journal of Transport Geography , 12*, 171-184.

Langenus, M., & Dooms, M. (2015). Port industry performance management: a meso-level gap in literature and practice?. *International Journal of Logistics Research and Applications*, *18*(3), 251-275.

Langenus, M., Dooms, M., Haezendonck, E., & Aerts, G. (2016). Socio-economic valuation of traffic in inland ports: the development of a weighing rule for the port of Brussels. *International Journal of Decision Sciences, Risk and Management, 6*(3), 297-318.

Leitner, S. J., & Harrison, R. (2001). *The identification and classification of inland ports.* Center for Transportation Research. Austin: University of Texas.

Lu, C., & Yan, X. (2014). The break-even distance of road and inland waterway freight transportation systems. *Maritime Economics & Logistics*, 1-18.

Macharis, C., Van Hoeck, E., Pekin E., & van Lier, T. (2010). A decision analysis framework for intermodal transport: Comparing fuel price increases and the internalisation of external costs. *Transportation Research Part A*, 44, 550-561.

Monios, J. (2011). The role of inland terminal development in the hinterland access strategies of Spanish ports. *Research in Transportation Economics , 33*, 59-66.

Ng, A. K., Padilha, F., & Pallis, A. A. (2013). Institutions, bureaucratic and logistical roles of dry ports: The Brazilian experiences. *Journal of Transport Geography , 27*, 46-55.

Ng, K. A., & Gujar, G. C. (2009). The spatial characteristics of inland transport hubs: evidences from Southern India. *Journal of Transport Geography , 17*, 346-356.

Notteboom, T. E., & Rodrigue, J. P. (2005). Port regionalization: towards a new phase in port development. *Maritime Policy & Management*, *32*(3), 297-313.

Pellegram, A. (2001). Strategic land use planning for freight: the experience of the Port of Londen authority. *Transport Policy , 8*, 11-18.

Petit, S. J., & Beresford, K. C. (2009). Port development: from gateways to logistics hubs. *Maritime Policy & Management , 36* (3), 253-267.

Priemus, H. (1999). Sustainable cities: how to realize an ecological breakthrough: a Dutch approach. *International Planning Studies , 4* (2), 213-23§.

Rahimi, M., Asef-Vaziri, A., & Harrison, R. (2008). An Inland port location-allocation model for a regional intermodal goods movement system. *Maritime Economics & Logistics , 10*, 362-379.

Rodrigue, J. P. (2010). Functions and actors of inland ports: European and North American dynamics. *Journal of Transport Geography , 18* (4), 519-529.

Rodrigue, J.-P. (2013). Urban Transportation. In J.-p. Rodrigue, C. Comtois, & B. Slack, *The Geography of Transport Systems* (pp. 188-225). New York, US: Routledge.
Roso, V., & Lumsden, K. (2010). A review of dry ports. *Maritime Economics & Logistics , 12*, 196-213.

Roso, V., Woxenius, J., & Lumsden, K. (2009). The dry port concept: connecting container seaports with the hinterland. *Journal of Transport Geography , 17* (5), 338-345.

Roso, V., & Lumsden, K. (2010). A review of dry ports. *Maritime Economics & Logistics*, *12*(2), 196-213.

Slack, B. (1999). Satellite terminals: a local solution to hub congestion? *Journal of Transport Geography , 7*, 241-246.

Veenstra, A., Zuidwijk, R., & van Asperen, E. (2012). The extended gateway concept for container terminals: expanding the notion of dry ports. *Maritime Economics & Logistics , 14*, 14-32.

Verbeke, A. (2013). *International Business Strategy: Rethinking the Foundations of Global Corporate Success.* Cambridge, UK: Cambridge University Press.

Verbeke, A., & Greidanus, N. (2009). The end of the opportunism versus trust debate: Bounded reliability as a new envelope concept in research on MNE governance. *Journal of International Business Studies , 40* (9), 1471-1495.

Wan, Y., Zhang, A., & Yuen, A. C. (2013). Urban road congestion, capacity expansion and port competition: empirical analysis of US container ports. *Maritime Policy & Management , 40* (5), 417-438.