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The future challenge for inland terminal operators in the Netherlands:

How to deal with the increasing involvement of deep sea actors in container barge transport?

Master Thesis Urban, Port & Transport Economics

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Abstract

This research analyzed the impact of vertical integration of deep sea actors on the performance of the container barge transport sector in the Netherlands. Based on academic literature, the most important factors influencing the performance of container barge transport are identified. The literature review showed that it is unclear in which way the container barge network will develop itself after the opening of the Maasvlakte II. It is expected that new service network types will emerge in near future. Therefore, a scenario analysis by means of a simulation tool has been conducted during this research. The model is applied to the hinterland of the Port of Rotterdam. Based on reports of workshops with market parties, different cooperation schemes are identified. This research found that the bundling of container flows is advantageous for the container barge transport sector in the Netherlands. The cost savings in a line network are larger than in a hub-spoke concept, because of the additional handling costs. Through bundling, the number of stops in the Port of Rotterdam can be limited and because of that, a more attractive barge product can be offered to shippers. The bundling effect is larger for small inland terminals in the Netherlands which suggest that there is a relation between the size of an inland terminal and the cost effectiveness of bundling. This research also showed that the vertical integration of deep sea actors could be harmful for inland terminal operators in the Netherlands, especially for small inland terminals offering a point-to-point service to the Port of Rotterdam. However, hardly any price effect can be observed when inland terminal operators offer a joint liner service to the Port of Rotterdam. This suggests that cooperation offers inland terminal operators the opportunity to deal with the increasing involvement of deep sea actors in container barge transport. This thesis concludes by discussing a potential future development strategy for inland terminal operators in the Netherlands.

Keywords: vertical integration, hinterland network, bundling, container barge transport, inland terminal operator, port, Rotterdam, cooperation

Table of Contents

1. Introduction

This research focuses on the container barge transport sector in the Netherlands. Section 1.1 provides some background information regarding the Port of Rotterdam. The role of the actors involved in the hinterland transport chain of container barging will be discussed in section 1.2. Section 1.3 discusses the most important coordination problems in the hinterland transport chain. This has resulted in a number of research questions which will be presented in section 1.4. The scope of this research will be defined in section 1.5 and an outline of this thesis will be presented in section 1.6.

1.1 Port of Rotterdam

The Port of Rotterdam is often considered as the *"Gateway to Europe"*. It is ideally located in the heart of Europe's largest consumer markets: Germany, France and the United Kingdom. Through the Port of Rotterdam, millions tons of goods are transshipped to locations in Europe by train, truck and barge. Consequently, numerous international companies are located in the Netherlands. The Port of Rotterdam is thus an important driver behind the Dutch economy. Because port competition in North-West Europe is relatively fierce (De Langen, Nijdam, & Van Der Lugt, 2012), the Port of Rotterdam should be able to continuously adapt to external developments in order to remain the *"Gateway to Europe"*.

Literature shows that nowadays the quality of a port's hinterland infrastructure has become increasingly important for the competitiveness of a container port (e.g. Robinson, 2002; De Langen, 2007). Traditionally, the hinterland of a port was physically captive, because shippers had just a few options to transport their cargo. Haezendonck and Notteboom (as cited in Konings, 2007) argue that the geographical market coverage of ports has increased due to the containerization. This has transformed the hinterlands of the ports from captive to contestable regions (De Langen & Chouly, 2004)[1]. Consequently, ports are much more in competition to serve the same inland areas. Welters (as cited in De Langen & Chouly, 2004) has identified two factors for the competitiveness of a port: port performance and the ability of a port to serve markets in the hinterland efficiently. Because the possibilities for ports to differentiate themselves from competitors on the maritime side are limited, hinterland accessibility is now perceived as a key success factor for European ports (De Langen, 2004).

However, the increasing container volumes put pressure on the capacity of the hinterland infrastructure, especially the road infrastructure in the Rotterdam port area. Geerlings and Lohuis (2007) note that the roads around the Port of Rotterdam are already often congested and the local air quality is deteriorating. The Rotterdam Port Authority also recognizes that the quality and reliability of the hinterland infrastructure is under pressure. Therefore, hinterland accessibility is one of the focus areas in the strategic plan of the Rotterdam Port Authority. Their ambition is: "*In 2030, access to the port and*

1 All regions where one port has a substantial competitive advantage over others, because of lower generalized transportation costs, belong to the captive hinterland of a port. In contrast, all regions where no single port has a clear costs advantage belong to the contestable hinterland of a port (De Langen, 2007). Notteboom and Winkelmans (as cited in Van der Horst & De Langen, 2008) argue that these flows can easily switch between ports.

industrial complex is easy and reliable by all four modes of hinterland transport (inland waterway, rail, road and pipeline)" (Port of Rotterdam Authority, 2011, p. 54).

In 2009, approximately 48% of all containers were transported by truck to/from the Maasvlakte port area (see Figure 1). To improve the hinterland accessibility of the Port of Rotterdam in a sustainable way, the Rotterdam Port Authority aims to achieve a modal split of 45% barge, 35% truck and 20% rail in 2033 at the Maasvlakte port area where a vast majority of containers is handled. To achieve the modal shift ambitions of the Rotterdam Port Authority, the container barge transport sector must be able to facilitate a volume growth from about 1.7 million TEU in 2009 to 8.1 million TEU in 2033. Although most inland waterways in Europe still have a large reserve capacity, the container barge transport sector was not able to increase its market share in last years. This is illustrated in Figure 1. The share of container barging in the modal split of the Maasvlakte port area increased slightly from 38% in 2003 to 39% in 2009. The stagnation of container barging in the modal split is caused by the bad performance of container barge handling in the Port of Rotterdam (van der Horst & Kuipers, 2013). The barge handling problems are thus a serious threat for future competitive position of the Port of Rotterdam. The most important coordination problems in container barging will be explained in more detail in section 1.3.

Modality	2003	2008	2009	2020 (Goal)	2033 (Goal)
Barge	38%	37%	39%	41%	45%
Rail	13%	16%	14%	17%	20%
Truck	49%	47%	48%	42%	35%

Figure 1: Development and goals modal split Maasvlakte port area
(Source: Port of Rotterdam Authority as included in Van der Horst & Kuipers, 2013)

1.2 Hinterland transport chain of container barging

De Langen (2004) argues that the quality of a port's hinterland infrastructure depends on the behavior of many actors such as deep sea terminal operators and barge operators. Figure 2 illustrates that many different companies are involved in container barge transport. This section will describe shortly the role of the main actors in container barge transport. The role of public actors as customs and the port authority is not relevant for this thesis and thus will not be discussed in this section.

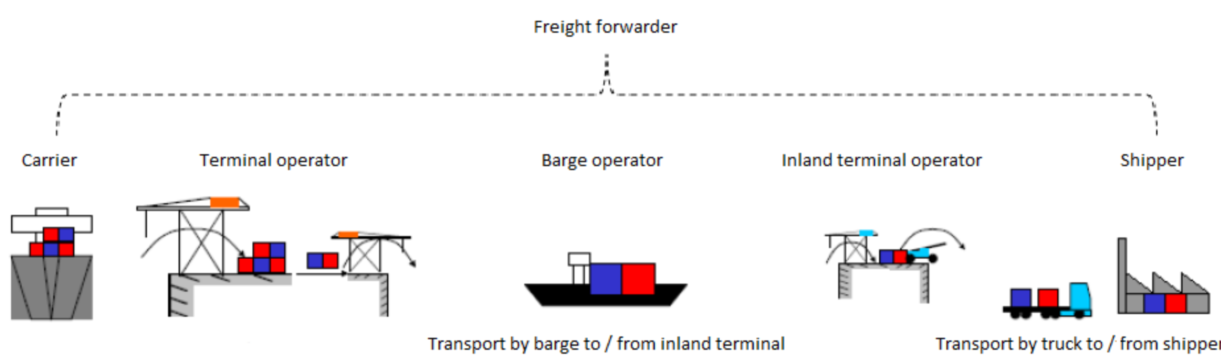

Figure 2: Hinterland transport chain of container barging
(Own elaboration on A&S Management, DLD, & Stichting Projecten Binnenvaart, 2003a)

Shippers are the key in the hinterland transport chain of container barging. They generate the demand for transport and are the owner of the goods. Because a reliable and in-time delivery is crucial for the continuity of a shipper, a shipper prefers to control the hinterland transport chain. A shipper is not involved in the organization of container barge transport, but determines in the end which actor is responsible for this. Commissioned by a shipper, a freight forwarder could arrange all or a part of the door-to-door transport activities. Freight forwarders are continuously looking to offer the best and cheapest solution. They do not own any vessels or terminals, but purchase transport services from third parties.

Traditionally, deep sea carriers are responsible for the transport of a container from one port to another. In a number of seaports, deep sea carriers have developed dedicated terminals for the handling of their vessels. Crucial elements for the continuity of deep sea carriers are reliable arrival and departure times, a high utilization of the vessels and a continuous insight in the container fleet (A&S Management et al., 2003a). Deep sea carriers are the only paying customers of deep sea terminal operators. The core business of a deep sea terminal operator is the loading and unloading of seagoing vessels. After loading and unloading, the containers need to be transshipped to other modalities.

A barge operator provides standard regular barge services to terminals in the port. By doing so, barge operators try to offer attractive rates and transit times to shippers. The customers of a barge operator can be different parties in the hinterland transport chain such as shippers, freight forwarders and deep sea carriers. The acquisition of containers is an important task for a barge operator. In general, barge operators focus on the organization and planning of the barge services. Therefore, barge operators usually do not own barges, but charter skippers that do own and operate the barges (Douma, 2008). Inland terminal operators handle the containers arriving by barge and transship the containers to the truck for the final transport to the shipper. An inland terminal can also function as a depot for the storage of empty containers. In the Netherlands, the exploitation of inland terminals and barge services is usually in one hand (see Figure 3: Option 3). This implies that an inland terminal operator also acts as a barge operator and contracts skippers who lease their barges including crew for a fixed period. In this case, an inland terminal operator is also responsible for a high utilization degree of the barges.

This section shows that many actors are involved in container barge transport. However, the role of the actors in the hinterland transport chain of container barging is changing. Through vertical integration, the actors expand their market activities which has blurred the traditional division of tasks within the hinterland transport chain (Notteboom, 2008a). Consequently, many different actors nowadays engage in the same activities. For example, deep sea carriers have started to develop dedicated terminals for the provision of terminal handling activities and deep sea terminal operators have started to develop inland terminals. By doing so, these actors are attempting to gain more control over the hinterland transport chain of container barging (De Langen, Fransoo & van Rooy, 2013). Each actor has its own specific reasons to get involved in hinterland transport. These reasons will be discussed in section 2.2.

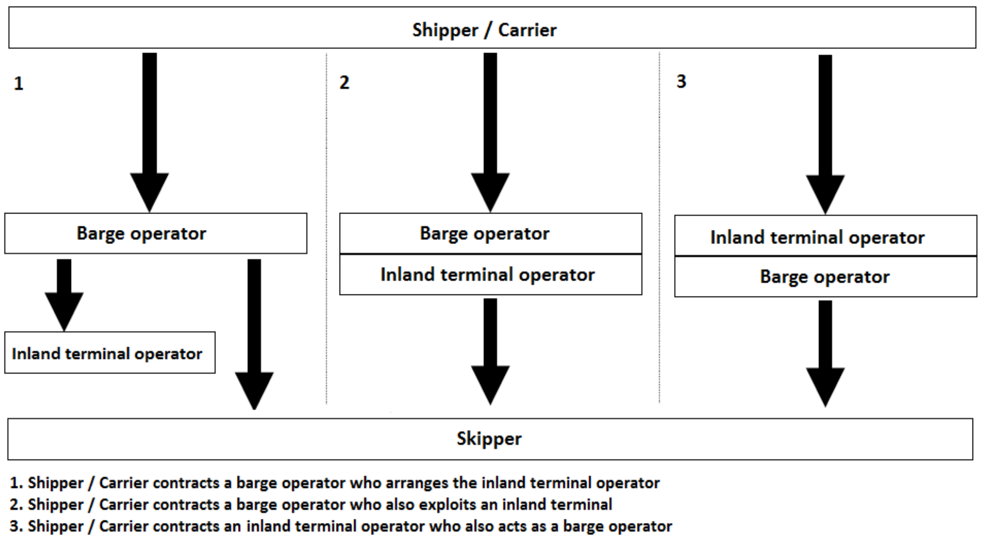

Figure 3: Organization container barge transport (Rabobank from A&S Management et al., 2003a)

1.3 Barge handing problems

De Langen (2004) argues that coordination between all actors involved in container barge transport is required to create an efficient hinterland transport chain. Van der Horst and De Langen (2008) investigated coordination in hinterland transport chains from an organizational perspective. They made a detailed analysis of the coordination problems in hinterland chains of seaports. Coordination does not arise spontaneously, because of:

- The unequal distribution of the costs and benefits of coordination
- The lack of resources or willingness to invest of at least one firm in the transport chain
- Strategic considerations
- The lack of a dominant firm
- Risk-averse behavior and a short-term focus of firms in hinterland chains

The most important coordination problems in container barge transport are the long duration of vessels in the port, inadequate terminal & quay planning for barge handling and limited exchange of cargo between barge operators. This section will explain the coordination problems in more detail.

The main problem in the Port of Rotterdam is that barges have to call at multiple terminals in the port, while the average call size is relatively small. This causes waiting times at the terminals, because many barges call simultaneously at the same terminal. Nextlogic (2012) reported that the average dwell time of a vessel in the port varies from 21 hours for small vessels (< 85 meter) up to 36 hours for large vessels (> 111 meter). Other studies show similar results (e.g. Pielage, Konings, Rijsenbrij, & van Schuylenburg, 2007). The barges call on average at 8 different port terminals per roundtrip. The average call size can vary significantly and is about 22 containers per terminal (Pielage et al., 2007). However, the share of call sizes with less than 10 moves is also substantial: ranging from 8% to 55% at the different terminals (Nextlogic, 2012).

The most important cause of the first two coordination problems is that deep sea terminal operators have no contractual arrangements with barge operators. They only have a contractual relation with deep sea carriers who are their only paying customers. Therefore, deep sea terminal operators prioritize the handling of seagoing vessels (barges are handled with the same infrastructure and equipment as seagoing vessels). That's why the waiting time in the port is very unpredictable. Nextlogic (2012) showed that in 41% of all calls the actual handling time deviated less than 2 hours from the scheduled time. This implies that in 59% of all terminals visits the handling of barges deviated more than 2 hours from the planning. An additional problem is that in case of delays, barge operators may miss the agreed time window at the next terminal. Consequently, the duration time in the port may be extended. To offer a reliable service, barge operators thus need to include large margins in their sailing schedule.

Next to a long duration of barges in the port and an inadequate terminal & quay planning, the exchange of cargo between barge operators is limited. Bundling of container flows could substantially contribute to a more efficient handling of barges in the Port of Rotterdam (Kreutzberger & Konings, 2013). Bundling allows barge operators to deploy larger vessels, to offer higher service frequencies and to reduce the number of calls in the port. Despite the need for bundling of container flows at inland terminals, the willingness to cooperate among inland terminal operators is limited, especially in the domestic market. Most inland terminals in the Netherlands are set up by trucking companies which execute the pre- and post-truck haulage themselves and prefer to serve their own terminal (Kreutzberger and Konings, 2013). Furthermore, the basic conditions for cooperation in the domestic market are not favorable. Many inland terminal operators are in competition to serve the same inland areas, because of the high number of new terminal initiatives and therefore have a negative attitude towards cooperation.

1.4 Research questions

It becomes clear from section 1.3 that the barge handling problems in the Port of Rotterdam are a serious threat for its future competitive position. A long duration of barges in the port has a negative influence on the total transit time and transportation costs of the barge services (Konings, Kreutzberger, & Maraš, 2013). It is expected that the barge handling problems in the Port of Rotterdam will worsen after the opening of the Maasvlakte II. More container terminals in the Port of Rotterdam imply an increase in the number of stops and a drop in the average call size. Time savings in the port would therefore considerably improve the hinterland accessibility of the Port of Rotterdam. A partial solution for the barge handling problems in the Port of Rotterdam is the bundling of container flows. However, the willingness of inland terminal operators to cooperate is limited, because of competitive issues.

Section 1.2 showed that many actors are involved in container barge transport. However, the role of the actors in the hinterland transport is changing. Deep sea carriers and deep sea terminal operators are changing their scope towards the hinterland and are nowadays more involved in container barge transport. Through vertical integration, these actors are attempting to gain more control over the hinterland transport chain (De Langen, Fransoo, & van Rooy, 2013). The integration is achieved through investments in assets or long term contractual agreements with other market players. Vertical integration improves the coordination between the different segments of the hinterland transport chain (Van der Horst & De Langen, 2008). Although the involvement of deep sea actors is still limited, it is expected that deep sea actors will become more involved in container barge transport in the near future, especially when the coordination problems in the Port of Rotterdam will continue to exist. Some deep sea actors are already expanding their activities to the hinterland. For example, deep sea carrier Maersk now offers the Inland CY product to shippers (barge services to/from inland terminals) and deep sea terminal operator ECT develops its own extended gate network. So far as known, no extensive research has been done on the impact of vertical integration of deep sea actors on the performance of container barge transport yet.

Vertical integration in the market may give rise to customer foreclosure (European Economic & Marketing Consultants, n.d.). Customer foreclosure occurs when the integrated firm no longer uses the services of the other market players, while it previously did. Consequently, the other market players have less volume available which makes it difficult for them to cover the fixed costs of their services and to offer an attractive product to shippers. This in turn may result in more market power for the integrated firm, especially when the non-integrated firm is not able to recover its costs and exits the market (Notteboom, 2008a). Because the exploitation of inland terminals and barge services in the Netherlands is usually in one hand, a smaller addressable market could be harmful for the current market position of inland terminal operators. This thesis investigates to what extent the increasing involvement of deep sea actors in hinterland transport influences the performance of container barge transport. The main question of this analysis is thus:

"*What is the effect of vertical integration of deep sea actors on the performance of container barge transport in the Netherlands in 2015 and 2025?*"

The research question can be divided into seven sub questions:

1. What are the reasons for deep sea actors to change their scope towards the hinterland?
2. Which factors influence the performance of container barge transport?
3. Which factors determine the market scope of container barge transport?
4. In which way design inland terminal operators their container barge network in 2015 and 2025?
5. What are the main characteristics of the different sailing areas in the Netherlands?
6. Which bundling network leads to the best performance of container barge transport?
7. In which way can inland terminal operators maintain their current market position?

1.5 Research scope

The main goal of this thesis is to investigate to what extent vertical integration of deep sea actors influences the hinterland accessibility of the Port of Rotterdam. During this project, a scenario analysis by means of a simulation tool will be executed. This research uses the simulation tool of the IDVV project of Rijkswaterstaat developed by the Delft University of Technology. A short description of the IDVV project is included in Appendix 1. This research is restricted to the hinterland of the Port of Rotterdam with respect to container barge transport. The expectation is that in this segment the largest growth will occur in the coming years due to the opening of the new container terminals at Maasvlakte

II and the modal shift ambitions of the Rotterdam Port Authority. This implies that container flows to/from the Port of Antwerp and Amsterdam are not taken into account in this research.

According to A&S Management et al. (2003a), three hinterland markets for container barge transport through the Port of Rotterdam can be distinguished: the Rhine river market, the Rotterdam-Antwerp market and the domestic market. A detailed description of the hinterland markets is included in Appendix 2. Each market has its own organizational and operational characteristics which makes it impractical to include all markets in this research. Therefore, this research only focuses on the domestic market of the Netherlands. The Rotterdam-Antwerp market is less interesting for this research. Because deep sea carriers are the main customers in this market, they already have a strong influence on the characteristics of the barge services. Furthermore, barge operators are in the position to use large vessels and to call at a limited number of terminals in the port, because a lot of containers need to be transported between both ports. Therefore, the barge handling problems as mentioned in section 1.3 are less problematic for the Rotterdam-Antwerp market. The Rhine river market is also out of scope. The Rhine corridor can be divided into three navigation areas: Lower Rhine, Middle Rhine and Upper Rhine. The Middle Rhine and Upper Rhine are not included in the simulation tool developed for the IDVV project, because hardly any data is available about these areas.

According to TNO, TU Delft, Panteia, EICB and Ab Ovo (2012), the hinterland of the Port of Rotterdam can be divided in sailing areas. All inland terminals with barge services to the Port of Rotterdam belong to a particular sailing area. An overview of all sailing areas is included in Appendix 3. The most important sailing areas of the Netherlands in terms of transshipment volume (TEU) are: Noord-Nederland, Groot-Amsterdam, Nijmegen-Maas, Rotterdam-Moerdijk-Antwerpen and West-Brabant. This research only focuses on inland terminals located in the largest sailing areas of the Netherlands. The Rotterdam-Moerdijk-Antwerpen market is out of scope, because a lot of inland terminals located in this area do not belong to the domestic market of the Netherlands (as explained above). Dutch inland terminals located in the sailing areas Zeeland-Gent, Alphen aan den Rijn and Twente are also out of scope. It concerns among others CCT Combi Terminal Twente (Hengelo), Kloosterboer (Vlissingen), Alpherium (Alphen a/d Rijn), Container Transferium Groenenboom (Ridderkerk) and Verbrugge Zeeland Terminals (Terneuzen).

Time regarding, this research analyzes the effect of vertical integration of deep sea actors on the performance of container barge transport for the years 2015 and 2025. The Rotterdam Port Authority has forecasted that the demand for container barge transport will grow after the opening of Maasvlakte II. Therefore, different grow scenarios will be taken into account. The IDVV project of Rijkswaterstaat uses the growth rates of WLO which take the modal split ambitions of the Port of Rotterdam Authority into consideration. This research will also use these growth rates. The forecasts of WLO have resulted into three growth scenarios: RC-, SE- and GE-scenario. Today, it is quite unrealistic that the growth rates of the GE-scenario (high growth) will be achieved due to the economic downturn. Therefore, this research only focuses on the RC- and SE-scenario. Also, the 0%-Growth scenario will be taken into account.

1.6 Outline of the thesis

The remainder of this thesis is structured as follows. In Chapter 2, a theoretical framework will be presented. Literature concerning vertical integration, service network design, the bundling of container flows and the competitiveness of container barge transport will be discussed. The literature review can be used to identify the factors influencing the performance of container barging. Chapter 3 outlines the functionalities of the simulation tool of the IDVV project which will be used during this research. Also, the research methods will be discussed in this chapter. The data used as input for the simulation tool will be analyzed and the results of this analysis can be found in Chapter 4. The main results of the scenario analysis will be presented in Chapter 5. This chapter discusses the costs effectiveness of bundling and the effect of vertical integration of deep sea actors on the performance of container barge transport. Some expert interviews will be conducted to verify the findings of this research and for some practical insights. On the basis of the interviews, Chapter 6 discusses in which way inland terminal operators in the Netherlands can deal with the increasing involvement of deep sea actors in container barge transport. Some final conclusions will be presented in Chapter 7. Chapter 8 discusses the limitations of the simulation tool. This chapter also presents some recommendations for further research.

2. Literature review

This chapter presents a literary framework which will be used to set up the research methodology in Chapter 3. The main goal of the literature review is to define the main concepts used in this research, to gain inspiration for the research model and to support some presuppositions concerning inland terminal operators. Section 2.1 presents the research model. The main reasons for deep sea actors to change their scope towards the hinterland will be discussed in section 2.2. Section 2.3 defines service network design. This section also discusses some literature concerning service network design in freight transportation. Because the bundling of freight flows is an important issue in container barge transport, the main properties of the basic bundling networks will be discussed in section 2.4. A framework for barge network design is presented in section 2.5. Section 2.6 discusses the main factors influencing the modal choice decision of shippers. These factors together determine the market scope of container barging which will be outlined in section 2.7. The most important developments in the container barge transport sector and their potential effect on service network design will be discussed in 2.8.

2.1 Research model

Section 1.4 showed that the increasing involvement of deep sea actors in container barge transport may result in a further fragmentation of hinterland flows, while there is actually a need for the bundling of container flows, because of the barge handling problems in the Port of Rotterdam. In the Netherlands, the organization of the barge services is usually in hands of inland terminal operators. The vertical integration strategies of deep sea actors are thus a serious threat for the current market position of inland terminal operators in the Netherlands. The available transport volumes influences the way an inland terminal operator design its service network which in turn is a main issue for the profitability of container barge transport. To be able to answer the main question, academic literature has been studied to identify the most important factors influencing the performance of container barge transport. Figure 4 presents the key factors influencing the performance of container barge transport. The different elements of the research model will be discussed further in the remainder of this chapter.

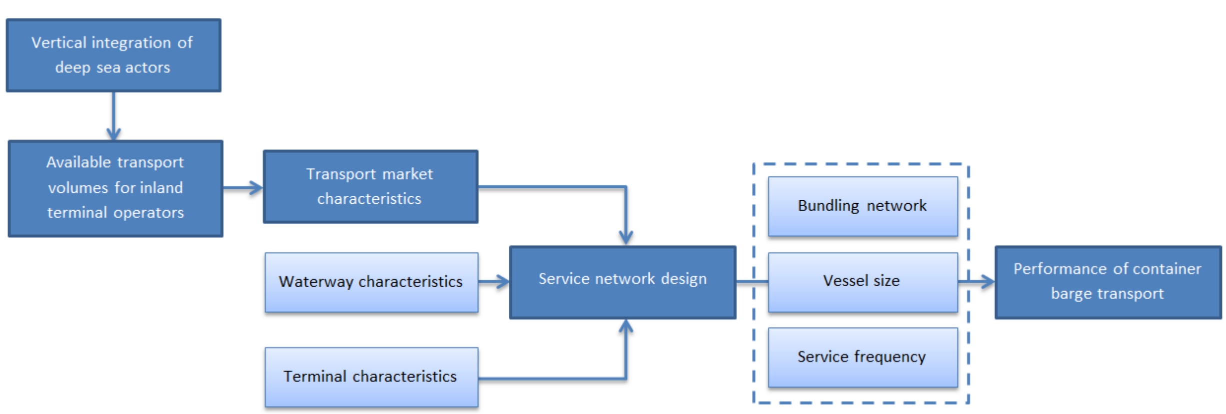

Figure 4: Research model (own elaboration on Konings, 2003)

2.2 Vertical integration in the hinterland market

Franc and Van der Horst (2008) analyzed the degree of involvement of deep sea actors in hinterland transport. They showed that until then deep sea carriers and deep sea terminal operators were hardly involved in container barge transport, but more focused on investments in rail transport and inland terminals. However, more vertical integration between deep sea actors and container barge transport has been observed in recent years (Erasmus Smart Port Rotterdam & NEA, 2012a). This section will provide an answer to the sub question: *"What are the reasons for deep sea actors to change their scope towards the hinterland?"* The Inside-Out and Outside-In concept of Wilmsmeier, Monios and Lambert (2011) will be introduced in section 2.2.1. Section 2.2.2 discusses the main reasons for deep sea carriers to change their scope towards the hinterland and section 2.2.3 focuses on deep sea terminal operators.

2.2.1 Inside-Out and Outside-In concept

Wilmsmeier et al. (2011) has presented two concepts from which the development of an inland terminal can be driven: Inside-Out and Outside-In (see Figure 5). Inside-Out refers to the situation where the development of an inland terminal is driven by landside actors and public organizations (e.g. barge operator or inland terminal operator). In contrast, Outside-In developments are driven by deep sea actors. An example is deep sea terminal operator ECT who changed its scope towards the hinterland through the acquisition of inland terminals in among others Duisburg and Venlo (see also section 1.4). The distinction between the Inside-Out and Outside-In concept is important for this research. It illustrates that the overall strategies and aims of the actors investing in the hinterland are different.

In case of the Inside-Out concept, inland terminals are developed with the aim of facilitating trade by attracting flows to that region. Notteboom and Rodrigue (2009) argue that developments driven by the public sector based on regional development motivations may result in an oversupply of inland terminals. This can also be observed in the domestic market of the Netherlands, because a lot of new terminals have been built in last years. Kreutzberger and Konings (2013) argue that the provision of subsidies and start-up premiums for terminal investments has certainly contributed to the rapid expansion of the terminal network in the Netherlands. The expectation is that the number of inland terminals in the Netherlands will increase further in coming years (A&S Management et al., 2003b).

According to Franc and van der Horst (2008), two basic reasons trigger deep sea actors to change their scope towards the hinterland: minimizing logistics costs and increasing competitiveness through differentiation. The specific reasons for deep sea carriers and deep sea terminal operators to get involved in hinterland transport will be discussed in the remainder of this section. It is important to mention that not all deep sea actors are changing their scope towards the hinterland. Focusing on deep sea carriers, it can be observed that some carriers heavily invest in hinterland transport, while others stick to their core business and contract barge operators and freight forwarders to arrange the final transport to the shipper. A reason for this is that the implementation of a hinterland strategy requires a good knowledge of the local market (Franc & Van der Horst, 2008) and significant transport volumes.

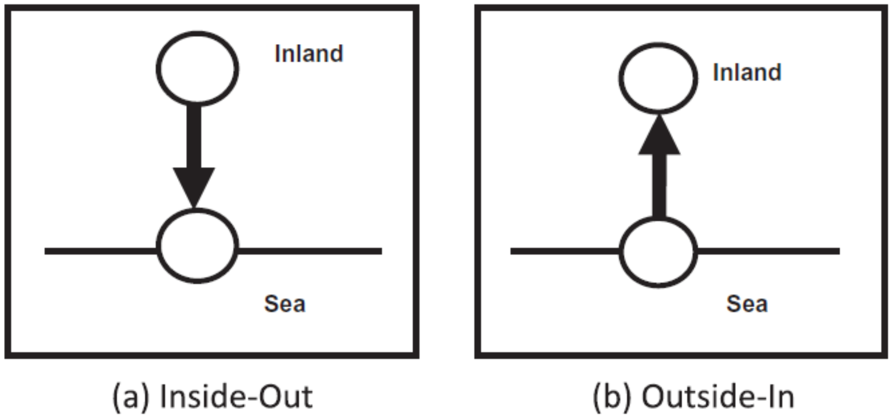

Figure 5: Inside-Out and Outside-In concept (Wilmsmeier et al., 2011)

2.2.2 Deep sea carriers

When containers are transported under carrier haulage, deep sea carriers take care of hinterland transport and the final delivery of the container to the shipper. The organizational control over hinterland transport is an important strategy for deep sea carriers to control the supply chain and to generate additional revenues. Traditionally, the proportion between carrier and merchant haulage was about 70%-30%. This implies that the power in the hinterland transport chain was mainly in hands of deep sea carriers. However, this situation has changed and the percentage of carrier haulage is currently about 30% on the European continent (Notteboom, 2008a). Because a deep sea carrier has no control and information over the container flows transported under merchant haulage, deep sea carriers are continuously looking for opportunities to increase the share of carrier haulage.

Nowadays, deep sea carriers face difficulties to warrant their future revenues due to the overcapacity in the shipping industry which has resulted in a dramatically decrease in freight rates. Furthermore, the economies of scale on sea have reached their limits (Franc & Van der Horst, 2008). As a result of scale increases in vessel size, mergers & acquisitions and the formation of alliances, inland costs have increased in importance. The share of inland costs in total door-to-door costs typically ranges from 40% to 80% depending on the repositioning costs of empty containers. Deep sea carriers increasingly acknowledge that hinterland transport is an important target for reducing logistics costs. They consider hinterland transport as: *"The most vital area still left to cut costs"* (Notteboom & Rodrigue, 2005, p. 303-304). To be attractive for shippers, the carrier haulage-tariffs need to be lower than the open market rates. When this is not the case, the merchant haulage alternative becomes more attractive for shippers. To minimize their logistics costs, deep sea carriers are now expanding their scope towards the hinterland.

Another driver for the involvement of deep sea carriers in container barge transport is empty container repositioning issues. The main cause of the problem is global trade imbalances. Another cause is that most deep sea carriers use containers as a way of branding the company name which makes it difficult to widely introduce the 'grey box concept' (Notteboom & Rodrigue, 2007). Deep sea carriers own or lease a fleet of containers and are responsible for efficiently managing this fleet. Therefore, they are continuously looking to increase the number of yearly container shipments. Because freight forwarders and shippers do not have the incentive to return the container quickly, deep sea carriers aim to get grip over the container fleet by the provision of hinterland transport (De Langen et al., 2013). In addition, the involvement in hinterland transport offers deep sea carriers the opportunity to actively match import- & export flows and to reduce their empty container repositioning costs.

2.2.3 Deep sea terminal operators

Most deep sea terminal operators work exclusively for deep sea carriers. One of the major problems in the shipping industry is that deep sea carriers are facing poor schedule reliability. Notteboom (2006) conducted a survey among deep sea carriers and reported that the main source of schedule unreliability on the East Asia-Europe route is port/terminal congestion. Drewry Shipping Consultants (as cited in Notteboom, 2008a) reported that on this route only 44% of all vessels sailed according to their schedule. To secure terminal capacity, deep sea carriers have started to develop dedicated terminals. As a consequence of this development, deep sea terminal operators are now losing market power in the terminal handling industry. For example, ECT expects that it will lose a quarter of its turnover after the opening of the Maasvlakte II in 2014 (NEA, 2010).

As the provision of terminal handling activities is quite a homogenous product, it is hard for a deep sea terminal operator to differentiate from competitors. To improve the efficiency of their terminal handling activities and to differentiate their customer base, terminal operating companies as ECT and DP World are now developing extended gates. Veenstra, Zuidwijk and van Asperen (2012, p. 21) define based upon the work of Leveque and Roso an extended gate as follows: *"An inland intermodal terminal that is directly connected to seaport terminals with high capacity transport means, where customers can leave or pick up their standardized units as if directly with a seaport and where the seaport terminal can choose to control the flow of containers to and from the inland terminal"*. The central idea of the extended gate concept is to extend the delivery point of the containers to an inland terminal to avoid congestion. In this concept, a deep sea terminal operator organizes the transport between the port and an inland terminal which is called terminal haulage. As such, deep sea terminal operators are directly dealing with barge operators. They buy slots and commercialize them.

The advantages of the extended gate concept are substantial. A deep sea terminal operator is in the position to bundle the containers of different customers. This makes it possible to increase scale and consequently, to reduce the transportation costs and CO_2 emissions per TEU/km of the barge services. Furthermore, barge arrivals will become more scheduled which enables deep sea terminal operators to guarantee a better alignment of quay and barge planning. Moreover, barges do not have to call at multiple container terminals which may reduce the length of stay of barges in the port. An important condition for a successful implementation of the extended gate concept is the availability of information about the goods arriving in the port. However, this information is usually only in hands of shippers and not available for other actors in the hinterland transport chain (Veenstra et al., 2012).

2.3 Service network design

Although studies specifically addressing service network design for container barge transport are scarce, the literature identifies service network design as a core issue for the profitability of container barge transport (e.g. Konings, 2009; De Langen et al., 2013). De Langen (2010) argues that firms design networks differently based on differences in their underlying business models. For example, barge operators will focus on minimizing the costs of their barge services, while deep sea terminal operators will take the effect of a barge service on terminal performance into account. This section defines service network design and specifies which tactical issues are important in container barge transport. Also, the literature concerning service network design in freight transportation will be discussed shortly.

2.3.1 Definition of service network design

According to Konings (2009, p. 19), a service network is: *"The artifact or production model of transport services"*. It expresses how transport services are scheduled and routed. Crainic (2000, p. 273) states that service network design comprises the main tactual issues and decisions for transport operators and defines service network design as: *"The selecting and scheduling of the services to operate, the specification of terminal operations and the routing of freight"*. According to Crainic and Kim (2007), service network design concerns two major decisions. The first decision relates to the service network. This includes the selection of the routes on which the services will be offered and the characteristics of each service, such as the service frequency. The second decision is to determine the routing of freight. This includes the specification of the routes used to transport a particular demand. Crainic (2000) argues that empty container repositioning strategies also need to be taken into account.

Research concerning service network design in container barge transport is scarce. According to Notteboom (2008b), service planners are confronted with the following three key decisions: service frequency, vessel capacity and the number of stops at intermediate terminals. Before an optimal decision can be made about these issues, accurate information about the market characteristics is needed. Braekers, Caris and Janssen (2013) presented a decision support model for service network design in container barge transport. The model determines the optimal shipping routes for a given vessel capacity and roundtrip frequency. From their perspective, the main tactical decisions for actors involved in container barge transport are thus decisions about shipping routes, vessel capacity and service frequency. In line with Braekers et al. (2013), Crainic (2000) and Notteboom (2008b), this thesis defines service network design as: *"The selection of the shipping routes on which the barge services will be offered and the specification of these services in terms of service frequency, terminals passed through and vessels used".* Empty container repositioning issues are not taken into account in this research.

2.3.2 Service network design in freight transportation

Crainic (2000) and Wieberneit (2008) consider service network design from a methodological perspective. They have presented a review of the service network design modeling efforts in freight transportation. In contrast, Woxenius (2007) and Kreutzberger (2010) have dealt with service network design in a more conceptual way. Woxenius (2007) has presented a generic framework for transport network designs which illustrated in Figure 6. The framework consists of six different options to transport an order from origin to destination, namely: direct link, corridor, hub-and-spoke, connected hubs, static routes and dynamic routes. Woxenius (2007, p. 735) states that for geographical reasons, container barge transport is mainly based on a corridor network design which he defines as: *"a design based on using a high-density flow along an artery and short capillary services to nodes off the corridor"*. Kreutzberger (2010) has introduced a framework with the major bundling types in intermodal rail freight. He compared the bundling types and analyzed which type is the most relevant for improving intermodal efficiency and competitiveness. This framework will be discussed further in section 2.4.

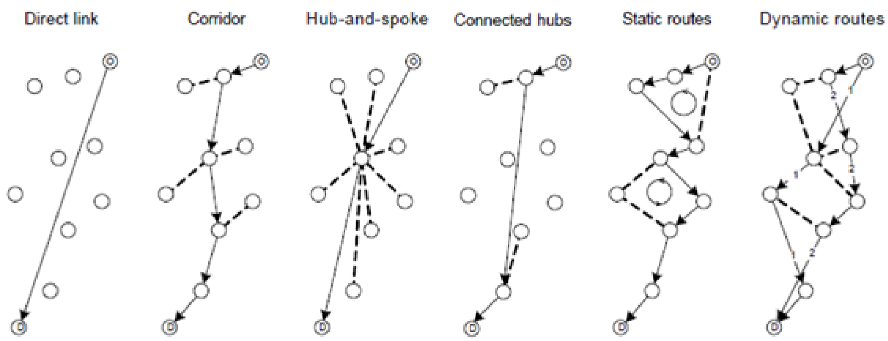

Figure 6: Generic framework intermodal network design (Woxenius, 2007)

2.4 Bundling networks

One of the most important decisions related to service network design is the decision whether to offer a direct service from a particular origin to destination or to transport the containers through intermediate terminals where containers can be bundled. Macharis, Vereecken and Verbeke (as cited in Woxenius, 2007, p. 733) define bundling as: *"The collection of goods to fill a transport unit"*. Another definition is provided by Kreutzberger (2003, p. 6): *"Bundling is the process of transporting freight belonging to different flows in common transport and/or load units on common parts of their routes".* According to Woxenius (2007), the decision to bundle depends on a number of factors: consignment size, transport distance, transport time demand, product characteristics and the availability of other goods along the route. Bundling can result in a higher vessel utilization degree and thus decreased transportation costs. It also provides opportunities to increase the frequency of the services. Because less transport volume is required to operate the services, more destinations can be serviced if containers are bundled. However, bundling may result in longer routes (detours) and a longer transit time. In most cases, it requires additional transshipment which makes the service possibly more expensive, slower and less reliable than a point-to-point service.

As introduced in the previous section, Kreutzberger (2010) has presented a framework with the major bundling types in intermodal rail transport. This framework can also be applied to container barge transport. As illustrated in Figure 7, the most important bundling networks in intermodal rail transport are a point-to-point network, hub-and-spoke network, line network, trunk-collection & distribution network and trunk-feeder network. The trunk-collection and distribution type has not been applied in container barge transport yet (Konings, Bontekoning, & Maat, 2006). This network type is not really attractive for container barge transport compared to the others. The containers need to be transshipped two times which is expensive and difficult to be compensated by the network advantages on the main haul. Therefore, the trunk-collection and distribution type will not be taken into account in this research. The remainder of this section discusses the properties of the different network types in more detail.

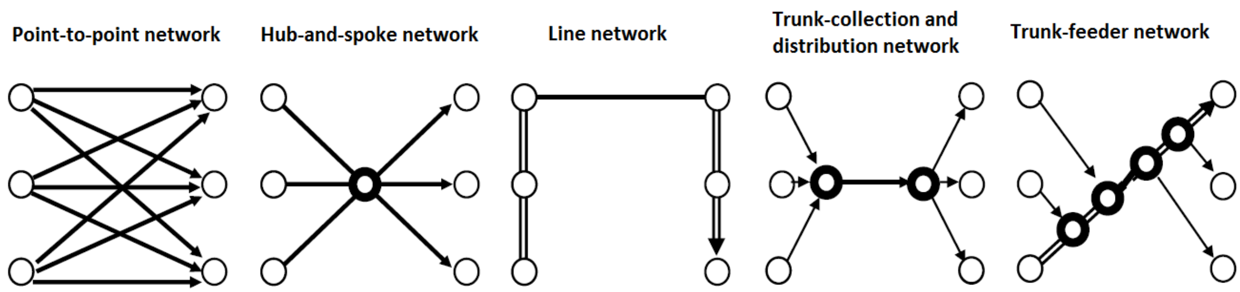

Figure 7: Basic service network types (own elaboration on Kreutzberger, 2010)

2.4.1 Point-to-point network

A point-to-point network is the most efficient network type. A short transit time, a high reliability and low costs can be ensured by offering a direct service without immediate stops. However, a substantial transport volume is required to offer to a regular service to the Port of Rotterdam and to offer an attractive alternative for road transport. Konings et al. (2006) calculated that a transport volume of 20.000 TEU per year is needed to offer a point-to-point service with an acceptable service frequency (3 times/week). Despite its disadvantages, most barge operators however start to operate a point-to-point service in practice. According to Konings and Kreutzberger (as cited in Konings, 2003), a well-known strategy in container barge transport is that barge operators use the growth of transport volumes first to increase the number of sailings. After that, they can increase the size of the vessels in order to optimize the network. To offer an attractive alternative for road transport on short distances, almost all inland terminal operators in the Netherlands currently offer point-to-point services (see Appendix 2).

2.4.2 Hub-and-spoke network

In a hub-and-spoke network, all origins and destinations are connected through a centrally located hub terminal. At the hub terminal, the containers are sorted and bundled according to their final destination. The idea behind a hub-and-spoke network is that sailing with larger vessels on the main haul compensates the additional handling costs at the hub terminal. An advantage of a hub-and-spoke network is that it connects a large number of origins and destinations with a high frequency. This implies that also regions with a low transport demand can be served on a regular basis. In addition, the re-use fraction of empty containers can be increased. The demand for empty containers in one service area could be fulfilled by using the empty containers of the other regions (De Langen et al., 2013).

Although still not applied in practice, the importance of developing a hub-and-spoke network to solve the barge handling problems in the port is extensively cited in literature (e.g. Douma, 2008; Konings et al., 2013; Caris, Janssen, & Macharis, 2011). Through the bundling of container flows, barges do not have to call at multiple terminals and the average call size can be increased (Douma, 2008). As such, the waiting times in the port can be reduced which improves the cost performance of the barge services. Konings et al. (2013) argue that the implementation of a hub-and-spoke network would be a promising strategy to improve the cost performance of container barge transport in the Port of Rotterdam.

The development of a hub-and-spoke network implies that an inland terminal operator has to give up a part of this transport operations. A hub-and-spoke network requires cooperation between inland terminal operators. This is quite a challenge from an organizational perspective as many parties are involved in the hinterland transport chain (Van Rooy, 2010). This network is only attractive if there is no imbalance between the costs and benefits for the parties involved. An important condition for a successful implementation of a hub-and-spoke network is thus the willingness of the actors to share the costs and benefits (Pielage et al., 2007). Another disadvantage of a hub-and-spoke network is the longer transit time and the vulnerability of the network to disruptions (Konings, 2006). A problem at a particular terminal could have a major impact on the performance of whole network.

The hub terminal should preferably be located at or nearby crossroads of good navigable waterways (Konings, 2006). Two possible locations for a hub terminal can be identified: in/near the Port of Rotterdam (< 50 km) or at a more distant location (Pielage et al., 2007). The location of the hub terminal has an important influence on the container volumes that could potentially be captured in the hub-and-spoke network. This suggests that a hub terminal near the port would be favorable: the greater the distance between the port and the hub terminal, the smaller the potential volumes that could be captured. However, a hub terminal located at a greater distance from the port may be better for exploiting economies of scale in sailing.

According to Konings et al. (2013), the handling costs of exchanging containers at the hub terminal and significant transport volumes are the major determinants for the feasibility of a hub-and-spoke network. Other influencing factors are vessel type and size, the barge-handling process in the hub and the port, the length of the spokes and the main haul, the location of the hub and the re-use fraction of empty containers (e.g. Konings et al., 2013; Konings, 2006; De Langen et al., 2013). Konings (2009) conducted a preliminary analysis concerning the feasibility of hub-and-spoke networks. He concluded that a hub-spoke network is an attractive alternative for a point-to-point network when the distance between the port and the hub terminal is about 200 - 300 km. On shorter distances, the cost savings on the main haul are outweighed by the additional handling costs at the hub terminal. The cost savings are larger when small vessels are operated between the hub and inland terminal in the initial situation. This is in accordance with the findings of De Langen et al. (2013) and Konings et al. (2013). In addition, De Langen et al. (2013) found that the cost savings are the greatest when import- & export flows are completely balanced.

2.4.3 Line network

In a line network, barge operators bundle containers of several inland terminals located along the same waterway. Line bundling enables a barge operator to transport more cargo and to maintain a sufficient vessel utilization rate. Most barges services in the Rhine river market are offered as a line service, while this service type has not been commonly operated in the domestic market yet (see Appendix 1).

However, this is gradually changing: a recent example is that the inland terminals HOV Harlingen and ROC Kampen have started to operate a joint liner service that also calls at terminals in Amsterdam.

Line bundling offers the opportunity to attain economies of scale and to increase the frequency of service. It can result in a reduction of the number of calls in a roundtrip and an increase of the average call sizes at the terminals in the port. Another advantage is that no additional transshipment is required. However, the vessel turnaround is longer in comparison with a point-to-point network, because additional stops need to be made. This reduces the delivery speed of the containers which may have a negative effect on the competitive position of container barge transport. This suggests that a line service is not attractive when inland terminals are located at a short distance of the port.

The choice of calling at one or more inland terminals depends on a number of factors: available transport volumes at the different terminals, service frequency and vessel size. In addition, the possibility to realize favorable vessel turnaround times also plays a role. In a sailing schedule with more slack, it may be advantageous to call at multiple terminals in the hinterland (Konings et al., 2013). Furthermore, inland port charges influence the decision to call at multiple terminals (Notteboom, 2008b). Caris, Macharis and Janssen (2012) developed a service network design model for intermodal barge transport and applied this model to the port of Antwerp. They investigated whether a corridor design can improve the performance of container barge transport by means of a scenario analysis. Caris et al. (2012) concluded that line bundling is the most interesting for terminals with small volumes located at a further distance of the port.

2.4.4 Trunk-feeder network

Road transport is an attractive alternative for container barge transport when the waterway infrastructure restricts the usage of large vessels. To improve the competitiveness of container barge transport on small waterways, it may be interesting to implement a trunk-feeder network along small waterways in the Netherlands. This network type is already operated along tributaries of the Rhine river market. In a trunk-feeder network, the containers will be transported from the port to a cross-road terminal or a terminal along good navigable waterways, where the containers are transshipped to a feeder service to arrive at their final destination along a small waterway (and the other way around).

According to Konings (2004), the feasibility of trunk-feeder services depends on a number of factors: location of the hub terminal, the length of the feeder and trunk haul, available transport volumes and the waterway characteristics. Although additional transshipment costs need to be taken into account, Konings (2004) showed that the implementation of a trunk-feeder network could result in costs advantages, because of a better utilization of the vessels on the trunk haul. The cost advantages are the largest in case of networks with small transport volumes.

The domestic market of the Netherlands is characterized by its waterway limitations (A&S Management et al., 2003b). 52% of the waterway infrastructure in the Netherlands consists of small waterways (Konings, 2004). The waterway infrastructure in Europe is divided in CEMT-classes. This classification is based on the length and width of the waterways and the capacity of the vessels that can be deployed on the waterways (Erasmus Smart Port Rotterdam & NEA, 2012a). In the remainder of this thesis, all inland terminals that are located along waterways in CEMT-class I, II and III are defined as "*capillaries*". Currently, three inland terminals in the Netherlands are located along capillaries, namely Barge & Rail Terminal Tilburg, Inland Terminal Veghel and ROC Waalwijk (TNO et al., 2012).

2.5 Framework for barge network design

According to Konings (2003), the main factors directly influencing the performance of container barge transport are vessel size and vessel circulation time. These factors are not independent decision variables for a barge operator, but are related to the waterway and transport market characteristics. Barge operators thus need to take these external conditions into account by designing their network. Konings (2003) has presented a framework for barge network design. This framework is presented in Figure 8 and can be used as a conceptual tool to analyze the relation between barge network design, the waterway characteristics, the transport market characteristics and the performance of container barge transport. This section will discuss the framework of Konings (2003) in more detail and will provide an answer to the sub question: "*Which factors influence the performance of container barge transport?*"

2.5.1 Transport market characteristics

Konings (2009) suggests that there is a relationship between the type of transport market and preferred service network. The transport distance directly affects the vessel turnaround time, but cannot be changed. The number of containers that needs to be transported determines the type of vessel that can be used. Because most costs in container barge transport are fixed, it is important for a barge operator to have a sufficient vessel utilization rate in order to recover the costs. As an insufficient loading degree has a substantial influence on the cost effectiveness of a barge service, it is better to use small vessels in regions with low demand for container barge transport. As mentioned in section 2.4.1, Konings et al. (2006) calculated that a transport volume of 20.000 TEU per year is needed to offer a point-to-point service with a frequency of three times per week. Other bundling network types are thus more efficient is smaller transport networks. Next to the available transport volumes and transport distance, Ab Ovo and Panteia (2013) argue that the following factors also play a role in determining the optimal network structure: demand fluctuations, product characteristics and import- & export balance.

2.5.2 Waterway characteristics

In addition to the transport market characteristics, the quality of the inland waterways is a determining factor for the feasibility of the different network structures. There is a large difference in the navigability of the inland waterways due to variations in draft and other physical conditions. These factors together determine the maximum size of the vessels that can be deployed which in turn affects the cost performance of container barge transport. Furthermore, the presence of low bridges and locks directly influences the transit time and the reliability of the barge services. The maximum vessel size itself affects the duration time in the port and thus the vessel turnaround time. On one hand, a larger vessel implies that more time is required to collect and distribute all containers. On the other hand, a barge operator using large vessels is in the position to make appointments with deep sea terminal operators about fixed time windows for loading and unloading. The duration time in the port depends also to a large extent on the type of the barge services offered, because this affects the number of calls and the average call size. Kerstgens (as cited in Konings et al., 2013) showed that in 2008 a vessel sailing between the port of Rotterdam and Wörth (650 km) spent 44% of its time in the port, while it spent only 43% of its time on sailing and 13% on visiting the inland terminals. This suggests that network structures with a limited duration in the port are favorable for the container barge transport sector as a whole.

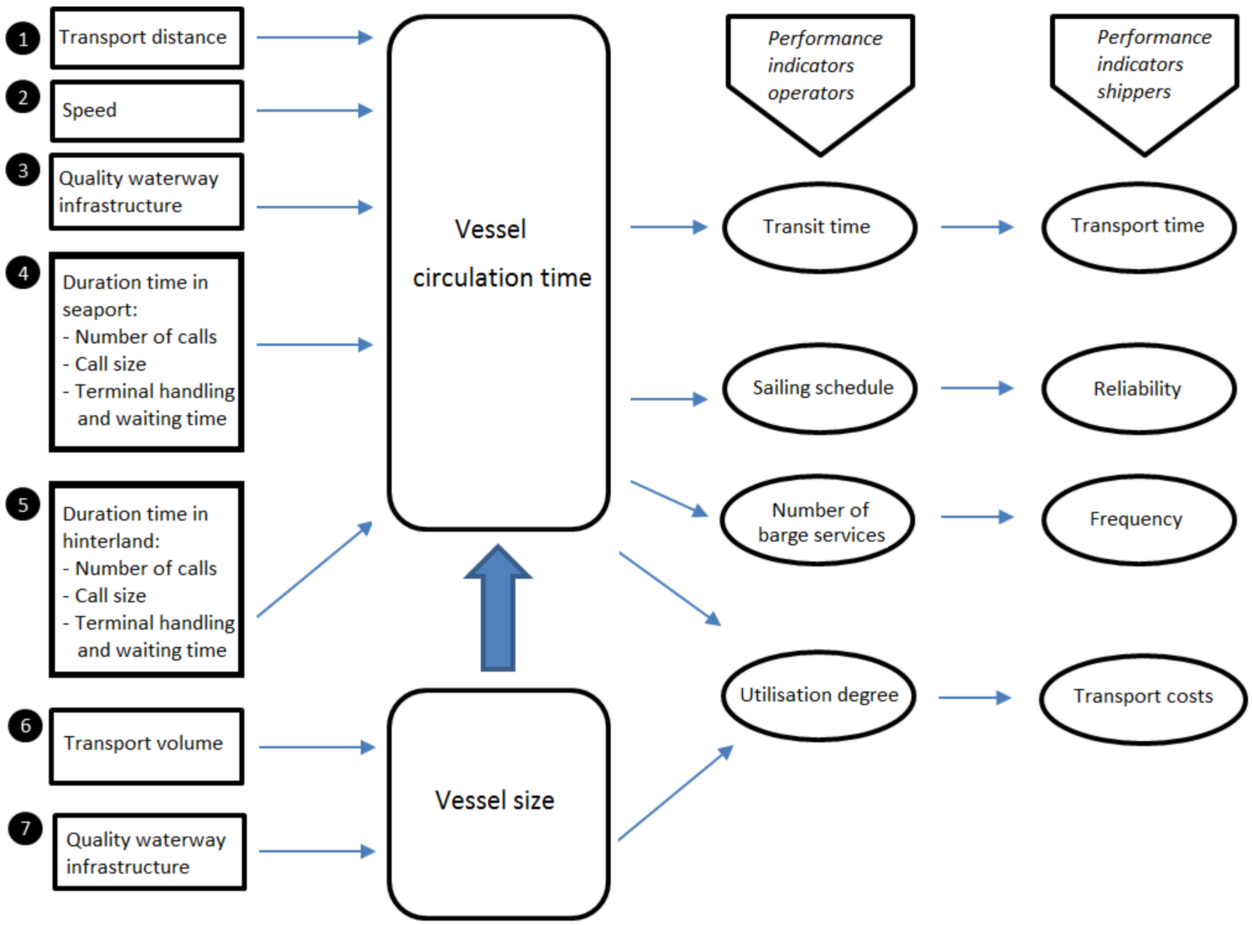

Figure 8: Framework barge network design (own elaboration on Konings, 2003)

2.5.3 Terminal characteristics

Although not specifically mentioned in the framework of Konings (2003), Ab Ovo and Panteia (2013) argue that the capacity of all terminals involved directly affects the performance of container barge transport. The capacity of the terminals and the opening hours together determine the terminal handling and waiting time at the different terminals which in turn influences the vessel circulation time. For example, all container terminals at the Maasvlakte are open 24 hours a day, while terminals located in the Eemhaven and Waalhaven are closed at night and in the weekends. Considering the capacity of the terminals, the number of cranes and reach stackers determine the time that is required to handle a vessel. The stack capacity of a terminal limits the number of containers that can be stored and the length of the quay determines the maximum number of vessels that can be handled simultaneously.

2.6 Modal choice decision of shippers

To define the performance indicators for container barge transport in this research, it is useful to have insight in the variables influencing the modal choice decision of the shippers. McGinnis (1990) conducted a study among shippers in the USA. They identified six factors that influence the decision process of a shipper, namely: freight rates, reliability, transit time, loss and damage, shipper market considerations and carrier considerations (e.g. availability and reputation). McGinnis concluded that in general, shippers focus more on the overall service level than on costs. Five years later in an update of the study, Murphy and Hall (1995) observed that reliability has a strong influence on the decision process of shippers in comparison with other factors. This is confirmed by Muilerman (2001). He showed that shippers in the food industry highly value reliability compared to other logistics requirements. Other studies indicate that the reliability of the transport services is even more important than the duration of the transit itself (Murphy, Daley, & Hall, 1997).

Cullinane and Toy (2000) conducted a content analysis and considered 75 papers dealing with modal choice decisions. They analyzed which factors are most often mentioned in literature. The first five categories were: costs/price/rate, speed, transit time reliability, product characteristics and service. More recently, Bolis and Maggi (2003) interviewed 22 shippers in Italy and Switzerland. They showed that the logistics context where a firm is operating in is relevant for the choice of the transport mode. The most important decision variable is reliability, followed by price and speed. Next to these factors, frequency and flexibility are also important decision variables for firms operating in a JIT-context, for firms directly serving the consumer market and for firms whereby the product is the final product.

Although not extensively cited in literature, shippers are nowadays increasingly focused on sustainability (e.g. Erasmus Smart Port Rotterdam & NEA, 2012b; NEA, 2010). By means of a literature study, Erasmus Smart Port Rotterdam & NEA (2012b) has identified the driving forces in logistics in 2030 of which sustainability is one. Compared to road transport, container barge transport currently performs significantly better with respect to CO_2 emissions. However, the container barge transport sector faces little progress in limiting pollutions such as NO_x and PM. The expectation is that road transport will be more sustainable in 2020 due to the rapid modernization of the fleet. The current competitive advantage of container barge transport in field of sustainability is thus under pressure, because other modalities innovate faster and better (Wiegmans, 2005). Concluding, numerous factors influence the decision-making process of shippers. The following factors will be taken into account in the remainder of this research: transport costs, reliability, transit time, service frequency and sustainability.

2.7 Market scope of container barge transport

Section 2.6 discussed the factors influencing the model choice decision of shippers. In comparison with road transport, container barge transport is cheaper, more reliable and sustainable. On the other hand, it is slower and less frequent than road transport. This section describes to what extent container barge transport can compete with road transport. The following sub question will be answered: "*Which factors determine the market scope of container barge transport?*"

Traditionally, it was assumed that container barge transport could only be an attractive alternative for road transport over distances of at least 500 km given the high fixed costs and low variable costs of the barge services (Van Klink & Van den Berg, 1998). More recently, Macharis and Verbeke (2001) calculated the break-even point for the port of Antwerp and found that container barge transport can compete with road transport on a distance of 95 km. The study of Decisio (2002) showed similar results. They calculated that intermodal barge transport is cheaper than road transport over distances of 90 km. Without pre- or post-truck haulage, it can compete with road transport over distances of 65 km.

According to Konings et al. (2006), the major determinants for the geographical scale of intermodal barge transport are transshipment costs, barge haul costs and pre- & post-truck haulage costs. These factors together determine the hinterland transport costs. Macharis and Verbeke (2004) have calculated the cost structure of the intermodal barge transport chain for the Port of Antwerp where only post haulage was needed. For a barge haul of 55 kilometers and a truck haul of 20 kilometers, the total costs consists of 25% for barge transport, 30% for transshipment and 45% for post-truck haulage. This illustrates that the cost share of pre- and post-truck hauls is relatively large in container barge transport.

Notteboom and Rodrigue (2009) argue that the size of the service area has a large impact on the profitability of inland terminals. Given the high share of pre- and post-truck hauls, Konings and Priemus (2008) state that the region in which barge transport can be a competitive alternative for road transport is usually an area with a circumference of 15 km. Kennisinstituut voor Mobiliteitsbeleid (KiM, 2012) showed that 80% of the customers of an inland terminal are situated within a 25 km catchment area. However, the distance of the barge haul determines to a large extent the potential size of the catchment area. The longer the distance to the port, the larger the cost difference with road transport becomes and thus the larger the distance in pre-or post-truck haulage can be. Notteboom and Rodrigue (2009) presented a framework that can be used to analyze the relationship between the characteristics of the service area of inland terminals and terminal profitability in the Netherlands (see Figure 9). The framework shows that the expected profitability of terminals with a high throughput operating in a small service area is the highest.

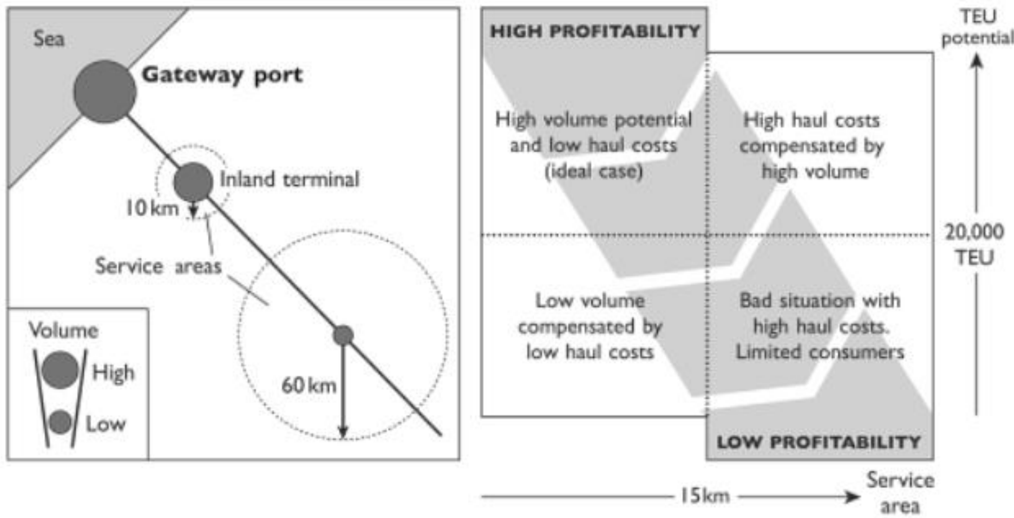

Figure 9: Framework terminal profitability in the Netherlands (Notteboom and Rodrigue, 2009)

2.8 Development of container barge network

Notteboom and Konings (2004) have distinguished four phases in the historical growth pattern of the European container barge network. Each phase has distinctive characteristics related to terminal development, barge service design, container volumes and market organization. Notteboom and Konings (2004) expect that the container barge network will change considerably in the near future, because of increasing container volumes and the increasing involvement of deep sea actors in container barge transport. This section discusses the major developments in the container barge transport and their potential effect on barge service design. This section will provide an answer on the sub question: *"In which way design inland terminal operators their container barge network in 2015 and 2025?"*

Until now, the involvement of deep sea actors in container barge transport is still limited. One condition for deep sea actors to implement a hinterland strategy is substantial transport volumes (see section 2.2.1). Given the forecasts of the Rotterdam Port Authority, it is expected new players will enter the container barge transport market in the near future. This is certainly the case when the barge handling problems in the Port of Rotterdam will continue to exist. Section 2.3 outlined that all actors have their specific reasons to get involved in hinterland transport and design their network in line with their underlying business model. Deep sea actors will thus design their container barge network in a different way than inland terminal operators. To take full advantages of economies of scale in terminal operations and sailing, Notteboom and Konings (2004) expect that deep sea carriers and deep sea terminal operators will have a great interest to concentrate their container volumes to a limited number of preferred inland terminals. As such, they can compete on price with inland terminal operators in the Netherlands. The involvement of deep sea actors will thus have a major impact on the future continuity of inland terminal operators.

Currently, most inland terminal operators in the Netherlands offer a point-to-point service to the Port of Rotterdam. However, inland terminal operators have limited control over the handling of barges in the Port of Rotterdam, because they have no contractual arrangement with deep sea terminal operators. To improve their position in the hinterland transport chain of container barging and to deal with the increasing involvement of deep sea actors, it is expected that they will develop new service network types in near future. Some inland terminal operators in the Netherlands are already rearranging their barge services and focus on "network optimization". Inland terminal operators such as BCTN, CTU and MCS follow a horizontal integration strategy and take shares in other inland terminals. As such, they can control a larger catchment area and develop their own container barge network. Notteboom and Konings (2004) expect that the domestic market will be characterized by mergers, acquisitions and joint ventures in the coming years. Through horizontal integration, it becomes easier from an organizational perspective to bundle container flows and to develop roundtrips between inland terminals. This in turn enables inland terminal operators to use larger vessels and to increase the service frequency.

It can also be observed that the container barge transport market is gradually changing towards more cooperation between inland terminals. A recent example is that four individual terminals located in West-Brabant have started to cooperate under the name "*Brabant Intermodal*". These terminals are situated at a relatively short distance from the Port of Rotterdam and are faced with fierce competition of trucking companies. By working together, the inland terminal operators try to create an improved proposition towards other players in the hinterland transport chain (De Langen et al., 2013). However, most inland terminals operators in the Netherlands still have a negative attitude towards cooperation and consider it as a threat for their competitive position in the hinterland transport chain of container barging (see also section 1.3). Although cooperation between inland terminal operators in the Netherland is desirable, it is difficult to achieve, because of the lack of confidence (Van der Horst & De Langen, 2008). According to TNO et al. (2012), cooperation is only plausible in the following cases:

- There is relatively little or no competition between the inland terminals
- There is a shortage in terminal capacity
- Containers can be bundled is such way that larger vessels can be used
- Import- & export flows can be matched (repositioning empty containers)

As mentioned above, it is expected that the container barge network will change considerably in the near future and that new service network types will be developed. Notteboom and Konings (2004) argue that on one hand it is likely that a point-to-point network will gain importance, because of growing transport volumes ("one-stop services"). On the other hand, a hierarchy in terminals might emerge as a consequence of the increasing involvement of deep sea actors in container barge transport and the high number of new terminal initiatives (as explained in section 2.2.1). Some strategically located terminals will become hub terminals with an important container exchange function and will focus on serving large markets. Other inland terminals will become subordinated to these hub terminals and will particularly focus on serving regional and local markets. Until now, it is unclear in academic literature in which way inland terminal operators will design their container barge network exactly in coming years.

3. Methodology

The previous chapter has introduced the research model. The next step is to identify a fitting research method that would lead to the answer on the main question of this research. To structure the project, this research is divided into three phases. The different phases of the project will be introduced in section 3.1. Section 3.2 elaborates on the first phase of this research and section 3.3 on the second phase. The main functionalities of the simulation tool of the IDVV project will be discussed in section 3.4. Section 3.5 describes the final phase of this research.

3.1 Research approach

The research model presented in Chapter 2 shows that the vertical integration of deep sea actors in container barge transport results in a smaller addressable market for inland terminal operators in the Netherlands. Changing market circumstances have an influence on the way an inland terminal operator designs its barge services. This in turn influences the number of stops in the Port of Rotterdam, the service frequency and the vessel size that can be deployed, and thus the performance of container barge transport. Because it is unknown in which way the container barge network in the Netherlands will develop itself in coming years, a structured research approach is required to answer the main question of this research. This research project is divided into three phases. In these phases, different research methods will be applied. A secondary research will be done in the first phase of this research. In the second phase, a scenario analysis by means of a simulation tool will be performed. In final phase, some interviews will be conducted to verify the results of this research. The different phases of this research are visualized in Figure 10 and will be explained in more detail in the remainder of this chapter.

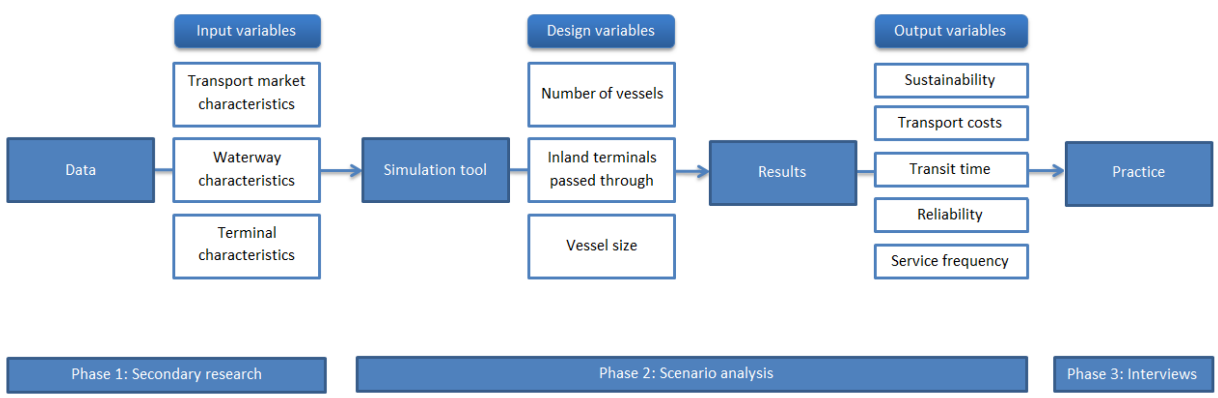

Figure 10: Phases of research project

3.2 Secondary research

It became clear from the literature review that hinterland actors need to take the transport market characteristics, waterway characteristics and terminal characteristics into account by designing their network. In the first phase of this research, data will be collected about these characteristics which are called the "*input variables*" in Figure 10. This will be done by means of secondary research. An alternative term in literature is desk research. Hewson (as cited in Smith, 2008, p. 3) defines secondary data analysis as: "*The further analysis of an existing dataset with the aim of addressing a research question distinct from that for which the dataset was originally collected and generating novel interpretations and conclusions*". It becomes clear from this definition that secondary research involves collecting and analyzing data from existing sources. This includes among others academic journals, government documents and news articles. The results of the data analysis will be discussed in Chapter 4.

3.2.1 Data sources

To collect the required information about the input variables for the simulation tool, several data sources were used. For the transport market characteristics, information is collected about the transshipment volumes of the inland terminals in the Netherlands. However, limited public information is available about the transshipment volumes, because this is sensitive information for inland terminal operators. The information that is available is retrieved from previous studies such as TNO et al. (2012) and Bureau Voorlichting Binnenvaart (2012). Furthermore, some reports of governmental bodies provided information about the transshipment volumes of the inland terminals such as the report of Provincie Limburg (2012). Because this research only focuses on container flows to/from the Port of Rotterdam, the transshipment volumes had to be adapted. Therefore, information has been collected about the number of sailings to the Port of Antwerp and Port of Rotterdam. Subsequently, the Port of Antwerp share is subtracted from the total transshipment volume. Information about the number of sailings is gathered from the websites of the terminals, Containerafvaarten (2013), InlandLinks (2013) and Bureau Voorlichting Binnenvaart (2013a, 2013b). Information about the forecasted growth rates is retrieved from internal sources. The waterway characteristics of the container barge network in the Netherlands are mapped on the basis of a report of Rijkswaterstaat (2013). Information about the terminal characteristics, terminal equipment and opening hours of the terminals is mainly retrieved from InlandLinks (2013), Port of Rotterdam (2013) and the websites of the terminals. Sometimes the existing data sources contradicted each other. To verify the reliability of the different data sources, some inland terminal operators in the Netherlands were approached by email. Several previous studies have been done on the capacity of the inland terminal network in the Netherlands. The information of the studies of TNO et al. (2012), Defares (2011), KiM (2012) and Ecorys (2010) is compared and adapted to the current situation. Figure 11 provides an overview of the main data sources used for this research.

Source	Transshipment volumes	% Sailings to Rotterdam	Growth rates	CEMT-classes of waterways	Terminal capacity	Terminal characteristics	Terminal equipment	Opening hours of terminals
Internal sources			X					
Previous studies	X				X			
Reports IDVV project	X		X		X			
Governmental bodies	X	X		X	X	X		
InlandLinks (platform)		X			X	X	X	X
Website of terminals		X				X	X	X
News articles	X				X	X		
Email terminal operators						X	X	X
Other sources		X						

Figure 11: Overview of data sources

3.3 Scenario analysis

Section 2.8 showed that there are a lot of uncertainties about the future development of the container barge network in the Netherlands. The attitude of inland terminal operators in the Netherlands is gradually changing towards more cooperation. Some inland terminal operators follow a horizontal strategy and take shares in other terminals to expand the geographic scope of their network, while others stick to their original business model. Until now, it is unclear in which way the container barge network will develop itself after the opening of Maasvlakte II. On one hand, it is expected that point-to-point services will gain importance when the container volumes grow. On the other hand, more container terminals in the Port of Rotterdam imply an increase in the number of stops which increases the need for the bundling of container flows. Because of these uncertainties, a scenario analysis will be conducted during the second phase of this research. A scenario analysis is a useful tool to evaluate "what-if"-situations. According to Grant (2010, p. 287), scenario analysis can be defined as: *"A systematic way of thinking about how the future might unfold that build on what we know about current trends and signals"*. The objective of the scenario analysis is to analyze the effect of vertical integration of deep sea actors on the performance of container barge transport in the Netherlands under changing market circumstances. It is assumed that the available container volumes for inland terminal operators in the Netherlands will decrease with about 25% when deep sea actors start to offer their own dedicated barge services. This research uses the simulation tool developed for the IDVV project of Rijkswaterstaat. For this research, a number of alternative bundling scenarios are identified. The IDVV project has organized some game sessions with market players in the container barge transport sector

(April & May 2013). The reports of these sessions and the study of Ab Ovo, TNO and TU Delft (2013) are used to identify the bundling scenarios for this research. The scenarios will be explained in Chapter 5.

3.4 Simulation model

This section discusses the main functionalities of the simulation tool of the IDVV project of Rijkswaterstaat that will be used to perform the scenario analysis. Section 3.4.1 discusses the way the simulation model can be used to calculate the effect of the different scenarios on the performance of the container barge transport sector. Several parameters are determined upfront. The parameters will be explained in more detail in section 3.4.2. Section 3.4.3 presents the assumptions of the model. The simulation tool generates a large number of statistics. For this research, a number of statistics are selected which will be used to compare the different scenarios. This will be explained in section 3.4.4.

3.4.1 Scenario analysis

The simulation tool takes the current situation as starting point. By means of the simulation tool, the effect of the different developments in the container barge transport sector can be calculated. For this research, the tool will be used to calculate the effect of vertical integration of deep sea actors on the performance of container barge transport under changing market circumstances. Before the scenarios can be runned, a number of choices need to be made in the simulation tool. Depending on the applied scenarios, choices need be made concerning the number of vessels, the vessel size used and inland terminals passed through (see section 2.3.1). In Figure 10, these variables are called *"design variables".*

This research distinguishes the following basic bundling network types: point-to-point network, line network, hub-and-spoke network and trunk-feeder network. Depending on the bundling scenario that will be applied, a choice has to be made concerning the terminals passed though. This influences the availability of the transport volumes and the maximum vessel size. The number of vessels that can be chosen has been limited, because a lot of different vessels are in circulation. The vessels and their characteristics are included in Figure 12. The vessels correspond with the CEMT-classification of the Conférence Européenne des Ministres de Transport (see Appendix 4 for the vessel operating costs).

Code	Name	CEMT-class	Width (m)	Length (m)	Speed (km/h)
M02	Kempenaar	II	6.6	50	14
M04	Dortmund-Eems	III	8.2	67	15
M06	Europaschip	IV	9.5	80	16
M08	Groot Rijnschip	V	11.4	110	17
M10-4	Rijnmaxschip	VI	17	135	17

Figure 12: Vessel characteristics

Because most costs in container barge transport are fixed, it is important for a barge operator to have a sufficient loading degree in order to recover the costs. Barge operators have estimated that the break-even loading degree of a vessel has to be at least 75% (Konings, 2003). To offer an attractive barge product to shippers, a service frequency of at least 3 times per week needs to be offered. Figure 13 shows the minimum required annual volume for a barge service of three times a week. The figure shows that a minimum volume of 22.000 TEU per year is needed to deploy a 90 TEU Europaschip in an efficient way. These figures correspond with the calculations of Konings et al. (2006), mentioned in section 2.4.1. The required annual transport volumes together with the waterway characteristics of the inland terminals (CEMT-class) determine the vessel size that can be applied in the different scenarios.

Code	Name	TEU	Volume (TEU)
M02	Kempenaar	24	6.000
M04	Dortmund-Eems	48	12.000
M06	Europaschip	90	22.000
M08	Groot Rijnschip	208	49.000
M10-4	Rijnmaxschip	408	96.000

Figure 13: Required annual volume per vessel type

The chosen vessel size in turn influences the vessel circulation time. Next to the vessel size, the vessel circulation time depends on the following factors: duration time at the seaport, duration time in the hinterland, sailing speed, sailing distance and the waterway characteristics (Konings, 2003). A lot of factors thus influence the vessel circulation time. One of the limitations of the simulation tool is that the sailing times are very unrealistic. The same applies to the number of stops in the Port of Rotterdam. For example, a barge service between Osse Overslag Centrale and the Port of Rotterdam with 24 stops has a total vessel turnaround time of 133.3 hours (over 5 days). However, the total transit time is in practice around 16 hours (InlandLinks, 2013). Therefore, it was impossible to predict the vessel circulation time of the barge services. Consequently, several simulations sessions had to be runned in order to determine the optimal number of vessels per scenario.

Once all choices are made, the scenarios can be runned. The simulation tool automatically plans the barge services, selects the shortest sailing route to the Port of Rotterdam, bundles containers for the different terminals on priority and calculates the performance indicators (defined in section 3.4.4). One of the assumptions of the model is that a barge only calls at a particular terminal when the minimum call size is reached. The minimum call size (in TEU) is the minimum number of containers to be distributed or collected before a barge service starts. The minimum call sizes of the vessels are included in Figure 14.

Code	Name	Empty Depot	Container Terminal	Inland Terminal	Sailing
M02	Kempenaar	2	4	4	12
M04	Dortmund-Eems	2	4	4	24
M06	Europaschip	4	8	8	45
M08	Groot Rijnschip	4	8	8	104
M10-4	Rijnmaxschip	4	12	12	204

Figure 14: Minimum call size of the vessels in TEU

3.4.2 Input parameters

To calculate the costs and CO_2 production of transporting a container from an inland terminal to the Port of Rotterdam, several parameters are determined upfront. This has been done by Ab Ovo, TNO and TU Delft. As explained in section 2.7, the transport costs consist of the following key components: pre- or post-truck haul to/from the shipper, handling at the inland terminal, barge haul and handling in the Port of Rotterdam. The calculation of the CO_2 production in kg comprises the same elements. The following costs components are distinguished in the simulation tool:

- Fuel and maintenance costs of the cranes and reach stackers
- Labor costs of terminal personnel
- Depreciation costs of the terminal and terminal equipment
- Fuel and maintenance costs of operating a barge
- Labor costs of the barge crew
- Depreciation costs of the barges

Appendix 4 provides an overview of the input parameters that are used in the simulation tool. To provide an example with the different parameters, the costs of transporting a container between the stack and the waterside of an inland terminal can be calculated as follows. The costs consist of a cost component per move for fuel and maintenance (code QCVK) and a cost component per hour for labor (code QCVH). The cost component per hour has to be divided by the number of moves per hour (code QCMPH). Furthermore, the depreciation costs of the quay crane need to be taken into account (code QCFY). These costs have to be divided by the total number of handlings per year. When an inland terminal does not have a quay crane, the cost of using a reach stacker will be calculated.

3.4.3 Model assumptions

Given the limitations of the simulation model, the following assumptions are made for this research:

- Inland port charges are not included in the cost calculation
- It is assumed that import- & export flows are completely balanced
- Although products vary in weight, it is assumed that products are homogenous
- It is assumed that the demand for container barge transport does not fluctuate over time
- No distinction in the model is made between upstream and downstream sailing
- It is assumed that barges operate 50 weeks per year, 6 days per week and 16 hours a day
- The existence of locks, bridges and other obstacles is not taken into account in the model
- Barges are first completely unloaded before an operator starts with the loading process
- Barges are completely loaded and unloaded at hub terminals
- No distinction in the model is made between reach stackers and empty handlers
- The model only takes 20ft and 40ft containers into account

3.4.4 Output of the simulation tool

Section 2.6 discussed the major factors influencing the modal choice decision of shippers. It became clear from this section that the following factors are repeatedly cited in literature: transport costs, reliability, transit time, service frequency and sustainability. The simulation tool generates a large number of statistics. To compare the different scenarios, a number of statistics are selected which will be used as performance indicators for container barge transport in this research. The performance indicators corresponds with the so-called "*output variables*" in Figure 10. Figure 15 provides a description of the performance indicators and their unit of analysis. The simulation tool also generates statistics about the utilization degree of the vessels which is an important indicator of the efficiency of the barge services (see section 2.5.1). Therefore, this performance indicator is also included in Figure 15.

Indicator	Unit of analysis	Description
Frequency	Number per week	Average number of sailings per week
Reliability	Hours per roundtrip	Standard deviation of number of hours per roundtrip
Transport costs	€ per TEU	Average transport costs in € per TEU
Sustainability	Kg CO_2 per TEU	Average CO_2 production per TEU
Transit time	Hours per roundtrip	Average number of hours per roundtrip
Efficiency	%	Average number of transported containers per roundtrip divided by vessel capacity

Figure 15: Output variables of the simulation tool

3.5 Interviews

In the final phase of this research, interviews will be conducted with experts in the container barge transport sector. Interviews can contribute to a deeper understanding of the main topics of this research. The main goal of the interviews is to validate the results of this research with experts and to enrich the report with practical insights. The interview will help to answer the sub question: "*In which way can inland terminal operators maintain their current market position?"* Experts will be asked questions concerning the future development of the container barge network in the Netherlands and the competitive position of inland terminal operators in the market. As there are several ways to conduct an interview, this section describes in detail the interview methodology used in this research.

Interviews can be conducted in person or over the phone (Harrell and Brandley, 2009). An important advantage of face-to-face interviews is that it allows an interviewer to ask complex questions. In telephone interviews, the questions need to be simple and short. However, an important disadvantage of face-to-face interviews is that the results may be biased which influences the reliability of the answers. The interviewer plays an important role in the interview process. The personal characteristics of an interviewer may influence the amount of information interviewees are willing to reveal and their honesty about what they reveal. This is called the "*interviewer effect*" (Denscombe, 2007). In telephone interviews, there are fewer interviewer effects as the personal characteristics of the interviewer are less obvious. Another disadvantage of face-to-face interviews is that it is a time-consuming process. Because the primary objective of the interviews is to gain insight and to delve deeply into the topics, face-to-face interviews can be regarded as the most appropriate interview method despite its disadvantages.

According to Harrell and Brandley (2009), different kind of interviews can be distinguished based on the level of control the interviewer will have over the interaction. For this research, face-to-face semi-structured interviews will be executed. In a semi-structured interview, a standard questionnaire is used with topics that need be covered during the interview. A semi-structured interview provides the interviewer the opportunity to ask additional questions based on the answers of the interviewee. During the interview, probes can be used to stimulate the interviewee and to ensure the completeness and correctness of the answers. Beforehand, an interview questionnaire was designed with some key questions. These questions are open-ended and grouped thematically. This research uses the same questionnaire for all interviewees. The interview questions are included in Appendix 5 (in Dutch).

In total, 10 interviews were conducted for this research. The experts were chosen purposively, because they must have knowledge in the field of container barge transport to be able to answer the questionnaire. Three experts managing inland terminals in the Netherlands were selected. One of these experts is managing a group of inland terminals (BCTN), while the other two experts just manage one individual terminal (Container Terminal Beverwijk and Markiezaat Container Terminal). In addition, the initiator of Brabant Intermodal was interviewed. This is a subsidiary of four inland terminals in Brabant. Through cooperation, these inland terminals try to improve their position in the hinterland transport chain. Furthermore, two experts working for Kuehne + Nagel were interviewed simultaneously. Kuehne + Nagel is one of the largest freight forwarders in the Netherlands and a major client of inland terminal operators. In addition, an interview was conducted with an expert working for Pro-Log which is a barge operator. It charters skippers and organizes among others barge services between Groningen, Heerenveen and the Port of Rotterdam. Finally, four consultants working on strategic subjects related to the container barge transport sector were approached. Figure 16 presents a list of all interviewees.

Name	Company	Function
Ard-Jan Cieremans	Ab Ovo	Senior Consultant
Hugo de Valk	Ab Ovo	Senior Consultant
Walter Kusters	Ab Ovo	Senior Manager
Bertwin Zonneveld	BCTN	Chief Commercial Officer
Ben van Rooy	Brabant Intermodal	Consultant Business Development
Frits Bisschop	Connekt	Program Manager
Klaasjan Kolle	Container Terminal Beverwijk	Director
Wilko van Wijk Bart Post	Kuehne + Nagel Kuehne + Nagel	Manager Sea Freight Import Manager Intermodal
Richard Klaassen	Markiezaat Container Terminal	Account Manager
Ivo van Beijeren	Pro-Log	Coordinator Operations

Figure 16: List of interviewees

4. Data analysis of the input variables

It became clear from Chapter 2 that the transport market characteristics, waterway characteristics and terminal characteristics are important factors influencing the performance of container barge transport. To collect data about these characteristics as input for the simulation tool of the IDVV project, a secondary research has been done during the first phase of this research (as discussed in section 3.2). This chapter will present the results of the data analysis of the input variables. To simplify the analysis, the inland terminals are classified in sailing areas. This chapter will formulate an answer on the sub question: "*What are the main characteristics of the different sailing areas in the Netherlands?*" The classification of the sailing areas will be discussed in section 4.1. Section 4.2 presents the analysis of the transport market characteristics. Section 4.3 elaborates on the waterway characteristics and section 4.4 on the terminal characteristics. This chapter concludes with some final remarks in section 4.5.

4.1 Sailing areas

As discussed in section 1.5, this research focuses on inland terminals located in the largest sailing areas of the Netherlands: Noord-Nederland, Groot-Amsterdam, Nijmegen-Maas and West-Brabant. Inland terminals located in the Rotterdam-Moerdijk-Antwerp market are out of scope. The same applies to inland terminals located in the sailing areas Zeeland-Gent, Twente and Alphen aan den Rijn. In total, 35 inland terminals in the Netherlands are in the scope of this research. This makes it complex to compare the inland terminals at a detailed level. To simplify the data analysis, the sailing area classification of TNO et al. (2012) will be applied to compare the inland terminals. This classification will also be used for setting up the different bundling scenarios in Chapter 5. The classification of TNO et al. (2012) takes the location and the position of the inland terminals with respect to the major waterways in the Netherlands as starting point. Inland terminals that are located in the vicinity of each other belong to the same sailing area. These terminals operate in the same market environment and are in the position to cooperate. Figure 17 shows which inland terminals belong to the sailing areas mentioned above. The names included in Figure 17 are the original names of the terminals. In the remainder of this thesis, a shortened term will be used for the terminals. These terms are included in Appendix 6.

Noord-Nederland	Groot-Amsterdam	Nijmegen-Maas	West-Brabant
Barge Service Center Groningen	Container Stevedoring IJmuiden	Barge & Rail Terminal Born	Barge & Rail Terminal Tilburg
Container Terminal Heerenveen	Container Terminal Beverwijk	Container Terminal Cuijk	BTT – Dependence Vossenberg
CTU Kampen	Container Terminal Utrecht	Container Terminal Stein	Bossche Container Terminal
Harlinger Overslag & Veembedrijf	CT Vrede-Steinweg Amsterdam	Container Terminal Nijmegen	CCT + MCT Moerdijk
MCS Leeuwarden	CT Vrede-Steinweg Zaandam	CTU Rieverenland	Delta Marine Terminal
MCS Meppel	MEO Container Terminal	Logistiek Centrum Gorinchem	Inland Terminal Veghel
MCS Westerbroek	SCS Multiport	Osse Overslag Centrale	Markiezaat Container Terminal
ROC Kampen	United Stevedores Amsterdam	TCT Venlo	Oosterhout Container Terminal
Wijnne & Barends		Wanssum Intermodal Terminal	ROC Waalwijk

Figure 17: Classification of inland terminals (own elaboration on TNO et al., 2012)

For this research a number of adjustments are made with respect to the classification of TNO et al. (2012). The adjustments are summarized below:

- Delta Marine Terminal and CCT + MCT Moerdijk are added to West-Brabant. These terminals are well-positioned to develop as hub terminal for inland terminals in West-Brabant and thus interesting to include in the different bundling scenarios.
- Markiezaat Container Terminal in Bergen op Zoom is also added to West-Brabant, because of its position with respect to the terminals in Moerdijk. Overslag Terminal Bergen op Zoom is not included in this research. This terminal is only accessible for trucks. The quay is just 15 meter and thus not suitable for barges (personal communication, Ronald Hamelink, October 10, 2013).
- Logistiek Centrum Gorinchem is added to Nijmegen-Maas, because it is located along the same waterway as all other terminals in this sailing area. Logistiek Centrum Gorinchem has the potential to develop as container transferium for terminals in Nijmegen-Maas in the near future.
- Container Terminal Harderwijk and Barge Terminal Urk are not included in this research. The municipality of Harderwijk restricts the usage of CT Harderwijk for commercial purposes so it is not possible to set up cooperation schemes with this terminal (personal communication, Ard-Jan Cieremans, October 28, 2013). Barge Terminal Urk is not fully operational yet.

4.2 Transport market characteristics

Section 2.5.1 showed that there is a relationship between the type of transport market and preferred service network (Konings, 2009). The available transport volumes in the market are important for the feasibility of the different network structures. To compare the sailing areas, a detailed analysis of the transshipment volumes in the Netherland has been made. The analysis will be discussed in section 4.2.1. Section 4.2.2 discusses the size of the service areas of the terminals, because this influences the market scope of container barge transport. The final section provides an analysis of the forecasted growth rates.

4.2.1 Transshipment volume

First, it is important to mention that it was not possible to collect data for a specific year, because there is limited public information available about the transshipment volumes. This research uses data from the years 2010 and 2011. It is assumed that no major changes have been occurred in these years, because of the economic downturn[2]. Figure 18 shows the total transshipment volume in the different sailing areas. The figure shows that all inland terminals in the Netherlands together handle approximately 1.85 million TEU per year. West-Brabant is the largest sailing area in the Netherlands, followed by Nijmegen-Maas. Many large shippers with European distribution centers are located in these areas such as Sabic, Samsung and OCE. The inland terminals in West-Brabant and Nijmegen-Maas together handle approximately 1.3 million TEU per year which is equal to 70.5% of total transshipment volume in the Netherlands. Noord-Nederland is the smallest sailing area in the Netherlands. The terminals in Noord-Nederland together handle approximately 187.500 TEU per year which is equal to 10.1% of total transshipment volume. The remaining 19.4% is handled in Groot-Amsterdam.

[2] The share of container barging in the modal split of the Port of Rotterdam is the same in 2010 and 2011. In 2010, 2.351 million TEU was transported to/from the Port of Rotterdam by barge. This is equal to 32.8%. In 2011, 2.393 million TEU was transported by barge which is also equal to a share of 32.8% (Port of Rotterdam Authority, 2012).

Based on an analysis of the number of weekly sailings to the Port of Rotterdam and Antwerp, it is estimated that about 78.5% of total volume is transported to/from the Port of Rotterdam. Appendix 7 shows that most terminals in West-Brabant, Nijmegen-Maas and Groot-Amsterdam offer a standard barge service to the Port of Rotterdam as well as the Port of Antwerp, while this is not the case for terminals in Noord-Nederland. This has partly to do with the distance of the terminals to the Port of Antwerp, but there is also too little demand for container barge transport in Noord-Nederland to set up a cost effective barge service to this port. Section 1.1 has introduced the concept of captive and contestable hinterlands. The captive hinterland of a port includes all locations where a port has a significant market share. Figure 18 shows that the Port of Rotterdam handles a vast majority of all containers transported to/from inland terminals in the Netherlands. Only inland terminal CTS Stein (Nijmegen-Maas) offers more weekly sailings to the Port of Antwerp than to the Port of Rotterdam. Just approximately 20% of its volume is transported to/from the Port of Rotterdam (see Appendix 7). Focusing on container barge transport only, the results of this analysis suggest that most regions in the domestic market of the Netherlands belong to the captive hinterland of the Port of Rotterdam.

Sailing area	Volume (TEU)	% of Volume	% Rotterdam	Volume PoR (TEU)
Noord-Nederland	187.500	10.1%	100.0%	187.500
Groot-Amsterdam	358.050	19.4%	82.0%	293.540
Nijmegen-Maas	518.000	28.0%	74.7%	386.900
West-Brabant	785.000	42.5%	74.5%	584.000
Total sailing areas	**1.848.550**	**100.0%**	**78.5%**	**1.451.940**

Figure 18: Transshipment volume per sailing area

Figure 19 shows the transshipment volume of the top 10 largest inland terminals in the Netherlands involved in this research. The 10 largest inland terminals in the Netherlands together handle approximately 1.1 million TEU per year which corresponds to 58% of total volume. About 29% of this volume is transported directly to/from the Port of Antwerp. The figure shows that CCT + MCT Moerdijk is the largest terminal in the Netherlands, followed by OCT Oosterhout and BT Born. CCT + MCT Moerdijk handles approximately 8% of total transshipment volume in the Netherlands, while OCT Oosterhout and BT Born are responsible for 7% of total volume. DMT Moerdijk and CT Den Bosch handle 6% of total volume and are on the fourth and fifth place of the top 10. These figures illustrate that inland terminal operators control just a small part of all containers handled in the Netherlands. An important observation is that the top 5 largest inland terminals in the Netherlands are all located in West-Brabant, excluding BT Born. Another observation is that no single inland terminal in Noord-Nederland belongs to the top 10 at all. The figure shows that all top 10 terminals offer a regular barge service to the Port of Antwerp. Appendix 7 provides an overview of the transshipment volumes of all inland terminals in the Netherlands. The appendix shows that the smallest inland terminal in the Netherlands is Wijnne & Barends Delfzijl (Noord-Nederland), followed by CSY Ijmuiden (Groot-Amsterdam) and CT Cuijk (Nijmegen-Maas). These inland terminals handle respectively 2.500 TEU, 8.500 TEU and 10.000 TEU per year. This is together equal 1.1% of total transshipment volume.

Inland Terminal	Sailing area	Volume (TEU)	% Rotterdam	% of Volume
CCT + MCT Moerdijk	West-Brabant	150.000	60%	8%
OCT Oosterhout	West-Brabant	130.000	80%	7%
BT Born	Nijmegen-Maas	125.000	70%	7%
DMT Moerdijk	West-Brabant	120.000	50%	6%
CT Den Bosch	West-Brabant	120.000	70%	6%
WIT Wanssum	Nijmegen-Maas	95.000	80%	5%
CTVrede Amsterdam	Groot-Amsterdam	95.000	80%	5%
CT Nijmegen	Nijmegen-Maas	85.000	80%	5%
MCT Bergen op Zoom	West-Brabant	70.000	80%	4%
CTU Utrecht	Groot-Amsterdam	67.550	80%	4%
	Total volume:	**1.063.550**	**71%**	**58%**

Figure 19: Top 10 largest inland terminals in the Netherlands

4.2.2 Service area of inland terminals

Section 2.7 showed that the major determinants for the market scope of intermodal barge transport are transshipment costs, barge haul costs and pre- & post-truck haulage costs. Decisio (2002) has calculated that intermodal barge transport is an attractive alternative for road transport over distances of 90 km. However, it is interesting to note that a number of existing terminals in the Netherlands are located at a shorter distance of the Port of Rotterdam. The transshipment volumes of these terminals are included in Figure 20. The figure shows that the terminals together handle approximately 852.550 TEU per year which is equal to 46% of total transshipment volume in the Netherlands. The previous section showed that CTU Utrecht, CT Den Bosch, CCT + MCT Moerdijk, DMT Moerdijk and OCT Oosterhout belong to top 10 largest inland terminals in the Netherlands. It becomes clear from the figure that these terminals are situated at a relatively short distance of the Port of Rotterdam which is remarkable and contradicts the findings of Decisio (2002). Appendix 8 provides an overview of the distance of the terminals to the port.

Inland Terminal	Sailing area	Distance (km)	Volume (TEU)	% of Volume
CCT + MCT Moerdijk	West-Brabant	40	150.000	8%
DMT Moerdijk	West-Brabant	41	120.000	6%
LCG Gorinchem	Nijmegen-Maas	50	50.000	3%
OCT Oosterhout	West-Brabant	56	130.000	7%
ROC Waalwijk	West-Brabant	68	50.000	3%
BTT Vossenberg	West-Brabant	70	40.000	2%
CTU Utrecht	Groot-Amsterdam	75	67.550	4%
BTT Tilburg	West-Brabant	79	55.000	3%
CT Den Bosch	West-Brabant	84	120.000	6%
MCT Bergen op Zoom	West-Brabant	88	70.000	4%
	Total volume:	**< 90 km**	**852.550**	**46%**

Figure 20: Transshipment volume of inland terminals < 90 km of the Port of Rotterdam

An important development in the container barge transport sector in the Netherlands is that a lot of new terminals have been built in last few years which has resulted in the fragmentation of container flows. Section 2.7 showed that the potential catchment area of an inland terminal depends to a large extent on the pre- & post-truck haulage costs. Given the high share of pre- & post-truck haulage costs in hinterland transport costs, the region in which container barge transport can be a competitive alternative for road transport is usually an area with a circumference of 15 km (Konings and Priemus, 2008). Appendix 9 shows the service areas of the existing inland terminals in the Netherlands (KiM, 2012). CTU Tiel, CTU Kampen and MCS Leeuwarden are not included in the figure, because these terminals are founded in 2012 and 2013. It becomes clear from Appendix 9 that a lot of inland terminals in the Netherlands are in competition to serve the same inland areas, excluding CTU Utrecht.

The appendix shows that a lot of inland terminals are located in West-Brabant. The terminals are faced with fierce competition of trucking companies. The service areas of the terminals overlap and are relatively small. This situation can also be observed in Groot-Amsterdam. The terminals in Groot-Amsterdam are located at a relatively short distance of each other and overlap. Currently, there is a lot of overcapacity in Groot-Amsterdam, since seagoing vessels do not longer call at the Port of Amsterdam. The same applies to Noord-Nederland. Terminals in this region heavily compete to attract substantial container volumes to offer a cost effective barge service to the Port of Rotterdam. A number of large shippers are located in Noord-Nederland such as FrieslandCampina. Given the small size of this area, these shippers can exert much influence on the provision of the barge services. Considering Nijmegen-Maas, it can be observed that the terminals are more spread across the region compared to terminals in West-Brabant and Groot-Amsterdam. The catchment area of the terminals is also larger, because the terminals are located at a greater distance of the Port of Rotterdam. However, there are also examples of terminals that are situated at a relatively short distance of each other. For instance, TCT Venlo and WIT Wanssum serve the same inland areas and are competing to attract the container flows of shippers. The same applies to among others BT Born and CTS Stein & CT Nijmegen and CT Cuijk.

4.2.3 Growth rates

As discussed in section 1.5, the Rotterdam Port Authority has forecasted that the container volumes will grow after the opening of Maasvlakte II. The Rotterdam Port Authority has the ambition to achieve a modal split of 45% barge, 35% truck and 20% rail in 2033. Because of the modal split ambitions of the Rotterdam Port Authority, it is expected that the demand for container barge transport will increase in the near future. This research uses the growth forecasts of WLO. These growth rates differ slightly from the forecasts of the Rotterdam Port Authority. Today, it is unlikely that the forecasted growth rates of the GE-scenario will be reached. Therefore, this research only focuses on the 0%-Growth scenario, RC-scenario (low growth) and SE-scenario (medium growth). Figure 21 shows the average forecasted growth rates per sailing area. It becomes clear from the figure that the forecasted growth rates differ per region. The figure shows that highest growth is expected in West-Brabant, followed by Nijmegen-Maas. The expected growth in Groot-Amsterdam is the lowest. It is important to mention that no growth rates were available for CT Heerenveen (Noord-Nederland) and CTU Tiel (Nijmegen-Maas). Because these terminals are close to MCS Westerbroek and OOC Oss, the same growth rates are applied to these terminals. Appendix 10 provides an overview of the growth rates per inland terminal.

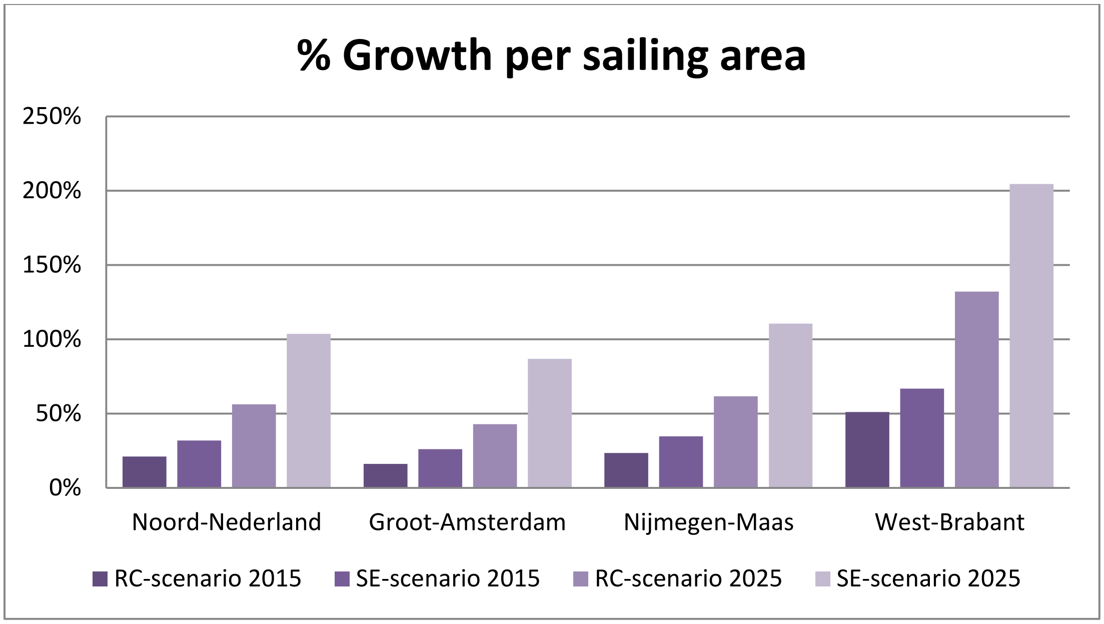

Figure 21: Forecasted growth rates with respect to current situation

Figure 22 shows the demand for container barge transport in absolute numbers for the different time periods and growth scenarios (see also Appendix 11). The largest growth is expected in the period 2010-2020 due to the modal split ambitions of the Rotterdam Port Authority. The forecasted annual growth rates for this period are 6.25% in the RC-scenario and 8.25% in the SE-scenario. The growth rates for the period 2020-2030 are respectively 1.0% in the RC-scenario and 2.6% in the SE-scenario. These growth rates imply that the demand for container barge transport will grow from 1.45 million TEU to approximately 1.97 million TEU in 2015 and 2.80 million TEU in 2025 according to the RC-scenario. This corresponds to a doubling of the current transport volumes in 2025. The container volumes will grow to approximately 2.16 million TEU in 2015 and 3.66 million TEU in 2025 in the SE-scenario.

Sailing area	0%-Growth	RC-scenario 2015	SE-scenario 2015	RC-scenario 2025	SE-scenario 2025
Noord-Nederland	187.500	227.303	247.279	293.080	382.029
Groot-Amsterdam	293.540	342.160	373.006	433.311	553.128
Nijmegen-Maas	386.900	482.608	527.251	638.483	832.467
West-Brabant	584.000	914.029	1.013.380	1.436.892	1.888.602
Total volume:	**1.451.940**	**1.966.100**	**2.160.916**	**2.801.766**	**3.656.266**

Figure 22: Demand for container barge transport in TEU (only flows to/from Port of Rotterdam)

4.3 Waterway characteristics

The accessibility of an inland terminal by barge is important for its competitive position in the market. It influences the maximum vessel size that can call at an inland terminal and thus the performance of container barge transport. It is advantageous for an inland terminal to be accessible for larger vessels, especially if the growth continues. As discussed in section 2.4.4, the European waterway infrastructure is divided in CEMT-classes. This classification is based on the length and width of the waterways and the capacity of the vessels that can be deployed on the waterways. Figure 23 provides an overview of the transshipment volume of the inland terminals in the Netherlands that are located along CEMT-class II, III and IV waterways. Currently, 8 inland terminals in the Netherlands are located along small waterways. These terminals together handle approximately 366.000 TEU which is equal to 20% of total volume in the Netherlands. The figure shows that waterway limitations play particularly a role in West-Brabant and to a lesser extent in Noord-Nederland. ROC Waalwijk, BTT Tilburg and IT Veghel are located along so-called "*capillaries*" (CEMT-class II and III). Furthermore, CT Den Bosch and BTT Vossenberg are located along class IV waterways. This is remarkable, because CT Den Bosch is one of the largest terminals in the Netherlands. It handles 6% of total transshipment volume in the Netherlands (see also section 4.2.1). Given the limited demand for container barge transport in Noord-Nederland, the waterway limitations are currently less problematic for the competitive position of the inland terminals in this region. The inland terminals in Groot-Amsterdam and Nijmegen-Maas are located along waterways in classes V and VI. Appendix 12 shows to which CEMT-class the different inland terminals in the Netherlands belong.

Inland Terminal	Sailing area	CEMT-class	Volume (TEU)	% of Volume
CT Den Bosch	West-Brabant	IV	120.000	6%
BTT Tilburg	West-Brabant	II	55.000	3%
IT Veghel	West-Brabant	II	50.000	3%
ROC Waalwijk	West-Brabant	III	50.000	3%
BTT Vossenberg	West-Brabant	IV	40.000	2%
CT Heerenveen	Noord-Nederland	IV	12.000	1%
MCS Westerbroek	Noord-Nederland	IV	24.000	1%
MCS Leeuwarden	Noord-Nederland	IV	15.000	1%
		Total volume:	**366.000**	**20%**

Figure 23: Transshipment volume of terminals located along CEMT-class II, III & IV waterways

4.4 Terminal characteristics

Section 2.5.3 showed that the size and facilities of all terminals involved in the hinterland network influence the performance of container barge transport. Therefore, the main characteristics of all inland terminals, container terminals and empty depots in the Port of Rotterdam are mapped. Data was collected about the following variables: quay length (m), plot size (m²), stack capacity (TEU), opening hours, number of cranes and number of reach stackers (including empty handlers). An overview of the operational characteristics of the terminals is included in Appendix 13 - 15. Section 4.4.1 will made a distinction between low-profile and full-service terminals. In section 4.4.2, the ownership structure of the terminals will be studied. Finally, the I/C-ratio of the terminals is calculated to analyze whether there is sufficient terminal capacity to facilitate future growth. This will be discussed in section 4.4.3.

4.4.1 Low-profile and full-service terminals

First of all, it is interesting to make a distinction between small and large terminals in the Netherlands. The classification of Decisio (2002) will be used to analyze the characteristics of the inland terminals involved in this research. Decisio (2002) distinguishes low-profile and full-service terminals. In general, low-profile terminals only have mobile cranes (such as reach stackers), no depot facilities, limited storage facilities and no regular service to the Port of Rotterdam (less than three times a week). In contrast, full-service terminals have a fixed crane, a regular service to the Port of Rotterdam and a substantial transshipment volume. Decisio (2002) argue that a minimum transshipment volume of 20.000 TEU is required to operate a terminal break-even. Just 8 inland terminals in the Netherlands handle less than 20.000 TEU on an annual basis. These terminals are classified as low-profile terminals for this research. The low-profile terminals together handle approximately 5.4% of total volume in the Netherlands. Figure 24 shows the main characteristics of the low-profile terminals in the Netherlands.

Inland Terminal	Sailing area	Volume (TEU)	Capacity (TEU)	Cranes	Reach stackers
CSY Ijmuiden	Groot-Amsterdam	8.500	24.000	0	1
MEO Velsen-Noord	Groot-Amsterdam	15.000	25.000	1	2
CTS Stein	Nijmegen-Maas	20.000	100.000	1	2
CT Cuijk [1]	Nijmegen-Maas	10.000		0	1
CT Heerenveen	Noord-Nederland	12.000	20.000	0	1
MCS Leeuwarden [1]	Noord-Nederland	15.000	.	1	1
ROC Kampen	Noord-Nederland	20.000	25.000	0	2
Wijnne & Barends Delfzijl	Noord-Nederland	2.500	20.000	1	1

Figure 24: Low-profile terminals in the Netherlands
1: Terminal capacity (TEU) is unknown

In line with Decisio (2002), most low-profile terminals in the Netherlands have little terminal capacity and handling equipment available, except for CTS Stein and MEO Velsen-Noord. Next to barges, MEO Velsen-Noord also handles seagoing vessels. CTS Stein is a trimodal terminal which may explain why these terminals do not correspond with the standard classification of Decision (2002). In addition to the terminals in Figure 24, two other terminals in the Netherlands have no fixed cranes yet. It concerns MCT Bergen op Zoom and IT Veghel (see Appendix 15). These terminals handle more than 20.000 TEU per year and have concrete plans to expand their terminal capacity on mid-term (InlandLinks, 2013). An important observation is that currently no low-profile terminals are located in sailing area West-Brabant. In contrast, 50% of all low-profile terminals are situated in Noord-Nederland. This shows that there is a large variation in the size of the inland terminals between the different sailing areas, particularly the contrast between Noord-Nederland and West-Brabant is interesting for this research.

4.4.2 Ownership structure

As discussed in section 2.8, an interesting development in the container barge transport sector is that some inland terminal operators in the Netherlands nowadays follow a horizontal integration strategy and take shares in other inland terminals. Figure 25 shows the total transshipment volume of companies with more than three inland terminals in the Netherlands and the region in which these companies operate. The regions included in Figure 25 do not correspond with sailing area classification as introduced in section 4.1. It is hard to apply the sailing area classification in this context, because some terminal operating groups have inland terminals in more than one sailing area. For example, CTU (Theo

Pouw Group) has inland terminals in Utrecht (Groot-Amsterdam), Kampen (Noord-Nederland) and Tiel (Nijmegen-Maas). Furthermore, some companies have shares in inland terminals that are out of the scope of this research. For example, MCS and BCTN both have shares in CCT Combi Terminal Twente. The transshipment volumes of these terminals are not included in the calculation and thus the results of this analysis need to be interpreted carefully. The figure shows that the companies together control 50% of total handled volume in the Netherlands. Brabant Intermodal is the largest terminal operating group in the Netherlands (18%), followed by BCTN (16%). It is interesting to note that all terminal operating groups have their own geographical scope. For example, BCTN focuses on Middle East Netherlands with terminals in Nijmegen, Den Bosch and Wanssum, while MCS is more focused on North Netherlands with terminals in Westerbroek (Groningen), Meppel and Leeuwarden. The same applies to HCL and IMS. Together HCL, IMS and MCS are responsible for 85% of total handled volume in Noord-Nederland. This is an interesting observation, because Noord-Nederland is a relatively small sailing area in terms of transport volume. This suggests that it is very important for inland terminal operators located in this region to develop their own container barge network and to bundle container flows. Appendix 16 provides an overview of the ownership structure of the inland terminals in the Netherlands.

Terminal operating group	Region	Volume (TEU)	% of Volume
Brabant Intermodal (BIM)	South West Netherlands	335.000	18%
BCTN	Middle East Netherlands	300.000	16%
CTU (Theo Pouw Group)	Middle Netherlands	132.550	7%
HCL + IMS [1]	North Netherlands	84.000	5%
MCS	North Netherlands	76.000	4%
	Total volume:	**927.550**	**50%**

Figure 25: Transshipment volume of companies with 3 or more inland terminals

1: Volume is including ROC Kampen. HCL & IMS offer a joint line service to Rotterdam in cooperation with ROC Kampen.

4.4.3 I/C-ratio of inland terminals

The I/C-ratio is a ratio between the intensity (transshipment volume) and the capacity of an inland terminal. Figure 26 shows the average I/C-ratios for the inland terminals located in the different sailing areas (see also Appendix 17). First, it is important to mention that the included transshipment volume in Figure 26 differs from other figures in this chapter. The capacity of a number of inland terminals is unknown. It concerns CTU Kampen, MCS Westerbroek (both Noord-Nederland) and CT Cuijk (Nijmegen-Maas). For that reason, the transshipment volumes of these inland terminals are not included in the calculation. Furthermore, OOC Oss (Nijmegen-Maas) and BTT Tilburg (West-Brabant) are trimodal terminals. It was not possible to split the capacity of these terminals in a barge and rail part. Therefore, the total transshipment volume (including rail) and the total capacity of these terminals are used for the calculation of the I/C-ratios. The figure shows that the total capacity of all terminals involved is equal to approximately 4.8 million TEU, while just 1.9 million TEU is used which is equal to 40% of total capacity. There is still a lot of reserve capacity in most sailing areas. Just approximately 36 a 37% of total capacity is used in Noord-Nederland, Groot-Amsterdam and West-Brabant. The inland terminals in Nijmegen-Maas are the most efficient, because currently approximately 54% of total capacity is used in this area.

Sailing area	Volume (TEU)	Capacity (TEU)	% Used
Noord-Nederland	147.500	405.000	36%
Groot-Amsterdam	358.050	1.004.000	36%
Nijmegen-Maas	558.000	1.041.000	54%
West-Brabant	873.000	2.340.000	37%
Total sailing areas	**1.936.550**	**4.790.000**	**40%**

Figure 26: Total terminal capacity (TEU) in the different sailing areas

The I/C ratio can be used to analyze whether an inland terminal has sufficient terminal capacity available to facilitate future growth. Based on the average forecasted growth ratios, the inland terminals in the Netherlands can be classified as follows (own elaboration on TNO et al., 2012):

- 0.00 - 0.40: Sufficient terminal capacity to satisfy demand in 2015 and 2025
- 0.41 - 0.65: Insufficient terminal capacity to satisfy demand in 2025
- 0.66 - 0.90: Insufficient terminal capacity to satisfy demand in 2015 and 2025
- 0.91 - 1.00: Little or no terminal capacity to satisfy current demand

According to this classification, there are currently no terminals with little or no capacity to expand their activities on short term. This implies that all inland terminals in the Netherland have sufficient capacity to satisfy current demand. Six inland terminals in the Netherlands have insufficient terminal capacity to satisfy the expected demand in 2015. It concerns ROC Waalwijk, OCT Oosterhout (both West-Brabant), OOC Oss, TCT Venlo, LCG Gorinchem (all Nijmegen-Maas) and ROC Kampen (Noord-Nederland). 44% of the inland terminals have insufficient terminal capacity in 2025, while the remaining 38% of the terminals have no capacity problems at all. These results are in line with the findings of Ecorys (2010) and KiM (2012). Both studies show that there is currently sufficient capacity available to achieve a modal shift from truck to barge and to facilitate growth until 2020. After 2020, most inland terminals in the Netherlands are unable to satisfy demand. Appendix 18 provides an overview of the I/C-ratio classification of the inland terminals in the Netherlands. Appendix 18 shows that 62.5% of all terminals located in Groot-Amsterdam have sufficient capacity left to satisfy demand in 2025. Since deep sea carriers do no longer call at the Port of Amsterdam, there is a lot of overcapacity in this sailing area.

4.5 Final remarks

It is important to mention that the results of this analysis need to be interpreted carefully. The data is incomplete which limits the reliability of the results. Several assumptions were made to complete the data collection phase. The various appendices precisely indicate when the values are estimated. Furthermore, the data may be outdated. The market conditions in the container barge transport sector are continuously changing: new inland terminals are built, existing terminals expand their capacity and shippers repeatedly shift their cargo to competing terminals. An example of an important development which has changed the market circumstances in Noord-Nederland is the re-opening of the barge terminal in Veendam. Until the end of 2013, BSC Groningen handled all containers destined for IMS Veendam. However, IMS Veendam has recently terminated its partnership with HCL. The re-opening of the inland terminal in Veendam has resulted in a further fragmentation of the available container volumes in Noord-Nederland which in turn influences the efficiency of the barge services to the Port of Rotterdam (Walter Kusters, personal communication, December 30, 2013). However, this development is not taken into account in the research. The results of this analysis are thus indicative.

5. Scenario analysis in the hinterland of the Port of Rotterdam

During the second phase of this research, a scenario analysis by means of a simulation tool has been conducted (see section 3.3). This chapter presents the results of the scenario analysis in the hinterland of the Port of Rotterdam. Section 5.1 introduces a scenario framework. The performance indicators in the current situation will be discussed in section 5.2. An analysis of the effect of increasing container volumes on the performance indicators can be found in section 5.3. Section 5.4 presents the alternative bundling scenarios which are identified for this research and elaborates on the cost effectiveness of the different bundling network types. Section 5.5 discusses to what extent the increasing involvement of deep sea actors in the hinterland influences the performance of container barge transport. This chapter concludes with some final remarks in section 5.6.

5.1 Scenario framework

The primary objective of the scenario analysis is to analyze the effect of vertical integration of deep sea actors on the performance of container barge transport in the Netherlands under changing market circumstances. As discussed in section 2.8, it is expected that the container barge network in the Netherlands will considerably change in the near future, because of the opening of the Maasvlakte II. New players will enter the market and develop their own dedicated barge services to the hinterland. The increasing involvement of deep sea actors in hinterland transport may result in a revision of the container barge network. Therefore, the following basic bundling network types, as discussed in section 2.4, will be applied in this analysis: point-to-point network, line network, hub-and-spoke network and trunk-feeder network. The scenario analysis will focus on the years 2015 (short term) and 2025 (medium term). The following WLO growth scenarios will be used: 0%-Growth scenario, RC-scenario and SE-scenario. The GE-scenario is out of the scope of this research which is explained in section 1.5. The scenario framework is presented in Figure 27 and can be used as guideline in this chapter.

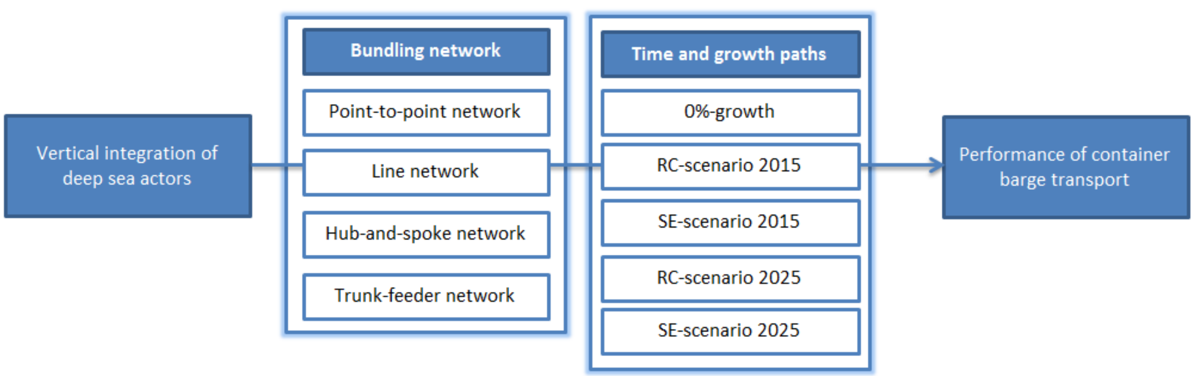

Figure 27: Scenario framework

5.2 Current situation

Currently, most inland terminal operators in the Netherlands offer a point-to-point service to the Port of Rotterdam. Figure 28 shows the performance indicators in het present situation. It can be observed that the service frequency is the lowest in Noord-Nederland, followed by Groot-Amsterdam. The service frequency is low, because these sailing areas are relatively small in terms of transshipment volume. A remarkable observation is that the service frequency in West-Brabant is relatively high compared to other sailing areas. This has to do with the waterway limitations in West-Brabant. The transport costs and CO_2 emissions per TEU are the lowest in West-Brabant, because most inland terminals in this area are located at a relatively short distance from the Port of Rotterdam. The transport costs and CO_2 emissions per TEU are the highest in Noord-Nederland. This has partly to do with the distance of the terminals to the Port of Rotterdam. Furthermore, most inland terminal operators in Noord-Nederland deploy small vessels, because the demand for container barge transport is limited. The figure shows that the reliability of the barge services is closely related to the vessel circulation time. The vessel circulation time in Nijmegen-Maas is relatively high compared to the other sailing areas. However, the sailing times are very unrealistic so not too much attention should be paid to this performance indicator. This is explained in more detail in section 3.4.2.

Sailing area	Frequency	Reliability	Transport costs	Sustainability	Transit time
Noord-Nederland	3.2	4.9	200.1	649.8	153.5
Groot-Amsterdam	3.8	3.0	139.1	433.3	120.8
Nijmegen-Maas	4.1	7.2	185.5	623.9	179.3
West-Brabant	9.6	2.8	111.1	322.0	101.2

Figure 28: Performance indicators (0%-Growth scenario)

Although the transport costs are the highest in Noord-Nederland, it is hard to draw conclusions of a comparison of transport costs in absolute numbers. To compare the sailing areas in terms of transport costs, it is important to correct the transport costs for the distance of the terminals to the Port of Rotterdam. Figure 29 shows the average transport costs per TEU/km in the sailing areas. It becomes clear that the average transport costs per TEU/km in Noord-Nederland are the lowest, while the transport costs in West-Brabant are relatively high. Section 2.7 showed that the cost share of pre- and post-truck haulage in container barge transport is relatively large given the high start-up costs of a road trip. Because of the short distance of West-Brabant to the port, the terminals are faced with fierce competition of trucking companies. For these terminals, it is difficult to attain a competitive advantage.

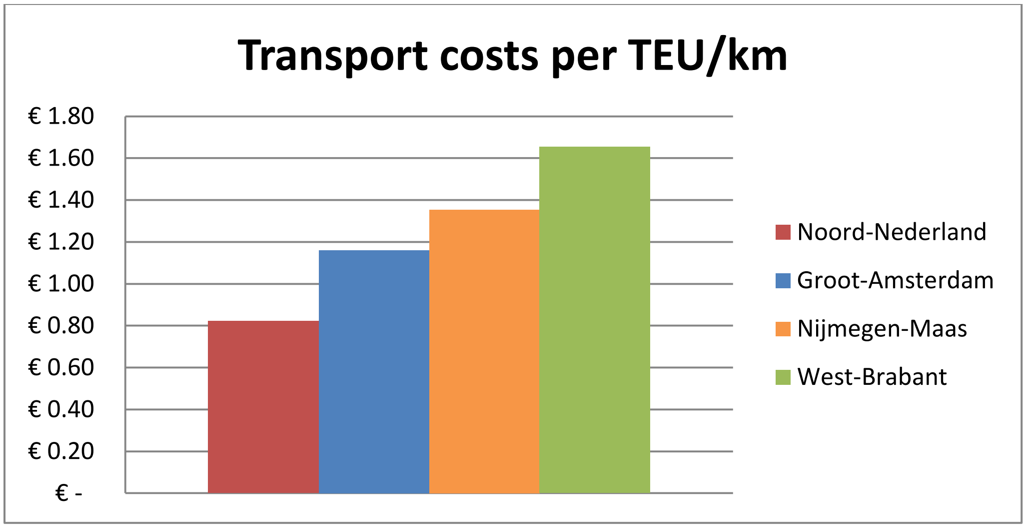

Figure 29: Transport costs per TEU/km (0%-Growth scenario)

The transport costs per TEU/km of the inland terminals are compared with the average costs in the sailing areas. This has provided an overview of the most expensive terminals in the Netherlands which are included in Figure 30. Wijnne & Barends Delfzijl and CTS Stein currently have too little volume to offer a regular barge service to the Port of Rotterdam. It is hard for these terminals to achieve a high vessel utilization degree. The vessel utilization degree for Wijnne & Barends Delfzijl is equal to 55% and for CTS Stein 58% in the present situation. Therefore, the transport costs per TEU/km for these terminals are relatively high compared to others. CSY IJmuiden, CT Cuijk, SCS Amsterdam and MEO Velsen-Noord also belong to the top 10. These terminals handle less than 20.000 TEU on an annual basis which makes it difficult to offer an attractive barge product to shippers. Furthermore, LCG Gorinchem, DMT Moerdijk and CCT + MCT Moerdijk are included in the top 10. These terminals are situated at a relatively short distance of the Port of Rotterdam and have difficulties to attain a high vessel utilization degree. Appendix 19 provides a detailed overview of the transport costs per TEU/km for all inland terminals.

Inland Terminal	Sailing area	Volume PoR (TEU)	Efficiency (%)	Vessel size (TEU)	Distance (km)	Costs (TEU/km)
Wijnne & Barends Delfzijl	Noord-Nederland	2.500	55%	24	309	€ 1.30
LCG Gorinchem	Nijmegen-Maas	35.000	75%	90	50	€ 1.83
CCT + MCT Moerdijk	West-Brabant	90.000	74%	208	40	€ 2.12
DMT Moerdijk	West-Brabant	60.000	77%	208	41	€ 2.05
CTS Stein	Groot-Amsterdam	4.000	58%	24	236	€ 1.68
CSY Ijmuiden	Groot-Amsterdam	8.500	87%	24	127	€ 1.34
CT Cuijk	Nijmegen-Maas	10.000	89%	24	125	€ 1.56
CTU Kampen	Noord-Nederland	25.000	71%	90	185	€ 0.93
SCS Amsterdam	Groot-Amsterdam	18.000	83%	48	127	€ 1.31
MEO Velsen-Noord	Groot-Amsterdam	12.000	83%	48	132	€ 1.29

Figure 30: Top 10 Most expensive inland terminals (0%-Growth scenario)

5.3 Increasing container volumes

This section will discuss the effect of increasing container volumes on the performance indicators of container barge transport per sailing area. Two sailing areas are chosen for this analysis, namely West-Brabant and Groot-Amsterdam. Section 4.2.3 showed that the highest growth is expected in West-Brabant, because a lot of shippers with European distribution centers are located in this region. The lowest growth is forecasted for Groot-Amsterdam. The results for Noord-Nederland and Nijmegen-Maas are included in Appendix 20 and will not be discussed further in the remainder of this section.

Figure 31 presents the effect of increasing container volumes on the performance indicators in a point-to-point network within West-Brabant. The service frequency will increase. In the RC-scenario 2015, inland terminal operators will be in the position to offer two additional sailings to the Port of Rotterdam. Over time, the service frequency will triple. The increasing container volumes will have a negative effect on the reliability of the barge services. This is especially the case in the 2025-scenarios which has to do with terminal capacity problems. Both OCT Oosterhout and MCT Bergen op Zoom will have insufficient capacity to satisfy the expected demand. For these terminals, a high growth is forecasted (222% in the period 2010-2025 according to the RC-scenario). OCT Oosterhout has too little terminal equipment to handle all containers (2 cranes + 3 reach stackers) and the quay of MCT Bergen op Zoom is too small to handle multiple vessels simultaneously (125 meter). The transport costs and CO_2 emissions per TEU will drop significantly over time, because of economies of scale and the bundling of container flows.

Performance indicator	Unit of analysis	RC 2015	RC 2025	SE 2015	SE 2025
Frequency	Number	2.3	6.0	3.3	9.7
Reliability	Hours	-2.2	-7.8	-2.9	-19.7
Transport costs	%	-2.8%	-5.3%	-5.1%	-8.5%
Sustainability	%	-8.4%	-12.0%	-11.9%	-17.3%
Transit time	Hours	6.9	14.4	5.7	30.1

Figure 31: Effect of increasing container volumes on performance indicators in West-Brabant

The results for Groot-Amsterdam are included in Figure 31. It can be observed that the service frequency remains more or less the same in this sailing area. The increasing container volumes will have a negative effect on the reliability of the barge services, but the effect is smaller compared to West-Brabant. The transport costs per TEU will drop significantly over time, but the effect is again smaller than in West-Brabant. In the RC-scenario 2015, the transport costs will fall with approximately 3.5% and the CO_2 emissions with 5.4%. Concluding, the increasing container volumes will have a positive effect on efficiency of the barge services and the competitive position of container barge transport in the market. It will have a negative influence on the reliability of the barge services. It is important to keep this in mind, because shippers highly value reliability which is explained in section 2.6.

Performance indicator	Unit of analysis	RC 2015	RC 2025	SE 2015	SE 2025
Frequency	Number	0.5	0.4	0.4	1.1
Reliability	Hours	-0.3	-0.4	-0.2	-0.9
Transport costs	%	-3.5%	-3.2%	-1.4%	-5.9%
Sustainability	%	-5.4%	-8.5%	-5.2%	-9.2%
Transit time	Hours	-3.0	11.5	6.3	13.4

Figure 32: Effect of increasing container volumes on performance indicators in Groot-Amsterdam

5.4 Cost effectiveness of bundling

In the base scenario, all inland terminal operators in the Netherlands operate independently and offer a point-to-point service to the Port of Rotterdam. For this research, a number of alternative bundling scenarios are identified. The cost effectiveness of the alternative bundling scenarios has been calculated by means of the simulation tool. The output is compared with the base scenario in which point-to-point services are offered. This section will provide an answer to the sub question: *"Which bundling network leads to the best performance of container barge transport?"* Appendix 21 and 22 provides a detailed overview of the performance indicators per bundling scenario in the different time periods.

5.4.1 Noord-Nederland

Noord-Nederland is the smallest sailing area in the Netherlands. One of the main characteristics of Noord-Nederland is that there are a lot of terminal initiatives to attract business to the region. This has resulted in an oversupply of terminal capacity and a fierce competition between the inland terminals. Figure 33 schematically presents the current network structure in Noord-Nederland. This research has initially identified two alternative bundling scenarios for inland terminals in Noord-Nederland, namely:

Scenario 1: A line network will be implemented in the first scenario. The set up of the liner services is based on the provinces in which the inland terminals are located: Groningen, Friesland and Drenthe. The terminals MCS Westerbroek, BSC Groningen and Wijnne & Barends Delfzijl jointly operate a liner service to the Port of Rotterdam. MCS Leeuwarden, HOV Harlingen and CT Heerenveen also operate a joint liner service. The same applies to MCS Meppel, ROC Kampen and CTU Kampen.

Scenario 2: In this scenario, a hub-and-spoke network will be applied to Noord-Nederland. The container terminals in Amsterdam and CTU Utrecht are both well-positioned to develop as a hub terminal in the near future. This scenario consists of two parts (A & B). In scenario 2A, CTVrede Amsterdam will be used as hub terminal for Noord-Nederland. This terminal has an annual capacity of 400.000 TEU. The capacity of all other container terminals in Amsterdam is insufficient to develop as hub terminal (see Appendix 17). In scenario 2B, CTU Utrecht functions as hub terminal.

Figure 33: Network structure in Noord-Nederland

Initially, two potential hub locations were identified for this analysis: CTU Utrecht and CTVrede Amsterdam. However, the analysis showed that CTU Utrecht currently has insufficient resources available to function as hub terminal for Noord-Nederland. Therefore, the results of this scenario will not be discussed further in this analysis. Figure 34 presents the performance indicators of the different bundling concepts in the 0%-Growth scenario. The figure shows that line bundling has a positive effect on the service frequency. The service frequency in a hub-spoke network remains more or less the same. The bundling of container flows has a negative influence on the reliability of the barge services, because additional stops need to be made along the route. Bundling will result in cost savings. The transport costs per TEU decrease on average with 17.0% in a line network and 14.2% in a hub-spoke network. The cost savings are a bit larger in case of line bundling, because no additional handling costs are required. Bundling is also more sustainable: the CO_2 emissions per TEU decrease on average with 22.8% in a line network and 48.6% in a hub-spoke network. The transit time decreases in a line network, while it increases in a hub-spoke network as the containers need to be transshipped at the hub terminal.

Performance indicator	Direct service	Line bundling	Hub-spoke
Frequency	3.2	7.6	3.6
Reliability	4.9	6.1	6.4
Transport costs	200.1	166.1	171.6
Sustainability	649.8	501.7	333.7
Transit time	153.5	141.5	211.1

Figure 34: Performance indicators in alternative bundling scenarios (0%-Growth scenario)

Konings et al. (2006) argue that through bundling only one third of the total transport volume of a direct connection is needed to offer the same frequency as within a point-to-point network. Figure 35 shows the effect of bundling on service frequency over time. It can be observed that the service frequency triples in a line network. However, the service frequency hardly increases in a hub-spoke network which contradicts the findings of Konings et al. (2006). In the 2025 scenarios, the frequency even declines which has to do with capacity problems at the hub terminal CTVrede Amsterdam. The same trend can be observed in all other sailing areas. It is important to note that the vessel size influences the service frequency that can be offered to shippers. This research assumes that inland terminal operators will always operate the greatest possible vessel size, while this is actually not the case in practice (as discussed in section 3.4.1). In practice, inland terminal operators will deploy smaller vessels on the spoke connections to increase their service frequency, possibly resulting in higher transport costs.

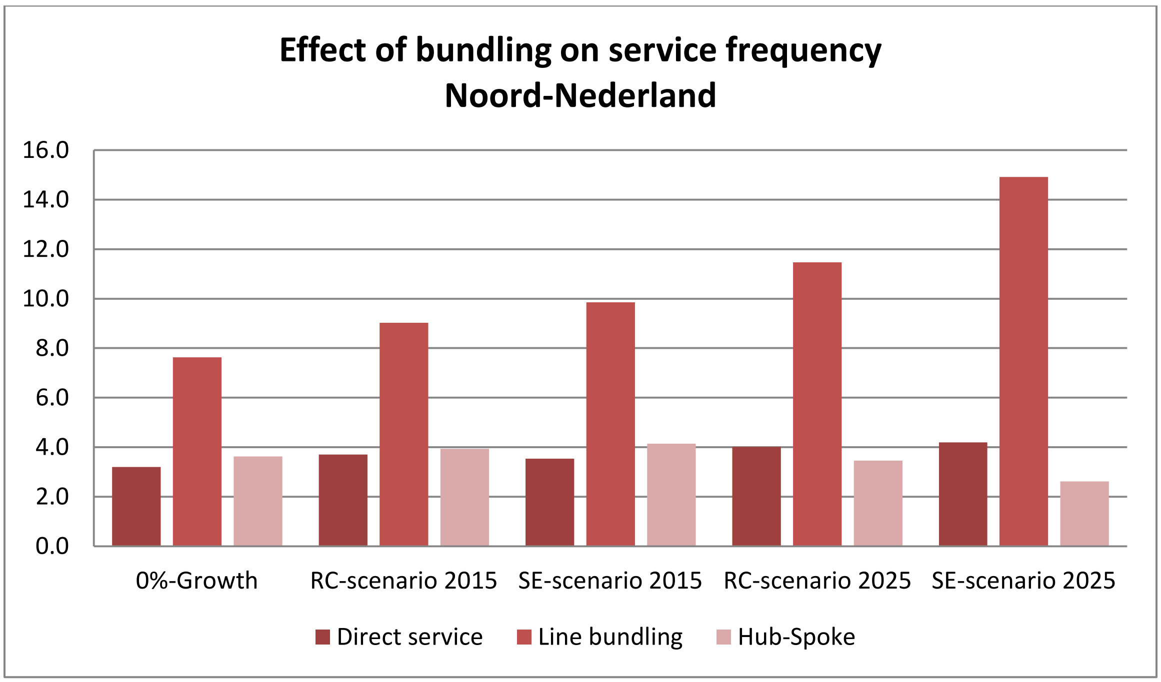

Figure 35: Effect of bundling on service frequency in Noord-Nederland

Figure 34 showed that line bundling as well as hub-spoke services will result in cost savings for Noord-Nederland. Section 5.4.2 will pay more attention to hub-spoke services in Noord-Nederland. To analyze the effect of line bundling on transport costs and the efficiency of the barge services in more detail, the results for the terminals in the RC-scenarios are included in Figure 36. It can be observed that the efficiency of the barge services increases with respectively 7%-point in the RC-scenario 2015 and 8%-point in the RC-scenario 2025. The figure shows that the vessel utilization degree and transport costs are closely related: the larger the efficiency gains, the larger the cost savings. Line bundling is profitable for almost all inland terminals in Noord-Nederland in the RC-scenario 2015, except ROC Kampen. The vessel utilization degree for ROC Kampen in this scenario decreases with 1%-point which explains the increase in the transport costs. The vessel utilization degree for MCS Leeuwarden also decreases. In contrast to

ROC Kampen, this terminal can benefit from economies of scale through line bundling, resulting in a positive price effect. It becomes clear that Wijnne & Barends Delfzijl highly profits from line bundling. The vessel utilization degree increases with about 32%-point in the RC-scenario 2015. The figure also shows that the transport costs for MSC Meppel increases in the RC-scenario 2025. This has to do with the waterway and quay limitations in Noord-Nederland. The maximum vessel size that can be deployed in a line network is a 90 TEU vessel. However, MCS Meppel is located along a CEMT-class V waterway and is thus able to handle 208 TEU vessels. This suggests that line bundling is only profitable for inland terminals that are not able to deploy large vessels within a point-to-point network, because of waterway limitations or too little transport volume. The results for the SE-scenarios are included in Appendix 23.

Inland Terminal	Volume (TEU)	*RC-scenario 2015* Transport costs (%)	Efficiency (%-point)	*RC-scenario 2025* Transport costs (%)	Efficiency (%-point)
Wijnne & Barends Delfzijl	2.500	-56.5%	32%	-56.5%	25%
CT Heerenveen	12.000	-19.9%	1%	-10.4%	-4%
MCS Leeuwarden	15.000	-9.7%	-5%	-20.2%	12%
ROC Kampen	20.000	2.8%	-1%	-7.6%	6%
HOV Harlingen	22.000	-5.7%	4%	-14.0%	10%
MCS Westerbroek	24.000	-17.6%	10%	-8.8%	-1%
CTU Kampen	25.000	-11.9%	10%	-14.7%	12%
BSC Groningen	30.000	-2.9%	1%	-8.3%	3%
MCS Meppel	37.000	-19.3%	9%	2.3%	6%
Noord-Nederland	**187.500**	**-21.2%**	**7%**	**-20.7%**	**8%**

Figure 36: Effect of line bundling on transport costs and efficiency in Noord-Nederland

5.4.2 Groot-Amsterdam

Groot-Amsterdam is a relatively small sailing area in terms of transshipment volume. One of the main characteristics of Groot-Amsterdam is that there is currently a lot of overcapacity since seagoing vessels do not longer call at the Port of Amsterdam. The terminals in Groot-Amsterdam are located at a relatively short distance from each other which is illustrated in Figure 37. Consequently, the service areas of the terminals overlap. Groot-Amsterdam can develop itself in two ways in the future. On one hand, Amsterdam could redevelop its port function. As such, it could attain an important position in the Le Havre-Hamburg range. On the other hand, the container terminals in Groot-Amsterdam could focus on serving regional markets and function as hub for inland terminals in Noord-Nederland. This research has identified two alternative bundling scenarios for inland terminals in Groot-Amsterdam:

Scenario 1: Similar to section 5.4.1, a line network will be implemented in the first scenario. The terminals CSY Ijmuiden, CTB Beverwijk and MEO Velsen-Noord jointly operate a liner service to the Port of Rotterdam. CTVrede Zaandam, CTVrede Amsterdam, USA Amsterdam and SCS Amsterdam also operate a joint liner service, while CTU Utrecht maintains its own barge service to the port.

Scenario 2: A hub-and-spoke network will be applied to Groot-Amsterdam in the second scenario. CTVrede Amsterdam will function as hub terminal for all terminals in the region Amsterdam, while CTU Utrecht continues to maintain its own barge service.

Figure 37: Network structure in Groot-Amsterdam

Figure 38 presents the performance indicators of the bundling scenarios in the 0%-Growth scenario. The results for Groot-Amsterdam are comparable with Noord-Nederland. Similar to Noord-Nederland, line bundling has a positive effect on the service frequency. The service frequency in a hub-spoke network remains more or less the same. The bundling of container flows results in cost savings. The transport costs per TEU decrease on average with 20.0% in a line network and 14.5% in a hub-spoke network, because of economies of scale. The CO_2 emissions per TEU decrease on average with 29.8% in a line network and 50.6% in a hub-spoke network. The transit time increases a bit in a line network, while this was not the case in Noord-Nederland. The reliability of the barge services decreases, but the effect is larger in a hub-spoke network. In Noord-Nederland, the effect on both network types was the same.

Performance indicator	Direct service	Line bundling	Hub-spoke
Frequency	4	11.3	4.4
Reliability	3.2	5.1	12.4
Transport costs	145.8	116.6	124.7
Sustainability	463.8	325.8	229.2
Transit time	122.0	130.8	204.4

Figure 38: Performance indicators in alternative bundling scenarios (0%-Growth scenario)
The results are excluding CTU Utrecht

CTVrede Amsterdam is well-positioned to develop as hub terminal for Noord-Nederland, but also for inland terminals in the surrounding region. The distance between CTVrede Amsterdam and the Port of Rotterdam is 124 km. As discussed in section 2.4.2, Konings (2009) has calculated that a hub-spoke network is an attractive alternative for a point-to-point network when the distance between the port and the hub terminal is about 200 - 300 km. On shorter distances, the cost savings on the main haul are outweighed by the additional handling costs at the hub terminal. The cost savings are larger when small vessels are operated between the hub and inland terminals in the present situation. Figure 39 shows the effect of a hub-spoke network on the transport costs in Noord-Nederland and Groot-Amsterdam over time. It can be observed that a hub-spoke network is beneficial for both sailing areas which contradicts the findings of Konings (2009). The study of Konings (2009) did not take the effect of bundling on barge handling in the Port of Rotterdam into account which may explain the difference in results. The costs savings are larger for inland terminals in Noord-Nederland compared to Groot-Amsterdam.

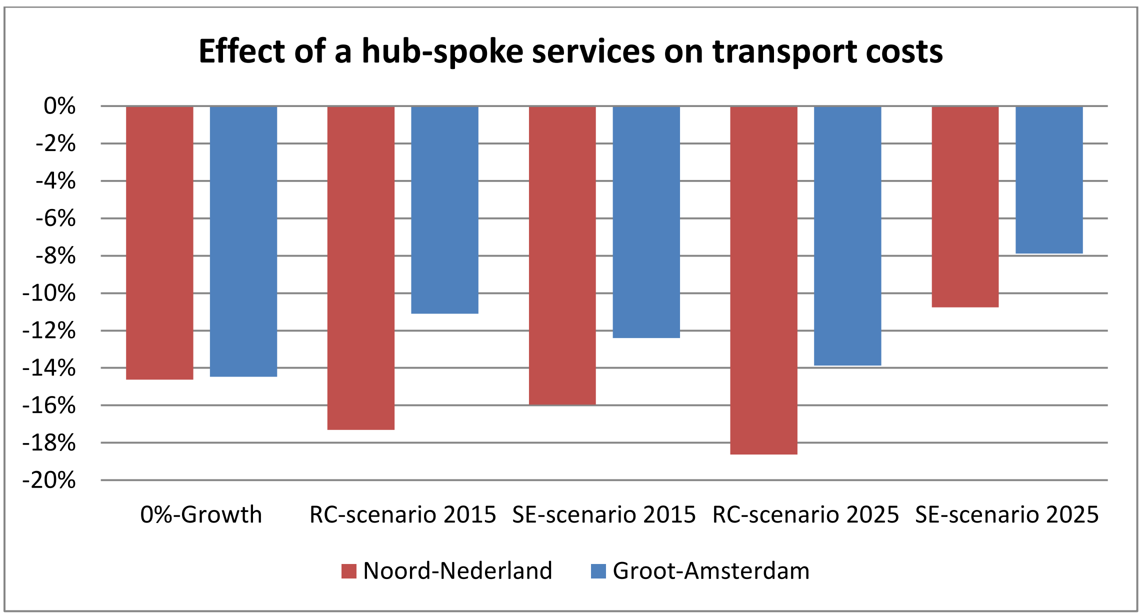

Figure 39: Effect of hub-spoke services on transport costs
The results are excluding CTU Utrecht

The cost effectiveness of a hub-spoke model has been analyzed in more detail. The results for the 0%-Growth scenario and RC-scenarios are included in the Figure 40. Appendix 23 provides an overview of the results in the SE-scenarios which are comparable with the results mentioned below. It is important to note that the figures in Appendix 23 do not correspond with Figure 40. The results in Figure 40 are excluding CTU Utrecht which maintains its own barge service to the port in the hub-spoke scenario. The figure shows that the implementation of a hub-spoke network will result in cost savings for the whole sailing area. It can be observed that the transport costs for CSY Ijmuiden, MEO Velsen-Noord and SCS Amsterdam drop substantially which are relatively small terminals. The cost savings are thus larger when small vessels are operated between the hub and inland terminals in the present situation which confirms the findings of Konings (2009). The transport costs for CTB Beverwijk will increase with approximately 16.5% in the RC-scenario 2015. CTB Beverwijk is a relatively large inland terminal which suggests that the size of an inland terminal is closely related to the feasibility of a hub-spoke network. Because of additional handling costs at the hub terminal, it is more profitable for large terminals to offer a point-to-point service to the Port of Rotterdam. The transport costs for small inland terminals are already relatively high. For these terminals, the additional handling costs are compensated by the cost savings. The inland terminals in Noord-Nederland are on average smaller than in Groot-Amsterdam which in turn explains why the cost savings in Noord-Nederland are larger (as illustrated in Figure 39).

Inland Terminal	Volume PoR (TEU)	0%-Growth	RC-scenario 2015	RC-scenario 2025
CSY Ijmuiden	8.500	-22.1%	-34.6%	-29.9%
MEO Velsen-Noord	12.000	-24.8%	-19.0%	-11.8%
SCS Amsterdam	18.000	-25.3%	-15.6%	-17.3%
USA Amsterdam	32.000	-10.3%	-0.1%	-6.9%
CTVrede Zaandam	36.000	-1.6%	3.2%	-6.1%
CTB Beverwijk	57.000	9.2%	16.5%	6.0%
CTVrede Amsterdam	76.000	-16.6%	-7.5%	-23.4%
Groot-Amsterdam	**239.500**	**-14.5%**	**-11.1%**	**-13.9%**

Figure 40: Effect of hub-spoke services on transport costs in Groot-Amsterdam
The results are excluding CTU Utrecht

5.4.3 Nijmegen-Maas

Nijmegen-Maas is a relatively large sailing area in terms of transshipment volume. Some inland terminals in Nijmegen-Maas are located on a relatively short distance of each other, for example Nijmegen and Cuijk & Born and Stein. Consequently, these inland terminals are in competition to serve the same inland areas. In Figure 41, the current network configuration in Nijmegen-Maas is presented. This research has identified two alternative bundling scenarios for inland terminals in Nijmegen-Maas:

Scenario 1: In the first scenario, the inland terminal operators in Nijmegen-Maas will offer a joint liner service to the Port of Rotterdam. BT Born, TCT Venlo and CTS Stein cooperate in this scenario. CT Nijmegen, CTU Tiel and LCG Gorinchem also cooperate. The same applies to CT Cuijk, WIT Wanssum and OOC Oss.

Scenario 2: In this scenario, a hub-and-spoke network will be applied to Nijmegen-Maas. The inland terminals LCG Gorinchem and CT Nijmegen are both located along crossroads of good navigable waterways. This scenario consists of two parts (A & B). In scenario 2A, LCG Gorinchem will function as a so-called container transferium for all inland terminals located in Nijmegen-Maas. In scenario 2B, CT Nijmegen will be developed as hub terminal. In the this scenario, OOC Oss, CTU Tiel and LCG Gorinchem operate independently and offer a direct service to the Port of Rotterdam.

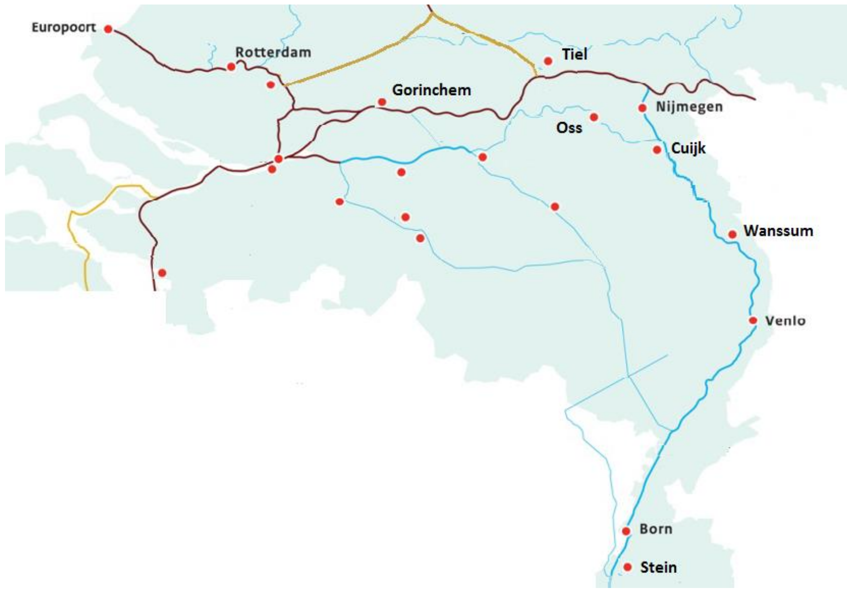

Figure 41: Network structure in Nijmegen-Maas

Initially, two alternative bundling scenarios were identified for inland terminals in Nijmegen-Maas (as mentioned above). However, it was not possible to apply the hub-spoke scenario in this sailing area. Both LCG Gorinchem and CT Nijmegen have insufficient terminal capacity to satisfy demand in the present situation. Therefore, only the line bundling scenario is applied to Nijmegen-Maas. It is interesting to mention that LCG Gorinchem as well as CT Nijmegen have concrete plans to expand their capacity on short term (InlandLinks, 2013). LCG Gorinchem is already expanding its capacity. The quay of the terminal will be extended from 135 meter to 350 meter. It is expected that the new terminal facilities will be operational in March 2014. The same applies to CT Nijmegen. The quay of the terminal will be extended from 175 meter to 350 meter and a new quay crane will be installed (Logistiek, 2011).

Section 2.4.3 discussed that line bundling offers the opportunity to attain economies of scale and to increase the frequency of service. The results for the 0%-Growth scenario are summarized in Figure 42. The results are comparable with Groot-Amsterdam and Noord-Nederland. The figure shows that line bundling has a positive effect on the average transport costs in Nijmegen-Maas. The transport costs per TEU decrease on average with 17.3%. Line bundling has also a positive effect on the CO_2 emissions in the hinterland transport chain of container barging. It can be observed that the CO_2 emissions per TEU decrease with approximately 25.3%. However, the reliability of the barge services decreases. In contrast to Noord-Nederland and Groot-Amsterdam, line bundling has a huge negative effect on the vessel circulation time in Nijmegen-Maas. This is remarkable and will be analyzed in more detail below.

Performance indicator	Unit of analysis	Line bundling
Frequency	Number	2.2
Reliability	Hours	-15.7
Transport costs	%	-17.3%
Sustainability	%	-25.3%
Transit time	Hours	42.2

Figure 42: Effect of line bundling on performance indicators in Nijmegen-Maas (0%-Growth scenario)

The study of Caris et al. (2012) showed that line bundling is an interesting network structure for inland terminals with small volumes located at a further distance of the port. Figure 43 presents the effect of line bundling on the transport costs in the 0%-Growth scenario and RC-scenarios. Appendix 23 provides an overview of the results in the SE-scenarios which are comparable with the results of the RC-scenarios. The figure illustrates that line bundling is an interesting alternative for inland terminals operators in Nijmegen-Maas, because it results in cost savings for the whole sailing area. It shows that the bundling effect is larger for the small inland terminals located at a further distance from the Port of Rotterdam which in accordance with the findings of Caris et al. (2012). For example, CTS Stein and CT Cuijk are relatively small inland terminals, while BT Born is a large inland terminal. In the RC-scenario 2015, the transport costs for the terminals for CTS Stein and CT Cuijk decrease with respectively 51.2% and 36.7%, while the transport costs for BT Born decrease with just 3.8%. The price advantage for CT Nijmegen is substantial which is remarkable because it is a relatively large inland terminal. It can also be observed that line bundling is less attractive for LCG Gorinchem which is located at a relatively short distance of the Port of Rotterdam. In the RC-scenario 2015, the transport costs for LCG Gorinchem increase with approximately 35.5%. Line bundling also results in a small negative price effect for OOC Oss (4.5% in RC-scenario 2015). Line bundling is thus not profitable for all inland terminals in Nijmegen-Maas.

Inland Terminal	Volume PoR (TEU)	0%-Growth	RC-scenario 2015	RC-scenario 2025
CTS Stein	4.000	-52.7%	-51.2%	-43.2%
CT Cuijk	10.000	-25.9%	-36.7%	-39.0%
CTU Tiel	32.000	-6.4%	-18.4%	-16.3%
TCT Venlo	34.400	-7.1%	-8.7%	8.2%
LCG Gorinchem	35.000	39.7%	35.5%	13.1%
OOC Oss	40.000	0.6%	4.5%	1.0%
CT Nijmegen	68.000	-16.4%	-18.8%	-23.3%
WIT Wanssum	76.000	-12.8%	-7.2%	-5.4%
BT Born	87.500	1.4%	-3.8%	-3.8%
Nijmegen-Maas	**386.900**	**-17.3%**	**-19.8%**	**-18.4%**

Figure 43: Effect of line bundling on transport costs in Nijmegen-Maas

As mentioned above, line bundling has a huge effect on the vessel circulation time in Nijmegen-Maas. The delivery speed of the containers decreases which may have a negative influence on the competitive position of container barge transport in the market. A detailed analysis of the effect of line bundling on the vessel circulation time in the 0%-Growth scenario is included in Figure 44. The figure shows that the vessel circulation time increases for almost all inland terminals. Line bundling is only advantageous for CT Nijmegen en WIT Wanssum. This may have to do with the distance between the inland terminals in this sailing area. For example, CT Nijmegen, LCG Gorinchem and CTU Tiel operate a joint liner service to the Port of Rotterdam in this experiment. LCG Gorinchem is located at 50 km from the Port of Rotterdam, while the distance of CT Nijmegen is equal to 120 km. The situation in Nijmegen-Maas is compared with the one in Groot-Amsterdam, because the terminals in Groot-Amsterdam are located at a relatively short distance of each other (excluding CTU Utrecht). The analysis is included in Appendix 24. The appendix shows that line bundling has a positive effect on the delivery speed of the containers for all terminals in Groot-Amsterdam, except CSY Ijmuiden and MEO Velsen-Noord. This may have to do with the increase in vessel size. These terminals are relatively small so small vessels are used in the present situation. The analysis shows that transport costs per TEU of the barge services are closely related to the vessel circulation time. This suggests that line bundling is only attractive for terminals that are located close to each other. When the distance between the terminals is large, a vessel has to sail many kilometers half full which has a negative influence on the efficiency of the barge services.

Inland Terminal	Distance (km)	Direct service	Line bundling	Difference (in hours)
CTS Stein	236	218.9	278.0	59.1
CT Cuijk	125	114.3	208.6	94.4
CTU Tiel	96	127.0	178.0	51.1
TCT Venlo	179	195.4	278.0	82.6
LCG Gorinchem	50	69.7	178.0	108.3
OOC Oss	102	133.3	208.6	75.4
CT Nijmegen	120	235.9	178.0	-57.9
WIT Wanssum	157	242.7	208.6	-34.1
BT Born	226	276.7	278.0	1.3
Nijmegen-Maas	**143**	**179.3**	**221.5**	**42.2**

Figure 44: Effect of line bundling on transit time in Nijmegen-Maas (0%-Growth scenario)

5.4.4 West-Brabant

West-Brabant is the largest sailing area in the Netherlands. One of the main characteristics of West-Brabant is its waterway limitations. The terminals in West-Brabant are located at a relatively short distance from Rotterdam. Consequently, the terminals are faced with fierce competition of trucking companies. The current network configuration in West-Brabant is presented in Figure 45. This research has identified three alternative bundling scenarios for inland terminals in West-Brabant which are:

Scenario 1: The first scenario implies the implementation of liner services. In this scenario, IT Veghel, CT Den Bosch and ROC Waalwijk will offer a joint liner service to the Port of Rotterdam. The same concept will be applied to MCT Bergen op Zoom, CCT + MCT Moerdijk and DMT Moerdijk. Barge Terminal Tilburg (Terminal Loven & Dependance Vossenberg) and OCT Oosterhout also cooperate in this scenario.

Scenario 2: In the second scenario, a hub-and-spoke network will be implemented in West-Brabant. The inland terminals in Moerdijk are located at the crossroad of a good navigable waterway (VI-class). Both terminals in Moerdijk are thus well-positioned to develop as hub terminal in the near future. CCT + MCT Moerdijk has an annual capacity of 1.00.000 TEU, while the capacity of DMT Moerdijk is just 400.000 TEU per year (see Appendix 17). For that reason, CCT + MCT Moerdijk is selected as hub terminal for this research.

Scenario 3: Three inland terminals in West-Brabant are located along so-called *"capillaries"*, namely BTT Tilburg, IT Veghel and ROC Waalwijk (see section 2.4.4). In the final scenario, a feeder service connecting BTT Tilburg with OCT Oosterhout will be implemented. In Oosterhout, the containers are transshipped to larger vessels and continue their way to the Port of Rotterdam. Also, a feeder service connecting IT Veghel with LCG Gorinchem and a trunk service connecting LCG Gorinchem with the Port of Rotterdam will be implemented. The same concept will be applied to CCT + MCT Moerdijk and ROC Waalwijk, while all other terminals maintain their own barge services to Rotterdam.

Figure 45: Network structure in West-Brabant

Given the fact that the terminals in West-Brabant are faced with fierce competition of trucking companies, it is interesting to analyze the effect of the alternative bundling scenarios on the cost performance of container barge transport. The effect of bundling on the transport costs and CO_2 emissions per TEU in the 0%-Growth scenario is schematically presented in Figure 46. The figure shows that the bundling of container flows results in a reduction of the CO_2 emissions. The implementation of a hub-spoke network will result in a CO_2 reduction of 49.7%. A reduction of 22.1% can be realized in trunk-feeder network and 12.9% in a line network. The bundling of container flows would thus be favorable for the competitive position of container barge transport, because shippers increasingly focus on sustainability (see section 2.6). The transport costs per TEU remain more or less the same in West-Brabant. A closer analysis reveals that the transport costs decrease with 0.7% in a line network and 2.2%

in a hub-spoke network. The costs savings are the largest in a trunk-feeder network, namely 4.8%. This is a remarkable, because a large positive price effect can be observed in all other sailing areas.

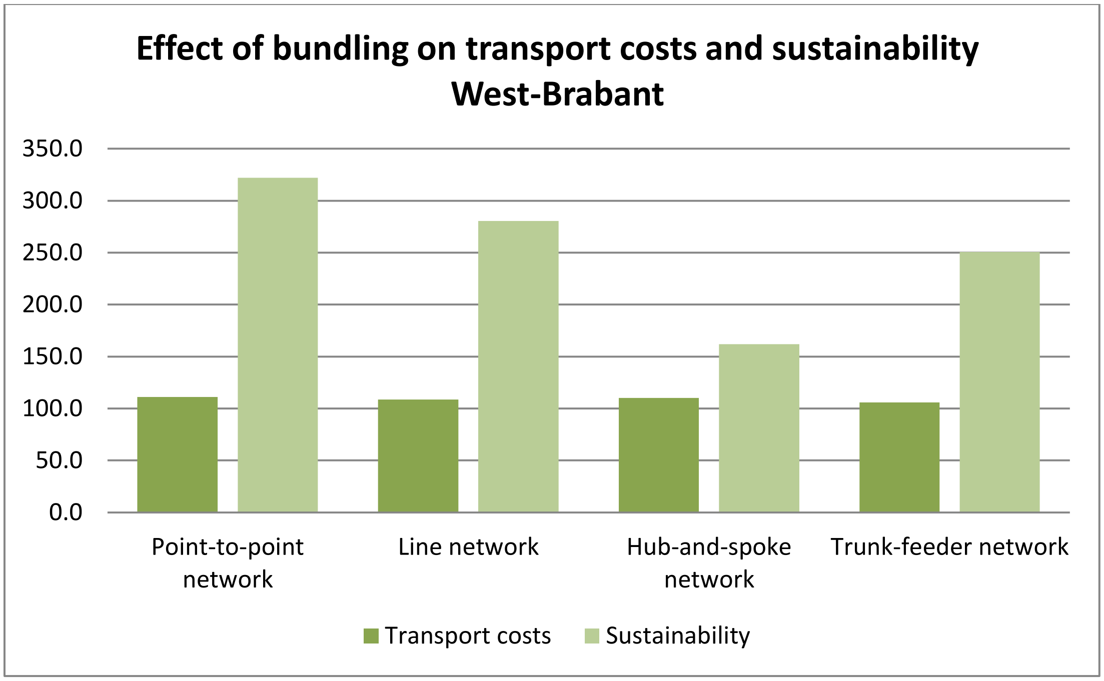

Figure 46: Effect of bundling on transport costs and sustainability in West-Brabant (0%-Growth scenario)

Figure 47 shows that the effect of bundling on transport costs in West-Brabant for the RC-scenarios. The results for the SE-scenarios are included in Appendix 23. Considering a hub-spoke network, it can be observed that the transport costs will increase substantially for a number of terminals: DMT Moerdijk, OCT Oosterhout and MCT Bergen op Zoom. These are relatively large terminals in the Netherlands. The results suggest that the size of a terminal influences the cost effectiveness of a hub-spoke network, because of additional handlings costs which is in line with the analysis of Noord-Nederland and Groot-Amsterdam. A remarkable observation is that the transport costs for CT Den Bosch decline, while this is also a large inland terminal. This terminal is only accessible for vessels up to 90 TEU which may explain why this terminal benefits from a hub-spoke concept. Overall, the transport costs will decrease with 3.9% in the RC-scenario 2015 and 2% in the RC-scenario 2025. In the SE-scenario 2025, the transport costs will increase with about 12.1%, because of capacity problems at the hub terminal CCT + MCT Moerdijk (see Appendix 23). Figure 47 also shows that the implementation of liner services is favorable for the container barge transport sector in West-Brabant. The transport costs will decrease with approximately 8.3% in the RC-scenario 2015 and with 2.4% in the RC-scenario 2025. However, it is important to mention that not all parties will benefit from line bundling which makes it complex to implement the network from an organizational perspective. The transport costs for OCT Oosterhout, ROC Waalwijk and CT Den Bosch increase in the RC-scenario 2015. This may have to do with the waterway limitations in West-Brabant. For example, ROC Waalwijk, IT Veghel and CT Den Bosch offer a joint liner service to the Port of Rotterdam in this experiment. IT Veghel is only accessible for vessels up to 24 TEU (Kempenaar), which limits the economies of scale that can be achieved through line bundling.

		RC-scenario 2015		RC-scenario 2025	
Inland Terminal	Volume PoR (TEU)	Line bundling	Hub-&-Spoke	Line bundling	Hub-&-Spoke
BTT Vossenberg	40.000	-9.5%	-12.8%	13.0%	-10.8%
IT Veghel	45.000	-21.2%	-24.1%	-20.8%	-21.9%
ROC Waalwijk	50.000	15.6%	-5.9%	2.8%	-12.8%
BTT Tilburg	55.000	-14.5%	-14.5%	2.4%	-16.1%
MCT Bergen op Zoom	56.000	-12.5%	46.8%	-4.0%	80.0%
DMT Moerdijk	60.000	-35.3%	10.6%	-35.8%	23.9%
CT Den Bosch	84.000	4.7%	-10.1%	4.6%	-8.0%
CCT + MCT Moerdijk	90.000	-23.4%	-17.4%	-30.3%	-16.3%
OCT Oosterhout	104.000	31.0%	25.7%	47.1%	15.9%
West-Brabant	**584.000**	**-8.3%**	**-3.9%**	**-2.4%**	**-2.0%**

Figure 47: Effect of bundling on transport costs in West-Brabant

As stated in section 2.4.4, the implementation of a trunk-feeder network is an interesting alternative for inland terminals located along small waterways. It may result in costs advantages, because of a better utilization of the vessels on the trunk haul. In Figure 48, the effect of a trunk-feeder network on the transport costs is presented. Only the results for terminals involved in this scenario are included in the figure. The implementation of a trunk-feeder network has a positive effect for BTT Tilburg and OCT Oosterhout. In the 0%-Growth scenario, the transport costs for BTT Tilburg decline with 13.0% and for OCT Oosterhout with 13.8%. It is interesting to note that OCT Oosterhout benefits from a trunk-feeder network, while it does not benefit from a line and hub-spoke network which was illustrated in Figure 47. The implementation of a trunk-feeder network also has a positive effect on IT Veghel and LCG Gorinchem. In the 0%-Growth scenario, the transport costs for LCG Gorinchem decline with 9.0% and for IT Veghel with 22.9% compared to the present situation. A remarkable observation is that the transport costs for ROC Waalwijk and CCT + MCT Moerdijk increase in a trunk-feeder network. This may have to do with the capacity of the vessel that can be deployed on the feeder-haul. BTT Tilburg and IT Veghel are located along a CEMT-class II waterway and are only accessible for 24 TEU-vessels. In contrast to IT Veghel and BTT Tilburg, ROC Waalwijk is located along a CEMT-class III waterway and accessible for vessels up to 48 TEU. The results for the SE-scenarios are quite similar and included in Appendix 23.

Inland Terminal	CEMT-class	Volume PoR (TEU)	0%-Growth	RC-scenario 2015	RC-scenario 2025
BTT Tilburg	II	55.000	-13.0%	-13.6%	-17.9%
OCT Oosterhout	V	104.000	-13.8%	-3.6%	-3.0%
IT Veghel	II	45.000	-22.9%	-19.2%	-21.7%
LCG Gorinchem [1]	V	35.000	-9.0%	-0.5%	-17.0%
ROC Waalwijk	III	50.000	11.9%	5.6%	5.2%
CCT + MCT Moerdijk	VI	90.000	7.2%	-3.3%	-5.4%

Figure 48: Effect of trunk-feeder services on transport costs in West-Brabant
1: LCG Gorinchem is located along a CEMT-class VI waterway in reality (see Appendix 12 for more information)

The results of this analysis show that the implementation of a trunk-feeder network could be advantageous for sailing areas characterized by waterway limitations. The transport costs for both OCT Oosterhout and BTT Tilburg decline, because the vessels are better utilized on the trunk haul. The efficiency of the vessels on the trunk haul increases from 78% to 93% in the 0%-Growth scenario which is illustrated in Figure 49. The same applies to LCG Gorinchem and IT Veghel whereby the efficiency of the vessels increases from 75% to 89% in the 0%-Growth scenario. Figure 49 shows that the implementation of trunk-feeder services provides an opportunity to increase the service frequency of the barge services to the Port of Rotterdam. This is especially the case for OCT Oosterhout. The service frequency of LCG Gorinchem reduces in the 0%-Growth scenario. LCG Gorinchem currently has too little volume to operate a 208 TEU vessel, so 90 TEU vessels are used in the present situation. Through bundling, it is possible to deploy 208 TEU vessels, but at the costs of a lower service frequency.

Scenario	Service	*LCG Gorinchem* Frequency	% Efficiency	*OCT Oosterhout* Frequency	% Efficiency
0%-Growth	Point-Point	4.8	75%	6.1	78%
	Trunk-Feeder	4.2	89%	8.0	93%
RC-scenario 2015	Point-Point	5.2	82%	10.3	87%
	Trunk-Feeder	5.1	87%	13.5	92%
RC-scenario 2025	Point-Point	3.1	73%	10.8	84%
	Trunk-Feeder	6.3	89%	16.2	91%

Figure 49: Effect of trunk-feeder services on service frequency and efficiency in West-Brabant

5.5 Vertical integration of deep sea actors

Until now, the involvement of deep sea actors in container barge transport in the Netherlands is still limited, but it can be observed that this situation is gradually changing. It is assumed that the available container volumes for inland terminal operators in the Netherlands will decrease with about 25% when deep sea actors start to offer their own dedicated barge services. This is in line with the findings of BCTN. They have calculated that BCTN will lose a third of its turnover as a consequence of the increasing involvement of deep sea actors in container barge transport (Bertwin Zonneveld, personal communication, January 8, 2014). This section analyzes the effect of vertical integration on the performance of container barge transport. Appendix 25 and 26 provide a detailed overview of the performance indicators per bundling scenario in the different time periods under vertical integration.

Figure 50 shows the effect of vertical integration on the performance indicators within a point-to-point network in the 0%-Growth scenario. It becomes clear that the service frequency in Nijmegen-Maas and West-Brabant decreases, because of vertical integration. However, the service frequency in Noord-Nederland and Groot-Amsterdam remains more or less the same, while the opposite was expected. The effect of vertical integration on the service frequency has been analyzed for Noord-Nederland in more detail (see Appendix 27). Noord-Nederland and Groot-Amsterdam are relatively small sailing areas in terms of transshipment volume compared to the others. As a consequence of vertical integration, some inland terminal operators in these sailing areas have to adapt their vessel capacity to offer an attractive barge product to shippers. Therefore, they can offer the same service frequency as before. The increasing involvement of deep sea actors will have a positive effect on the reliability of the barge services. However, the results for Noord-Nederland are contradicting which may have to do with the size of this sailing area. Another observation is that the transport costs per TEU will increase substantially in this area. The transport costs in Noord-Nederland increase with approximately 8.9%, while the transport costs in West-Brabant increase with just 0.9% in the present situation. The same applies to the CO_2 emissions per TEU. This is remarkable and will be analyzed in more detail below.

Indicator	Unit of analysis	Noord-Nederland	Groot-Amsterdam	Nijmegen-Maas	West-Brabant
Frequency	Number	0.28	0.36	-0.85	-1.67
Reliability	Hours	-3.19	0.37	0.35	0.26
Transport costs	%	8.9%	6.4%	3.0%	0.9%
Sustainability	%	9.2%	6.0%	3.1%	3.2%
Transit time	Hours	12.96	-13.20	7.41	-11.43

Figure 50: Effect of vertical integration on performance indicators in a point-to-point network (%0-Growth scenario)

The effect of vertical integration of deep sea actors on transport costs within a point-to-point network over time is schematically presented in Figure 51. The figure illustrates that vertical integration could be harmful for inland terminal operators in the Netherlands. This is especially the case for inland terminals in Noord-Nederland and Groot-Amsterdam. In the RC-scenario 2015, the transport costs in Noord-Nederland increase with approximately 6.7% and in Groot-Amsterdam 5.4%. The results for Nijmegen-Maas are conflicting. The transport costs increase with just 1% in the RC-scenario 2015, while a price effect of 7.2% can be observed in the RC-scenario 2025. Therefore, it is hard to draw a conclusion about the effect of vertical integration on the transport costs in Nijmegen-Maas based on the graph. It can be observed that there is hardly any price effect in West-Brabant. Section 4.2.1 showed that West-Brabant is the largest sailing area in the Netherlands, while Noord-Nederland and Groot-Amsterdam are relatively small in terms of transshipment volume. This suggests that large inland terminals are better positioned to deal with the increasing involvement of deep sea actor in container barge transport. Appendix 28 provides an overview of the effect of vertical integration on the service frequency in a point-to-point network over time. As discussed above, there is hardly any effect on the service frequency in Noord-Nederland and Groot-Amsterdam. The results for Nijmegen-Maas are again a bit conflicting. Considering West-Brabant, it can be observed that the service frequency will decrease, but it remains possible for large terminals in this region to maintain a daily barge service to the Port of Rotterdam.

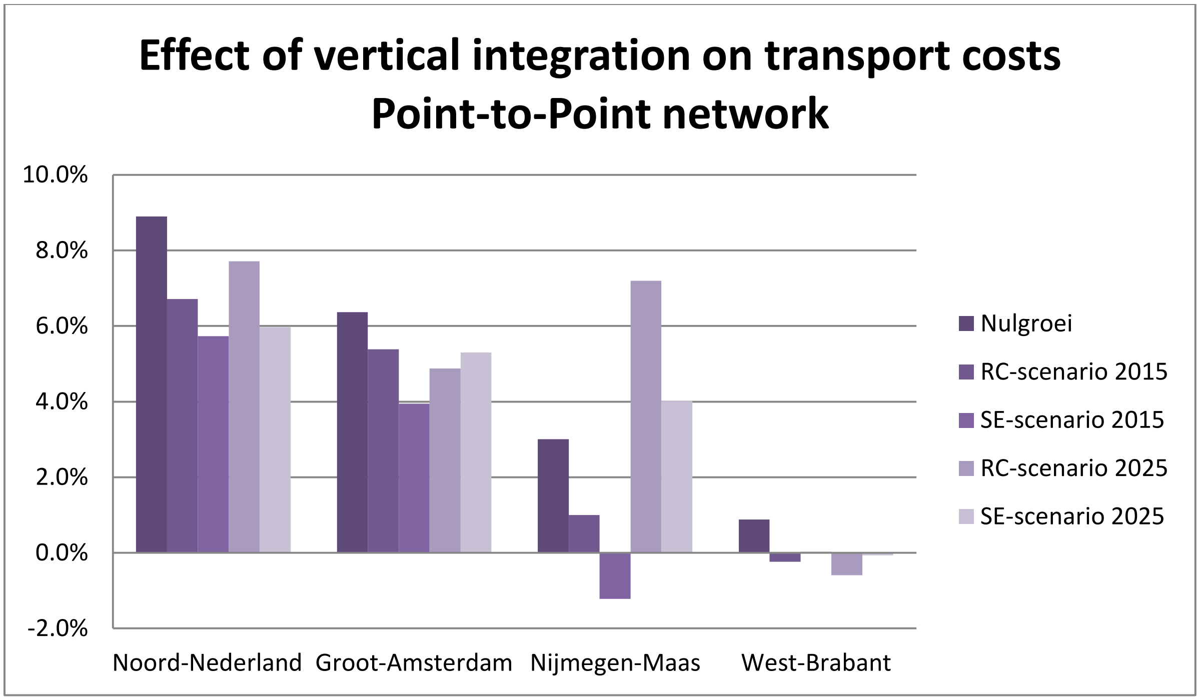

Figure 51: Effect of vertical integration on transport costs in a point-to-point network

To analyze the effect of vertical integration of deep sea actors on transport costs in more detail, the inland terminals are categorized in three sub categories: supra-regional terminals, regional terminals and local terminals (inspired by A&S Management et al., 2003b). The 10 largest inland terminals in the Netherlands are classified as supra-regional terminals. Section 4.4.1 has made a distinction between low-profile and full-service terminals. In that particular section, all inland terminals which handle less than 20.000 TEU per year were classified as low-profile terminals. These terminals are categorized as local terminals for the purpose of this analysis. All other inland terminals in the Netherlands are included in the category "regional terminals". Figure 52 shows the effect of vertical integration of deep sea actors on transport costs for all sub categories in a point-to-point network. In the RC-scenario 2015, the transport costs for regional terminals increase approximately with 2.2% and for local terminals 7.6%. In contrast, hardly any price effect can be observed for supra-regional terminals. The figure illustrates that the increasing involvement of deep sea actors is only harmful for local terminals and to a lesser extent for regional terminals. Appendix 29 provides a detailed overview of the effect of vertical integration on transport costs for all sub categories.

Scenario	Supra-regional terminals	Regional terminals	Local terminals
0%-Growth	3.0%	2.8%	9.8%
RC-scenario 2015	-0.2%	2.2%	7.6%
SE-scenario 2015	-2.4%	2.3%	5.1%
RC-scenario 2025	-0.4%	4.6%	10.5%
SE-scenario 2025	1.6%	4.9%	4.9%

Figure 52: Effect of vertical integration on transport costs in a point-to-point network

Figure 51 showed that vertical integration of deep sea actors could be harmful for inland terminal operators in the Netherlands, especially for small inland terminals in Noord-Nederland and Groot-Amsterdam. The question is whether this is also the case when alternative bundling scenarios are considered. Figure 53 illustrates the effect of vertical integration of deep sea actors on transport costs in a line network over time. It becomes clear that the price difference in Noord-Nederland and Groot-Amsterdam is smaller in all scenarios in comparison within a point-to-point network. In the RC-scenario 2015, the transport costs in Noord-Nederland increase with just approximately 1.8% and in Groot-Amsterdam with 1.4%. In Noord-Nederland, only 90 TEU-vessels can be deployed in a line network because of waterway and quay limitations. Even when the demand for container barge transport decreases with 25%, it is possible to deploy these kinds of vessels in near future. These results suggest that the bundling of containers provides an opportunity for inland terminal operators in the Netherlands to deal with the increasing involvement of deep sea actors in container barge transport. The results for West-Brabant are remarkable. In the RC-scenario 2025, a negative price effect of approximately 7.2% can be observed. This has to do with terminal capacity problems. OCT Oosterhout and MCT Bergen op Zoom currently have insufficient resources available to handle the forecasted container volume in 2025 (see section 5.3 for an explanation). Appendix 30 provides an overview of the effect of vertical integration on the service frequency in a line network. It can be observed that the service frequency will decrease, but that remains possible to maintain a daily liner service to the Port of Rotterdam.

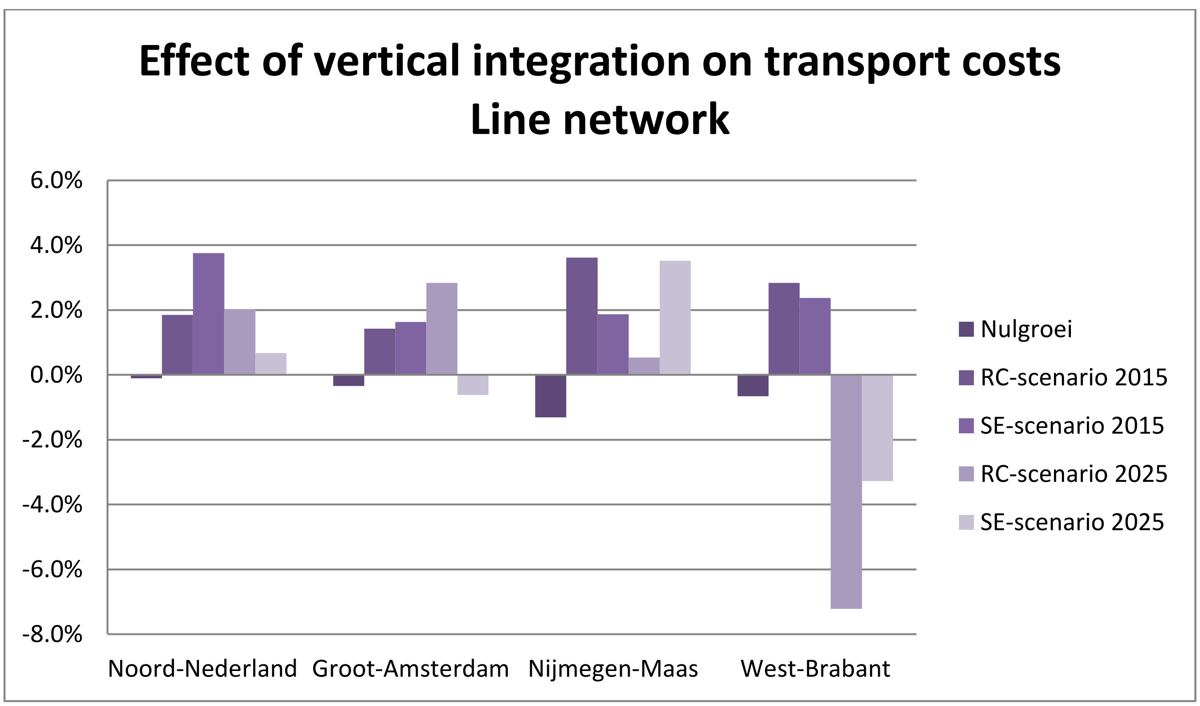

Figure 53: Effect of vertical integration on transport costs in a line network

The results mentioned above suggest that the bundling of containers provides an opportunity for inland terminal operators in the Netherlands to deal with the increasing involvement of deep sea actors in container barge transport. This is interesting, especially for the continuity of local terminals. Figure 54 confirms that there is hardly any price effect for local terminals in a line network. In the 0%-Growth scenario, the transport costs increase approximately with 1.5% in a line network and 3.5% in a hub-spoke network. The effect of vertical integration on the performance of a hub-spoke network and a trunk-feeder network will not be discussed further in depth, because the results are comparable with a line network. Only the price effect is smaller in a hub-spoke and trunk-feeder network. The results for these networks are included in Appendix 31 (hub-spoke network) and 32 (trunk-feeder network).

Inland Terminal	Sailing area	Volume (TEU)	Direct service	Line bundling	Hub-&-Spoke
Wijnne & Barends Delfzijl	Noord-Nederland	2.500	4.3%	-2.5%	-1.1%
CSY Ijmuiden	Groot-Amsterdam	8.500	19.3%	0.4%	6.8%
CT Cuijk	Nijmegen-Maas	10.000	17.2%	-	-
CT Heerenveen	Noord-Nederland	12.000	30.9%	4.9%	5.7%
MEO Velsen-Noord	Groot-Amsterdam	15.000	16.4%	0.4%	6.9%
MCS Leeuwarden	Noord-Nederland	15.000	19.8%	4.9%	6.1%
CTS Stein	Nijmegen-Maas	20.000	-3.0%	-	-
ROC Kampen	Noord-Nederland	20.000	-7.5%	-2.6%	0.2%
	Total volume:	**103.000**	**9.8%**	**1.5%**	**3.5%**

Figure 54: Effect of vertical integration on transport costs in the alternative bundling scenarios
(Local terminals in 0%-Growth scenario)

5.6 Final remarks

This research assumes that the available container volumes for all inland terminal operators in the Netherlands will decrease with about 25% when deep sea actors start to offer their own dedicated barge services. However, not all inland terminal operators will lose the same percentage in practice which is important to keep in mind by interpreting the results of this research. First, a deep sea carrier is one of the customers of an inland terminal operator. It is expected that the increasing involvement of deep sea actors in container barge transport is particularly harmful for inland terminals that handle a large proportion of carrier haulage. Second, deep sea actors will particularly focus on inland terminals in the Netherlands that serve large consumer markets or whereby large shippers are located in the region such as FrieslandCampina, Dell and Heineken. Therefore, it is expected that the vertical integration of deep sea actors is more harmful for small inland terminals in large sailing areas, such as West-Brabant and Nijmegen-Maas. Third, more vertical integration is expected in regions where a lot of cost savings can be achieved through the repositioning of empty containers on local scale, because this is one of the most important reasons for deep sea carriers to get involved in the hinterland (see section 2.2.2).

6. Future of inland terminal operators in the Netherlands

To gain a deeper understanding of the main topics of this research and to formulate an answer to the sub question: "*In which way can inland terminal operators maintain their current market position?"*, some interviews with experts in the container barge transport sector were conducted during the final phase of this research. A detailed description of the interviews is included in Appendix 33 (in Dutch). Section 6.1 elaborates on the future development of the container barge network and section 6.2 on the increasing involvement of deep sea actors in container barging. The hindering factors for a successful cooperation between inland terminal operators will be discussed in section 6.3. Section 6.4 discusses in which way inland terminal operators can deal with the increasing involvement of deep sea actors in container barging. Section 6.5 presents an overview of the major developments in container barging.

6.1 Development of container barge network

Currently, most inland terminals operators in the Netherlands offer a point-to-point service to the Port of Rotterdam (see Figure 55). In the port, a barge calls at multiple terminals to collect and distribute all containers. The opening of Maasvlakte II, the modal shift ambitions of the Rotterdam Port Authority and increasing containerization are opportunities for container barge transport sector in the Netherlands. It is expected that the demand for container barge transport will grow considerably in the near future, because of limited road and rail capacity. However, the barge handling problems in the Port of Rotterdam are a serious threat for the current market position of container barging. The size of seagoing vessels increases and the number of container terminals in the port will increase after the opening of the Maasvlakte II which stresses the need for the bundling of container flows. Therefore, it is expected that new service network types will be developed in near future. The following question was asked to interviewees: *What is your future vision about the container barge network in the Netherlands?*

For experts, the effect of the opening of the Maasvlakte II on the efficiency of their barge services is still unclear. On one hand, the new container terminals are better equipped to facilitate container barging. Furthermore, deep sea terminal operators will possibly pay more attention to barge handling, because of the overcapacity in Rotterdam. On the other hand, the opening of new terminals implies a further fragmentation of container flows in the port and an increase in the number of stops per roundtrip which influences the vessel circulation time. Two interviewees expect that the number of empty depots in Rotterdam city will decrease in near future, because of the clustering of volume at Maasvlakte II. Most experts expect that more container flows will be bundled in future. Some experts argue that large inland terminal operators will be in the position to offer a dedicated barge service to container terminals, because of growing container volumes. As such, they can deal with the barge handling problems in the port. In practice, a combination of different bundling network will emerge which is schematically shown in Figure 55. Most experts regard line bundling as the most appropriate network type and have a negative stance concerning hub-spoke concepts, because of the additional handling costs. They state that hub-spoke concepts are only possible when the containers are handled against marginal costs at the hub. Furthermore, the implementation of line bundling is easier from an organizational perspective.

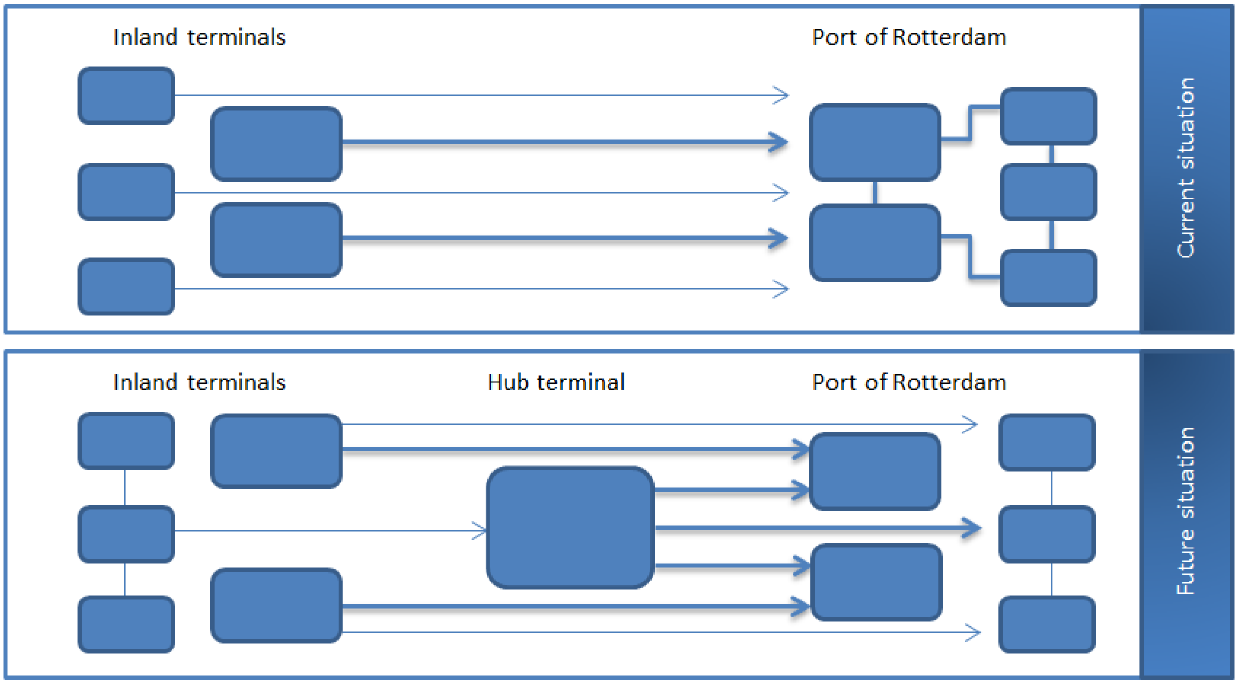

Figure 55: Potential future development of container barge network

6.2 Increasing involvement of deep sea actors

In the Netherlands, the organization and planning of the barge services is usually in hands of inland terminal operators. The previous chapter showed that the increasing involvement of deep sea actors in container barge transport is a serious threat for the current market position of inland terminal operators in the Netherlands, especially for small and medium-sized inland terminals. The following question was asked to interviewees: *Do you expect that the increasing involvement of deep sea actors in container barge transport will be a threat for the continuity of inland terminal operators in the Netherlands?*

Most experts expect that deep sea actors will increase their involvement in container barging after the opening of Maasvlakte II, but consider ECT with the European Gateway Services not as a serious player in the hinterland. Other experts do not agree with the findings of this research. They state that deep sea actors currently control too little volume to set up their own barge services. In other words: the share carrier haulage is too low. On mid-term, deep sea actors will have substantial container volumes to set up their barge services, but this is only reserved for the largest deep sea carriers in the world. For experts, it is unclear in which way deep sea actors will set up their hinterland services on short term. Some experts argue that deep sea actors will primarily focus on strategic alliances with inland terminal operators and will use existing concepts. They will choose 5 or 6 strategic parties. The expectation is that deep sea actors will particularly focus on regions that serve large consumer markets or where large shippers are located such as FrieslandCampina, Sony and Heineken. This development will result in a revision of the terminal network: large terminals will survive, while small terminals have to shut down their activities, because they have too little capacity to satisfy a deep sea actor. Others argue that deep sea actors will develop new logistics concepts, but that these concepts will be carried out by third parties, because of the high investment costs and the low return on investment in container barging.

6.3 Hindering factors for cooperation

This research showed that the bundling of container flows will result in cost savings, a reduction of the CO_2 emissions, higher service frequencies and efficiency gains in the port. It also shows that cooperation provides an opportunity for inland terminal operators to create an improved proposition towards other players in the hinterland transport chain. However, most inland terminals operators in the Netherlands still have a negative attitude towards cooperation. Because an in-time delivery is crucial for the service quality of an inland terminal, it is difficult to realize the bundling of container flows. To compare literature with daily practice, the interviewees were asked: *Which factors hinder cooperation in the container barge transport market? And what are the solutions to overcome these barriers?*

The interviewees state that the most important factor hindering cooperation is the lack of trust. Realizing cooperation requires a cultural shift which is a long term process. Some experts argue that cooperation is only plausible when there is little or no competition between the inland terminals, because a lot of inland terminals in the Netherlands are in competition to serve the same inland areas. Furthermore, the unequal distribution of costs and benefits is an important factor hindering cooperation which is in accordance with literature (Van Der Horst & De Langen, 2008). To achieve cooperation, it is important to create a win-win situation for all parties. This research shows that bundling will not always result in cost savings for all parties involved. It also shows that the price effect of bundling is larger for small terminals. This makes it less attractive for large inland terminals to bundle container flows, unless the parties share the benefits. Moreover, information sharing and transparency are very important, but difficult to achieve because of the high investment costs. This factor is also repeatedly mentioned in literature. One interviewee mentioned that a central barge planning is crucial for cooperation. This was not confirmed by others. Furthermore, an incentive for cooperation is lacking. Because of the price pressure in the sector, most actors are focused on daily practice. Other hindering factors are the opening hours of a terminal and inland port charges. This is interesting, because these factors are not often mentioned in literature. Some experts state that a solution to overcome these barriers is to have a neutral party involved in the organizational process that highlights the perspective of all parties.

6.4 Distinctiveness of inland terminal operators

The core business of an inland terminal operator is terminal handling. Inland terminals are an important link in the hinterland transport chain of container barging. However, terminal handling is a relatively homogenous product which makes it difficult for inland terminal operators to generate added value. To differentiate, inland terminal operators in the Netherlands have started to offer barge services to the Port of Rotterdam in the past. However, they have little control over barge handling in the port. It is expected that deep sea actors will have more control over handling in the port, because they organize their network from the port. As such, they are in the position to gain a competitive advantage. This is confirmed by most experts in the sector. They argue that the increasing involvement of deep sea actors will have a negative effect on the barge handling conditions in the port. The barges of deep sea actors will be prioritized, because of the lack of contractual arrangements. Therefore, the interviewees were asked the question: *In which way can inland terminal operators differentiate themselves in the market?*

Some experts state that the scale of an inland terminal will be an important distinguishing factor in future. Large inland terminals that are in the position to offer one-stop services to the Port of Rotterdam will gain a competitive advantage. By setting up a direct service, the inland terminal operators are largely independent of the barge handling problems in the port. Small inland terminals need to focus on bundling. They have to try to reduce the number of calls in the port in such way that this allows them to offer a reliable product. Another opportunity for small inland terminals is to work exclusively for deep sea actors. The experts expect that deep sea actors will never get full control over the hinterland transport chain. Most large shippers currently choose for merchant haulage. Deep sea actors are large and hierarchical organizations. Inland terminal operators have stronger ties with shippers and knowledge of the local market so they are better positioned to respond to the logistics needs of shippers. Other distinguishing factors for an inland terminal operator are flexibility, reliability and a high service level. Inland terminal operators can differentiate from deep sea actors by offering additional logistics services such as customs clearance, planning and warehousing. By offering a complete range of services, inland terminal operators can take over the role of freight forwarders in the hinterland transport chain of container barging and as such, they can maintain their current market position.

6.5 Major development in container barging

To finalize the thesis, the opportunities and threats for inland terminal operators in the Netherlands are mapped. The interviewees were asked the following question: *What is from your perspective the most important development in container barging and why?* The opportunities and threats are summarized in Figure 56. Also, the result of the studies of Decisio (2002), A&S Management et al. (2003b) and Erasmus Smart Port Rotterdam & NEA (2012b) are included to obtain a complete view of the developments in the sector. It became clear from the interviews that numerous factors influence the development of the container barge transport sector. However, just a few of these developments were taken into account in this research such as the modal shift ambitions of the PA and the opening of Maasvlakte II. In which way the container barge network will develop itself exactly in coming years, is unfortunately unpredictable.

Opportunities	Threats
Opening of Maasvlakte II	Barge handling problems
Modal shift ambitions of Rotterdam PA	Increasing involvement of deep sea actors
Increasing containerization (reefers)	Increasing vessel size in maritime sector
Congestion in road transport	Price pressure in road transport
Cooperation	New terminal initiatives
New logistics concepts	Image of container barge transport
Depot function for deep sea carriers	Disappointing economic growth
Professionalization	JIT-deliveries (focus on speed)
Increasing focus on sustainability	Other modalities innovate faster

Figure 56: Opportunities and threats for inland terminal operators in the Netherlands

7. Conclusion

Nowadays, the quality of a port's hinterland infrastructure has become increasingly important for the competitiveness of a container port. To improve the hinterland accessibility of the Port of Rotterdam, the Rotterdam Port Authority aims to achieve a modal split of 45% barge, 35% truck and 20% rail in 2033 at the Maasvlakte port area. Despite these ambitions, the container barge transport sector was not able to increase its share in the modal split in last years, because of a bad performance of barge handling in the port. To gain more control over the hinterland transport chain, deep sea carriers and deep sea terminal operators are now changing their scope towards the hinterland. Although the involvement of deep sea actors in container barge transport is still limited, it is expected that deep sea actors will become more involved in near future, especially when the barge handling problems in the Port of Rotterdam will continue to exist. This has resulted in the following research question which will be answered in this chapter: "*What is the effect of vertical integration of deep sea actors on the performance of container barge transport in the Netherlands in 2015 and 2025?"*

First of all, it is important to mention that deep sea actors have their specific reasons to get involved in hinterland transport. Deep sea carriers are particularly focused on container repositioning issues, while deep sea terminal operators are more focused on terminal efficiency. Nowadays, deep sea carriers face difficulties to warrant their future revenues. The overcapacity in the maritime sector has resulted in a dramatically decrease in freight rates. Consequently, inland costs have increased in importance. To gain control over their container fleet and to generate additional revenues, deep sea carriers are now continuously looking for opportunities to increase the share of carrier haulage. This offers deep sea carriers the opportunity to actively match import- and export flows and to reduce their empty container repositioning costs. In the last few years, deep sea carriers have started to develop dedicated terminals. Consequently, deep sea terminal operators are now losing market share in the terminal handling industry. Because the provision of terminal handling activities is quite a homogenous product, it is hard for deep sea terminal operators to differentiate from competitors. If a deep sea terminal operator finds out how the containers are transported to the hinterland, they can reduce the number of terminal handlings and improve efficiency. Therefore, deep sea terminal operators are now developing inland services.

In the Netherlands, the organization and planning of the barge services is particularly in hands of inland terminal operators. The vertical integration of deep sea actors in container barge transport may give rise to customer foreclosure. This occurs when deep sea actors no longer uses the services of inland terminal operators. As a result, inland terminal operators have less volume available which makes it difficult for them to cover the fixed costs of their barge services and to offer an attractive product to shippers. The available transport volumes influences the way an inland terminal operator design its service network which in turn influences the performance of container barge transport. Actors need to make decisions about the service frequency of the barge services and the vessel size used to transport the containers to the Port of Rotterdam. As there are many ways to transport a container from origin to destination, the decision whether to call at intermediate terminals where container flows can be bundled is also an important issue in service network design. Furthermore, actors need to take the transport market characteristics, terminal characteristics and waterway characteristics into account by designing their service network. The same applies to the service requirements of shippers. Sustainability, transport costs, transit time, reliability and service frequency are important factors influencing the modal choice decision of shippers.

Currently, most inland terminal operators in the Netherlands offer a point-to-point service to the Port of Rotterdam. However, it is expected that the increasing involvement of deep sea actors in hinterland transport will result in a revision of the container barge network. New service network types might emerge. It can be observed that some inland terminal operators in the Netherlands are already rearranging their barge services and develop their own network through horizontal integration. Furthermore, the attitude of inland terminal operators is gradually changing towards more cooperation. Until now, it is unclear in which way inland terminal operators will design their container barge network in future. This has provided the basis for a scenario analysis by means of a simulation tool. For this research, a number of alternative bundling scenarios were identified and the cost effectiveness of these scenarios has been calculated. Four basic bundling networks are applied to the hinterland of the Port of Rotterdam: point-to-point network, line network, hub-and-spoke network and trunk-feeder network.

For an in-depth analysis, the inland terminals in the Netherlands were first classified in four sailing areas: Noord-Nederland, Groot-Amsterdam, Nijmegen-Maas and West-Brabant. Each sailing area has its own distinctive characteristics. The main characteristics of the sailing areas are summarized in Figure 57. West-Brabant is the largest sailing area in the Netherlands. Many large shippers with European distribution centers are located in this area. West-Brabant is characterized by its waterway limitations. The terminals in West-Brabant are located at a relatively short distance from the Port of Rotterdam which has resulted in a fierce competition with trucking companies. Nijmegen-Maas is also a relatively large sailing area in terms of transshipment volume. The terminals in this area are more spread across the region and more efficient compared to terminals in other sailing areas. Noord-Nederland is the smallest sailing area in the Netherlands. A main characteristic of Noord-Nederland is that a lot of small terminals are located in this area (defined as low-profile terminals in Figure 57). The high number of terminal initiatives has resulted in a fierce competition between the terminals. Groot-Amsterdam is also a relatively small sailing area. The service areas of the terminals in Groot-Amsterdam overlap which has resulted in an oversupply. The lowest growth is expected in this area, while the highest growth is expected in West-Brabant.

Factor	Unit of analysis	Noord-Nederland	Groot-Amsterdam	Nijmegen-Maas	West-Brabant
Transshipment volume	% of Total	10%	19%	28%	43%
Sailings to Rotterdam	%	100%	82%	75%	75%
Terminals < 90 km of PoR	% of Volume	0%	19%	10%	94%
Forecasted growth	% RC 2010-2025	56%	43%	62%	132%
Terminals located along small waterways [1]	% of Volume	27%	0%	0%	40%
Low-profile terminals [2]	% of Volume	26%	7%	6%	0%
Terminal capacity	% Used	36%	36%	54%	37%

Figure 57: Main characteristics of the sailing areas

1: Terminals located along CEMT-class II, III and IV waterways | 2: Terminals handling < = 20.000 TEU per year

This research showed that the bundling of container flows allows inland terminal operators to deploy larger vessels, to offer higher service frequencies and to reduce CO_2 emissions. However, bundling has a negative influence on the reliability of barge services, because additional stops need to be made along the route. The results of the analysis for the 0%-Growth scenario are summarized in Figure 58. One of the main conclusions of this analysis is that line bundling as well as hub-spoke services will result in cost savings for all sailing areas. These findings contradict the existing literature which found that a hub-spoke network is only interesting for inland terminals located at a further distance from the port. The analysis showed that the cost savings are larger in a line network, because no additional handling costs are required. Furthermore, the price effect of bundling is larger in small sailing areas which suggest that the size of an inland terminal influences the cost effectiveness of the bundling concepts. Line bundling is especially beneficial for inland terminals that are located close to each other and inland terminals that are not able to deploy large vessels within a point-to-point network, because of waterway limitations or too little demand for container bare transport. Finally, this analysis showed that a trunk-feeder network is an interesting alternative for inland terminals located along small waterways (CEMT-class II).

Sailing area	Line network	Hub-spoke network	Trunk-feeder network
Noord-Nederland	-17.0%	-14.2%	x
Groot-Amsterdam	-20.0%	-14.5%	x
Nijmegen-Maas	-17.3%	x	x
West-Brabant	-2.2%	-0.7%	-4.8%

Figure 58: Effect of bundling on transport costs (0%-Growth scenario)

X: Not applicable

As mentioned before, the vertical integration of deep sea actors results in a smaller addressable market for inland terminal operators. This research has assumed that the available container volumes for inland terminal operators in the Netherlands will decrease with about 25% when deep sea actors start to offer their own dedicated barge services. The results of the analysis for the 0%-Growth scenario are summarized in Figure 59. The analysis showed that a further fragmentation of hinterland flows could be harmful for inland terminal operators in the Netherlands. The vertical integration of deep sea actors is particularly harmful for small inland terminals the Netherlands and to a lesser extent for medium-sized terminals. For the results, it is important to make a distinction between the sailing areas. The analysis showed that the service frequency in Nijmegen-Maas and West-Brabant decreases, because of vertical integration. However, it remains possible for large terminals in these areas to maintain a daily liner service to the Port of Rotterdam. The service frequency in Noord-Nederland and Groot-Amsterdam remains more or less the same. Noord-Nederland and Groot-Amsterdam are relatively small sailing areas compared to the others. As a consequence of vertical integration, inland terminal operators in these areas have to adapt the capacity of their vessels. As such, they can offer the same service frequency as before, but against higher costs. So, the transport costs will increase substantially for inland terminals in Noord-Nederland and Groot-Amsterdam. However, hardly any price effect can be observed in West-Brabant. The analysis also showed that the costs hardly increase in a line network. This suggests that the bundling of containers provides an opportunity for inland terminal operators in the Netherlands to deal with the increasing involvement of deep sea actors in container barge transport.

Sailing area	Point-to-point network	Line network	Hub-spoke network	Trunk-feeder network
Noord-Nederland	8.9%	-0.1%	2.1%	x
Groot-Amsterdam	6.4%	-0.3%	6.4%	x
Nijmegen-Maas	3.0%	-1.3%	x	x
West-Brabant	0.9%	-0.7%	0.8%	2.6%

Figure 59: Effect of vertical integration on transport costs (0%-Growth scenario)
X: Not applicable

Most experts in the container barge transport sector argue that deep sea actors currently control too little volume to offer an attractive barge product to shippers, but they expect that this will change after the opening of Maasvlakte II. It is expected that deep sea carriers and deep sea terminal operators will have a great interest to concentrate their container volumes to a limited number of preferred inland terminals. They will particularly focus on terminals in sailing areas that serve large consumer markets, such as West-Brabant and Nijmegen-Maas. The increasing involvement of deep sea actors will thus particularly be unfavorable for small and medium-sized inland terminals in these areas. From the perspective of shippers, the increasing involvement of deep sea actors in container barge transport is advantageous. Shippers can choose between different logistics concepts which may increase the attractiveness of container barging with respect to other modalities. It is expected that the rates will drop further. This will have an adverse effect on the container barge transport sector. A number of inland terminal operators will no longer be able to compete against market rates. It is expected that some inland terminals have to shut down their activities unless they find other ways to generate added value (for example through the provision of warehousing or custom clearance). The distance between an inland terminal and shipper will increase as a consequence of this development. Because of the large costs of pre- and post-truck haulage, this will favor road transport on short distances which may have a negative influence on the share of container barging in the modal split. The vertical integration of deep sea actors could thus be harmful for the container barge transport sector in the Netherlands as a whole.

8. Recommendations for further research

During this research, a lot of experiments with the simulation tool are done. Together with the interviews, this has provided insight in which topics are interesting for further research and in which way the simulation tool of the IDVV project needs to be adjusted for future application. Section 8.1 discusses the limitations of the simulation model and section 8.2 presents some recommendations for further research.

8.1 Extension of the simulation tool

First of all, an assumption of the simulation tool is that import- & export flows are completely balanced. However, this is certainly not the case in practice. Ab Ovo and Panteia (2013) argue that trade imbalances have a major impact on the optimal network structure. It would be interesting to extent the simulation model with empty container repositioning issues. Second of all, inland port charges should be included in the cost calculation of the simulation model. Notteboom (2008b) argues that inland port charges influence the decision to call at other inland terminals in the hinterland. This is confirmed by Richard Klaassen of Markiezaat Container Terminal (personal communication, January 14, 2014). Furthermore, locks and bridges should be included in the model. Experiments have shown that the inclusion of obstacles in the simulation tool results in unreliable output. Konings (2003) argues that the presence of low bridges and locks in the waterway infrastructure directly influences the vessel circulation time and the reliability of the barge services which is especially the case in sailing areas West-Brabant and Noord-Nederland. This is also confirmed by Richard Klaassen. He notes that the openings hours of the Burgemeester Peterssluis hinder a direct access to the Theodorushaven where the inland terminal is located. In addition, most experts in the container barge transport sector expect that large inland terminals will be in the position to offer one-stop services to the Port of Rotterdam in the future. In the original version of the simulation tool, it is not possible to select container terminals in the Port of Rotterdam and to make a distinction between the Maasvlakte and Rotterdam city terminals. It would be interesting if the possibility exist in the simulation model to set up dedicated barge services to container terminals and to examine how this decision influences the feasibility of the bundling concepts. Moreover, an assumption of the simulation model is that barges are completely loaded and unloaded at the hub terminal. However, this is actually not the case in practice. In practice, a barge calls at a hub terminal where it exchanges some containers. For example, it drops 10 containers for ECT and loads 15 containers which need to be transported to APM Terminals. After loading and unloading, the barge continues its way to the Port of Rotterdam. It would be interesting to analyze under which conditions such a concept is an attractive alternative to a point-to-point network. Finally, one of the limitations of the simulation tool is that the vessel turnaround times are very unrealistic. The same applies to the number of stops in the Port of Rotterdam. This has partly to do with one of the assumptions of the simulation model. Barges are first completely unloaded before a barge operator starts with the loading process. In some cases, a barge needs to call multiple times at a terminal in the port. Furthermore, no barges call at the terminals Pernis Combi Terminal, Waalhaven depot (Westzijde), Medrepair Barge Center and Mainport Rotterdam Services which is an error in the simulation tool. To evaluate the effect of bundling on the efficiency of barge handling in Rotterdam, a closer analysis is recommended.

8.2 General topics for further research

First of all, it would be interesting to investigate the effect of new terminal initiatives on the container barge network in the Netherlands. Although a lot of small inland terminals are already located in the Netherlands, the expectation is that the number of inland terminals will increase further in the near future (A&S Management et al., 2003b). For example, Nieuwsblad Transport (2013) has recently announced the development of a new container terminal in Lelystad. Kreutzberger and Konings (2013) argue that a new inland terminal may create additional flows for container barge transport, especially when an inland terminal is in the position to achieve a high throughput without cannibalizing the market of neighboring terminals. Some experts in the container barge transport agree with the statement of Kreutzberger and Konings (2013). Others have the opinion that an expansion of the terminal network will result in a further fragmentation of container flows which has a negative influence on the cost effectiveness of the barge services. Second of all, some experts state that cooperation is only plausible when there is little or no competition between the inland terminals (TNO et al., 2012), because a lot of inland terminals in the Netherlands are in competition to service the same inland areas. This research showed that line bundling is especially interesting for inland terminal located close to each other. The opening hours of a terminal and inland port charges were identified by the experts as hindering factors for cooperation, while these factors are not repeatedly mentioned in literature. It would be interesting to investigate thoroughly under which conditions cooperation between regions or sailing areas is feasible and which factors hinder cooperation. Furthermore, a shipper is the most important player in the hinterland transport chain of container barging. A shipper generates the demand for transport and determines in the end which actor is responsible for the inland leg. Traditionally, the proportion between carrier and merchant haulage was about 70%-30%. However, this situation has changed and the percentage of carrier haulage is currently about 30% on the European continent (Notteboom, 2008a). Although a lot of research has been done on the factors influencing the modal choice decision of shippers, it would be interesting for further research to investigate which factors influence the decision between merchant and carrier haulage. Finally, this research showed that deep sea actors are nowadays changing their scope towards the hinterland. Deep sea actors have their specific reasons to get involved in hinterland transport. De Langen (2010) argues that actors in the hinterland transport chain design their network in line with their underlying business model. The expectation is that deep sea actors will focus on a limited number of preferred inland terminals in the hinterland and will have more control over the handling of barges in the port compared to inland terminal operators. To set up an attractive barge product, deep sea actors need to control substantial container volumes. Some experts in the container barge transport sector state that deep sea actors currently control too little volume to increase their influence in container barge transport in future at all. It would be interesting to investigate by which actor container barge transport can be best organized and to what extent deep sea actors are in the position to offer a competitive barge product to shippers.

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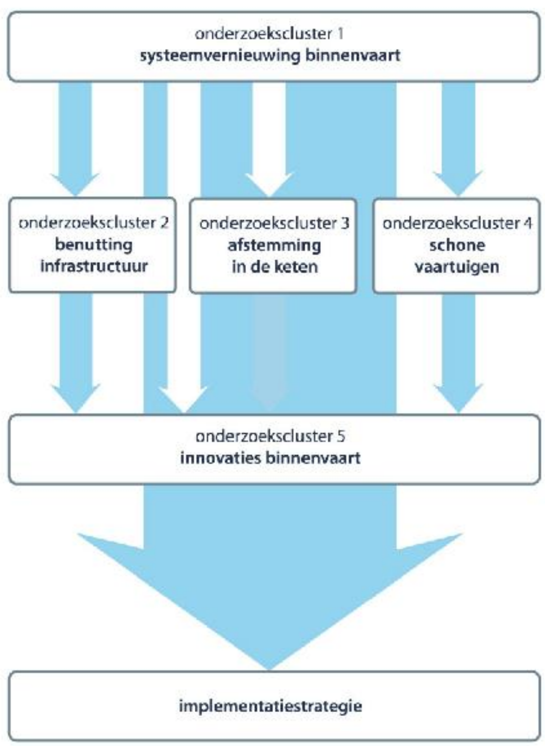
10.Appendices

Appendix 1: Short description of IDVV project

The simulation tool used in this research is developed by the Delft University of Technology. It is part of the IDVV project of Rijkswaterstaat (Translation IDVV: Impulse Dynamic Traffic Management Waterways). As a result of congestion problems in the Rotterdam port area, a modal shift from truck to barge is necessary to facilitate future growth and to maintain the competitive position of the Port of Rotterdam. The main goal of the IDVV project is to strengthen the position of container barge transport in the market in such way that more actors will choose for container barge transport in the future. The IDVV project can be divided into a number of clusters. The research program is schematically presented below (in Dutch). The development of the simulation tool is part of cluster 3 "*Cooperation in supply chains*". This cluster investigates which measures are needed to improve the efficiency and reliability of container barge transport. The simulation tool takes the current situation as starting point. By means of the simulation tool, the effect of the different developments in the sector on the performance of container barge transport can be calculated. The tool can be used to simulate among others the effect of the involvement of new actors in the sector, an expansion of the terminal network, increasing container volumes and cooperation between inland terminal operators in the Netherlands.



Appendix 2: Hinterland markets

The successful development of the container barge transport sector in the Netherlands can be largely ascribed to the favorable natural conditions of the Port of Rotterdam. It is connected to a high-quality and dense waterway network in the Netherlands and is located along the Rhine. According to A&S Management et al. (2003a), three hinterland markets for container barge transport through the Port of Rotterdam can be distinguished: the Rhine river market, the Rotterdam-Antwerp market and the domestic market. This classification is based on organizational and operational differences. Konings (2006) argues that the characteristics of the different hinterland markets determine to a large extent the type of barge service that is offered. This appendix will describe the different markets in more detail.

Rhine river market

The Rhine river market consists of the transport of containers between the Port of Rotterdam and large industrial and consumer markets in Germany. This market can be split up into three different navigation areas based on operational differences: Lower Rhine, Upper Rhine and Middle Rhine. Cooperation between barge operators is one of the main features of the Rhine river market (A&S Management et al., 2003a). In the past, barge operators have started to operate joint liner services in order to offer a regular service to the Port of Rotterdam. Typically, a vessel sails between the port and one of the navigation areas where about 3 to 5 inland terminals are visited. In addition, some truck line-feeder services exist to offer services along tributaries of the Rhine River. However, Notteboom and Konings (as cited in Van der Horst & De Langen, 2008) observed that the conditions for cooperation are gradually changing in this market due to higher market entry barriers, the stabilization of the number of operators and growing transport volumes.

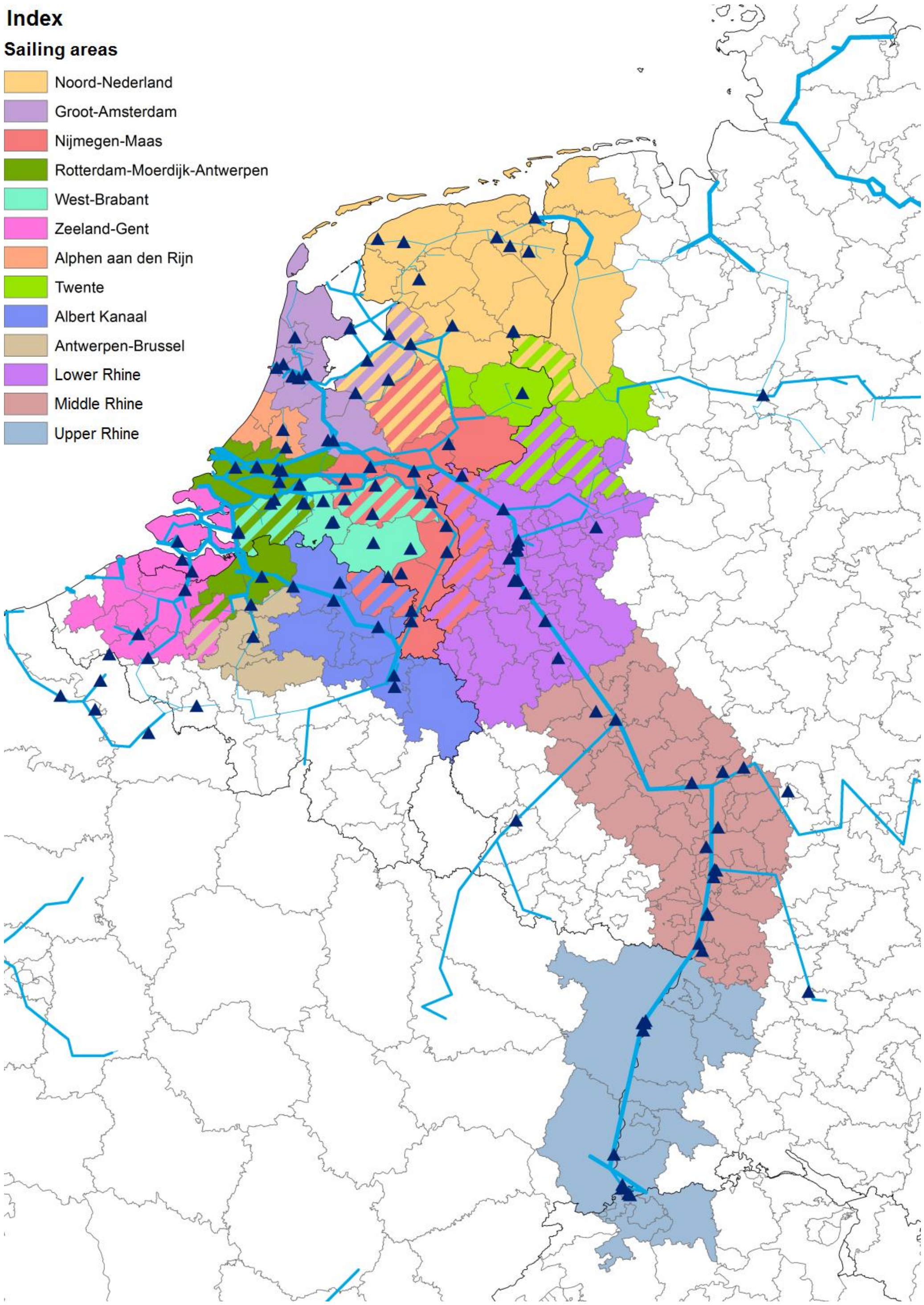
Rotterdam-Antwerp market

The Rotterdam-Antwerp market includes all feeder traffic between the Port of Rotterdam and Antwerp. Deep sea carriers play an important role in this market. They are the most important customers of barge operators and therefore have a strong influence on the characteristics of the barge services. This market is the result of strategic choices of deep sea carriers. For example, a deep sea carrier issues a Bill of Lading to Antwerp, while a vessel only calls at the Port of Rotterdam. As a result, large volumes of containers need to be transported between Rotterdam and Antwerp (Notteboom, 2008a). This enables barge operators to use large vessels and to call at a limited number of terminals in the port. Because the Port of Rotterdam is a major import port and the Port of Antwerp a more export-oriented, a large portion of the flows includes the repositioning of empty containers (Notteboom & Rodrigue, 2007).

Domestic market

The domestic market consists of the transport of containers between the Port of Rotterdam and inland areas in the Netherlands. The domestic market is characterized by relatively small inland terminals and the usage of small vessels due to waterway limitations (A&S Management et al., 2003b). The vessel size typically ranges from 24 to 208 TEU. Currently, about 35 inland terminals are located in the Netherlands. In the domestic market, almost all barge services to the Port of Rotterdam are offered as a point-to-point service. In contrast with the Rhine river market, just one terminal is visited in the hinterland. A reason for this is that the transit time should be kept small in order to be an attractive alternative for road transport on short distances. Furthermore, the exploitation of the inland terminals and barge services in the Netherlands is usually in one hand, allowing operators to serve their own terminal. The market power of inland terminal operators in the Netherlands is limited. Due to the small scale of the inland terminals, shippers and freight forwarders can easily switch to another operator. The exploitation of an inland terminal is therefore in most cases only feasible with the long term commitment of a large shipper in the region.

Appendix 3: Sailing areas with barge services to the Port of Rotterdam



Source: Own elaboration on TNO, TU Delft, Panteia, EICB and Ab Ovo (2012)

Appendix 4: Input parameters

Terminal characteristics

Code	Element	Description	Value
FT40	Ratio	Ratio between 20ft and 40ft containers [1]	0.6
TCFY	Terminal	Fixed costs per year	0
TCVH	Terminal	Variable costs per hour	0.01
TCFQM	Quay	Fixed costs per meter	250
TCFM2	Plot	Fixed costs per m^2	10
TCFTEU	Stack	Fixed costs per TEU	0
QCFY	Quay crane	Fixed costs per year	150.000
QCFXDS	Quay crane	Variable costs per move (deep sea terminal)	70
QCVX	Quay crane	Variable costs per move (inland terminal)	1
QCVH	Quay crane	Variable costs per hour	25
QCMPH	Quay crane	Number of moves per hour	30
CO2QC	Quay crane	Kg CO_2 per move	2.08
RCFY	Reach stacker	Fixed costs per year	20.000
RCVX	Reach stacker	Variable costs per move	1.25
RCVH	Reach stacker	Variable costs per hour	25
RSMPH	Reach stacker	Number of moves per hour	12
CO2RS	Reach stacker	Kg CO_2 per move	0.39
TRCKM	Trucking	Costs per TEU/km	0.75
CO2TKM	Trucking	Kg CO_2 per TEU/km	0.472

Vessel characteristics

Code	Name	Depreciation (€ per year)	Labor (€ per year)	Maintenance (€ per km)	Fuel (€ per km)	Handling (€ per TEU)	CO_2 (KG per TEU)
M02	Kempenaar	87.769	203.053	0.18	3.68	10.45	19
M04	Dortmund-Eems	190.508	203.053	0.27	5.45	9.42	29
M06	Europaschip	349.034	247.199	0.37	7.54	10.22	38
M08	Groot Rijnschip	784.745	286.973	0.72	10.00	18.09	50
M10-4	Rijnmaxschip	1.622.570	289.207	1.32	15.50	28.21	75

Notes:
1: Number of containers = TEU x FT40

Source: Ab Ovo, TNO and TU Delft (subtracted from simulation tool)

Appendix 5: Standaard vragenlijst voor de interviews

1. De laatste tijd is er veel geschreven over de vorming en toekomst van het achterlandnetwerk in Nederland. Hoe denk jij dat het achterlandnetwerk er in de toekomst uit zal zien als de containervolumes gaan toenemen na de opening van de Maasvlakte II? Zal er meer rechtstreeks naar Rotterdam worden gevaren of juist meer worden gebundeld?

2. Je ziet tegenwoordig dat steeds meer diepzee partijen zich gaan bemoeien met achterlandlogistiek. Op welke manier verwacht je dat diepzee partijen hun achterlanddiensten zullen opzetten (bijv. eigen terminals of vaardiensten)? Verwacht je dat deze bemoeienis een gevaar zal vormen voor het voortbestaan van de huidige inland terminal opeartors in Nederland? En wat zal het effect zijn van deze ontwikkeling voor de gehele binnenvaartsector?

3. Uit mijn onderzoek is gebleken dat verticale integratie van diepzee partijen nadelig kan zijn voor de bestaande inland terminals in Nederland. De volumes voor het varen zullen afnemen, waardoor er met minder grote schepen naar Rotterdam kan worden gevaren. Op welke manier kunnen inland terminals zich wapenen tegen deze ontwikkeling?

4. Over het algemeen staat de binnenvaart bekend als een betrouwbare modaliteit. Door de afhandelingsproblemen in de haven van Rotterdam staat de betrouwbaarheid van de binnenvaart echter onder druk. Voor diepzee partijen zal het wellicht eenvoudiger zijn om met deze problemen om te gaan, omdat zij hun netwerk organiseren vanuit Rotterdam. Op welke manier kunnen inland terminal operators zich blijven onderscheiden in de markt?

5. Mijn onderzoek laat zien dat samenwerking tussen marktpartijen zal leiden tot effiencyvoordelen voor de gehele binnenvaartsector. Zeker gezien de bemoeienis van diepzee partijen zal het in de toekomst interessanter worden om containerstromen te bundelen. Door welke factoren wordt samenwerking in de markt op dit moment belemmerd? En wat valt er aan te doen om deze belemmeringen weg te nemen?

6. Wat zijn de voorwaarden voor een succesvolle samenwerking tussen marktpartijen in de containerbinnenvaart? Of is een uitbreiding van het terminalnetwerk door middel van fusies en overnames de enige manier om de bundeling van containerstromen te resaliseren (bijv. BCTN)?

7. Op dit moment zijn er veel initiatieven in de markt om nieuwe terminals te ontwikkelen. Mijn stelling is: *"Een verdere uitbreiding van het huidige terminal netwerk zal gunstig zijn, omdat een verlader meer opties zal hebben waardoor het binnenvaartproduct aantrekkelijker wordt t.o.v. andere modaliteiten."* Wat is jouw mening hierover?

8. Op dit moment zijn er veel ontwikkelingen in de containerbinnenvaartsector. Wat zie jij op dit moment als de belangrijkste ontwikkeling in de sector en waarom?

Appendix 6: List of inland terminals in the Netherlands

Sailing area	Inland Terminal	Place	Name used in report
Groot-Amsterdam	Container Stevedoring IJmuiden	IJmuiden	CSY Ijmuiden
	Container Terminal Beverwijk	Beverwijk	CTB Beverwijk
	Container Terminal Utrecht	Utrecht	CTU Utrecht
	CT Vrede-Steinweg Amsterdam	Amsterdam	CTVrede Amsterdam
	CT Vrede-Steinweg Zaanstad	Zaandam	CTVrede Zaandam
	MEO Container Terminal	Velsen-Noord	MEO Velsen-Noord
	SCS Multiport	Amsterdam	SCS Amsterdam
	United Stevedores Amsterdam	Amsterdam	USA Amsterdam
Nijmegen-Maas	Barge & Rail Terminal Born	Born	BT Born
	Container Terminal Cuijk	Cuijk	CT Cuijk
	Container Terminal Nijmegen	Nijmegen	CT Nijmegen
	Container Terminal Stein	Stein	CTS Stein
	CTU Rivierenland	Tiel	CTU Tiel
	Logistiek Centrum Gorinchem	Gorinchem	LCG Gorinchem
	Osse Overslag Centrale	Oss	OOC Oss
	TCT Venlo	Venlo	TCT Venlo
	Wanssum Intermodal Terminal	Wanssum	WIT Wanssum
Noord-Nederland	Barge Service Center Groningen	Groningen	BSC Groningen
	Container Terminal Heerenveen	Heerenveen	CT Heerenveen
	CTU Kampen	Kampen	CTU Kampen
	Harlinger Overslag & Veembedrijf	Harlingen	HOV Harlingen
	MCS Westerbroek	Westerbroek	MCS Westerbroek
	MCS Leeuwarden	Leeuwarden	MCS Leeuwarden
	MCS Meppel	Meppel	MCS Meppel
	ROC Kampen	Kampen	ROC Kampen
	Container Terminal Wijnne & Barends	Delfzijl	Wijnne & Barends Delfzijl
West-Brabant	Bossche Container Terminal	Den Bosch	CT Den Bosch
	Barge & Rail Terminal Tilburg	Tilburg	BTT Tilburg
	BTT - Dependence Vossenberg	Vossenberg	BTT Vossenberg
	CCT + MCT Moerdijk	Moerdijk	CCT + MCT Moerdijk
	Delta Marine Terminal	Moerdijk	DMT Moerdijk
	Inland Terminal Veghel	Veghel	IT Veghel
	MCT Bergen op Zoom	Bergen op Zoom	MCT Bergen op Zoom
	Oosterhout Container Terminal	Oosterhout	OCT Oosterhout
	ROC Waalwijk	Waalwijk	ROC Waalwijk

Appendix 7: Transshipment volume of inland terminals

Nijmegen-Maas

Inland Terminal	Volume (TEU)	% Rotterdam	Volume PoR(TEU)	Source Volumes & % Rotterdam
BT Born	125.000	70%	87.500	TNO et al. (2012) | Provincie Limburg (2012)
CT Cuijk [1]	10.000	100%	10.000	Schuttevaer (2012)
CT Nijmegen	85.000	80%	68.000	BCTN | Bureau Voorlichting Binnenvaart (2012)
CTS Stein	20.000	20%	4.000	Provincie Limburg (2012)
CTU Tiel [1+2]	40.000	80%	32.000	Schuttevaer (2011a)
LCG Gorinchem	50.000	70%	35.000	TNO et al. (2012) | Bureau Voorlichting Binnenvaart (2013a)
OOC Oss	50.000	80%	40.000	TNO et al. (2012) | Osse Overslag Centrale
TCT Venlo	43.000	80%	34.400	Provincie Limburg (2012)
WIT Wanssum	95.000	80%	76.000	Provincie Limburg (2012) | BCTN

West-Brabant

Inland Terminal	Volume (TEU)	% Rotterdam	Volume PoR (TEU)	Source Volumes & % Rotterdam
CT Den Bosch	120.000	70%	84.000	TNO et al. (2012) | BCTN
BTT Tilburg	55.000	100%	55.000	GVT Group of Logistics | Buck Consultants International (2010)
BTT Vossenberg [1]	40.000	100%	40.000	GVT Group of Logistics | Nieuwsblad Transport (2012)
CCT + MCT Moerdijk	150.000	60%	90.000	TNO et al. (2012) | Bureau Voorlichting Binnenvaart (2013a)
DMT Moerdijk	120.000	50%	60.000	TNO et al. (2012) | Delta Marine Terminal | InlandLinks (2013)
IT Veghel	50.000	90%	45.000	TNO et al. (2012) | Bureau Voorlichting Binnenvaart (2013a)
MCT Bergen op Zoom	70.000	80%	56.000	TNO et al. (2012) | Richard Klaassen (personal communication, January 14, 2014)
OCT Oosterhout	130.000	80%	104.000	TNO et al. (2012) | Oosterhout Container Terminal
ROC Waalwijk	50.000	100%	50.000	TNO et al. (2012) | Bureau Voorlichting Binnenvaart (2013a)

Noord-Nederland

Inland Terminal	Volume (TEU)	% Rotterdam	Volume PoR (TEU)	Source Volumes & % Rotterdam
BSC Groningen	30.000	100%	30.000	TNO et al. (2012) | Harlinger Container Lines
CT Heerenveen	12.000	100%	12.000	TNO et al. (2012) | Harlinger Container Lines
CTU Kampen [1]	25.000	100%	25.000	Walter Kusters (personal communication, November 29, 2013)
HOV Harlingen	22.000	100%	22.000	TNO et al. (2012) | Harlinger Container Lines
MCS Westerbroek	24.000	100%	24.000	TNO et al. (2012)
MCS Leeuwarden [1]	15.000	100%	15.000	EICB (n.d.)
MCS Meppel	37.000	100%	37.000	TNO et al. (2012)
ROC Kampen	20.000	100%	20.000	TNO et al. (2012)
Wijnne & Barends Delfzijl	2.500	100%	2.500	TNO et al. (2012)

Groot-Amsterdam

Inland Terminal	Volume (TEU)	% Rotterdam	Volume PoR (TEU)	Source Volumes & % Rotterdam
CSY Ijmuiden	8.500	100%	8.500	Schuttevaer (2011b)
CTB Beverwijk	57.000	100%	57.000	TNO et al. (2012) | Container Terminal Beverwijk
CTU Utrecht	67.550	80%	54.040	TNO et al. (2012) | CTU
CTVrede Amsterdam	95.000	80%	76.000	Containerafvaarten (2013)
CTVrede Zaandam	45.000	80%	36.000	TNO et al. (2012) | Bureau Voorlichting Binnenvaart (2012) | Containerafvaarten (2013)
MEO Velsen-Noord	15.000	80%	12.000	Walter Kusters (personal communication, November 29, 2013)
SCS Amsterdam	30.000	60%	18.000	TNO et al. (2012) | Bureau Voorlichting Binnenvaart (2013b)
USA Amsterdam [2]	40.000	80%	32.000	Gemeente Amsterdam (2010)

Notes:

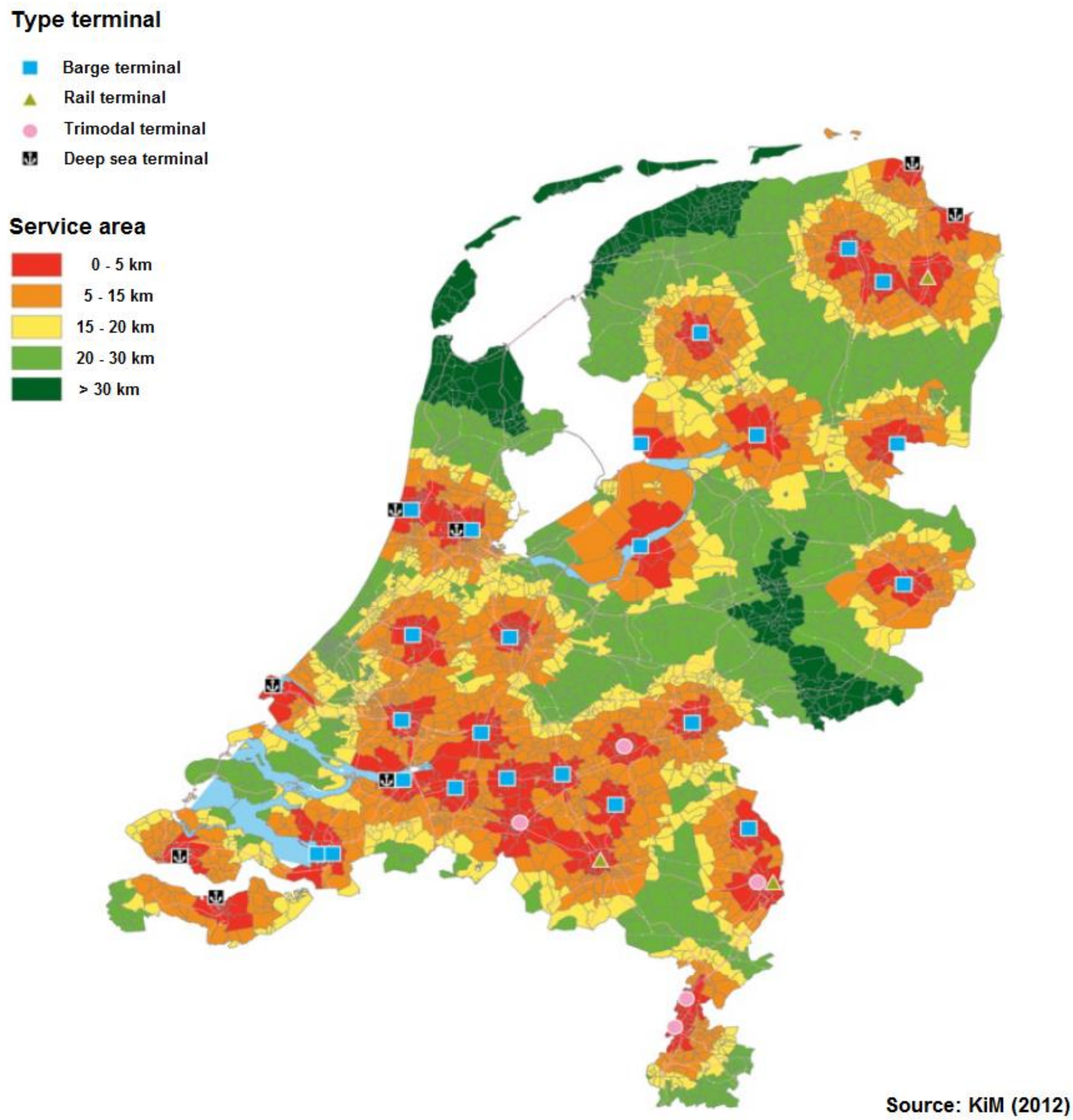
1: BTT Vossenberg, CT Cuijk, CTU Tiel, CTU Kampen and MCS Leeuwarden are founded in 2012 and 2013. The annual transshipment volume of these inland terminals has been estimated on the basis of forecasts and feasibility studies.

2: CTU Tiel and USA Amsterdam offer barge services to the Port of Antwerp. However, no specific information has been found about the number of weekly departures. Therefore, it is assumed that 80% of total handled volume is transported directly to the Port of Rotterdam.

Appendix 8: Distance of inland terminals to the Port of Rotterdam

Sailing area	Inland Terminal	Distance (km)
Groot-Amsterdam	CSY Ijmuiden	127
	CTB Beverwijk	133
	CTU Utrecht	75
	CTVrede Amsterdam	124
	CTVrede Zaandam	119
	MEO Velsen-Noord	132
	SCS Amsterdam	127
	USA Amsterdam	125
Nijmegen-Maas	BT Born	226
	CT Cuijk	125
	CT Nijmegen	120
	CTS Stein	236
	CTU Tiel	96
	LCG Gorinchem	50
	OOC Oss	102
	TCT Venlo	179
	WIT Wanssum	157
Noord-Nederland	BSC Groningen	281
	CT Heerenveen	227
	CTU Kampen	185
	HOV Harlingen	235
	MCS Westerbroek	288
	MCS Leeuwarden	245
	MCS Meppel	210
	ROC Kampen	187
	Wijnne & Barends Delfzijl	309
West-Brabant	CT Den Bosch	84
	BTT Tilburg	79
	BTT Vossenberg	70
	CCT + MCT Moerdijk	40
	DMT Moerdijk	41
	IT Veghel	103
	MCT Bergen op Zoom	88
	OCT Oosterhout	56
	ROC Waalwijk	68

Appendix 9: Service area of inland terminals



Appendix 10: Growth rates per inland terminal

Noord-Nederland

Inland Terminal	RC 2010 - 2015	SE 2010 - 2015	RC 2010 - 2025	SE 2010 - 2025
BSC Groningen	20%	31%	55%	101%
CT Heerenveen [1]	21%	31%	57%	104%
CTU Kampen	22%	32%	59%	108%
HOV Harlingen	21%	31%	57%	104%
MCS Westerbroek	20%	31%	55%	101%
MCS Leeuwarden	21%	31%	57%	104%
MCS Meppel	22%	33%	54%	103%
ROC Kampen	22%	32%	59%	108%
Wijnne & Barends Delfzijl	20%	32%	52%	101%
Average growth%	**21%**	**32%**	**56%**	**104%**

Groot-Amsterdam

Inland Terminal	RC 2010 - 2015	SE 2010 - 2015	RC 2010 - 2025	SE 2010 - 2025
CTB Beverwijk	12%	22%	30%	72%
CSY Ijmuiden	12%	22%	30%	72%
CTU Utrecht	21%	31%	57%	104%
CTVrede Amsterdam	20%	31%	56%	103%
CTVrede Zaandam	11%	20%	28%	66%
MEO Velsen-Noord	12%	22%	30%	72%
SCS Amsterdam	20%	31%	56%	103%
USA Amsterdam	20%	31%	56%	103%
Average growth%	**16%**	**26%**	**43%**	**87%**

Nijmegen-Maas

Inland Terminal	RC 2010 - 2015	SE 2010 - 2015	RC 2010 - 2025	SE 2010 - 2025
BT Born	20%	31%	54%	102%
CT Cuijk	23%	33%	60%	108%
CT Nijmegen	47%	63%	122%	191%
CTS Stein	20%	31%	54%	102%
CTU Tiel [1]	23%	33%	60%	108%
LCG Gorinchem	17%	29%	44%	90%
OOC Oss	23%	33%	60%	108%
TCT Venlo	19%	29%	48%	92%
WIT Wanssum	19%	29%	48%	92%
Average growth%	**23%**	**35%**	**62%**	**110%**

West-Brabant

Inland Terminal	RC 2010 - 2015	SE 2010 - 2015	RC 2010 - 2025	SE 2010 - 2025
CT Den Bosch	23%	33%	60%	108%
BTT Tilburg	22%	32%	60%	106%
BTT Vossenberg	22%	32%	60%	106%
CCT + MCT Moerdijk	87%	110%	222%	326%
DMT Moerdijk	87%	110%	222%	326%
IT Veghel	23%	33%	60%	108%
MCT Bergen op Zoom	87%	110%	222%	326%
OCT Oosterhout	87%	110%	222%	326%
ROC Waalwijk	22%	32%	60%	106%
Average growth%	**51%**	**67%**	**132%**	**204%**

Notes:
1: No growth rates are available for CT Heerenveen and CTU Tiel. These inland terminals are close to MCS Leeuwarden and OOC Oss. The growth rates of these terminals are also applied to CT Heerenveen and CTU Tiel.

Appendix 11: Demand for container barging in the different growth scenarios

Sailing area	Inland Terminal	0%-Growth (TEU)	RC 2015 (TEU)	SE 2015 (TEU)	RC 2025 (TEU)	SE 2025 (TEU)
Groot-Amsterdam	CSY Ijmuiden	8.500	9.517	10.341	13.235	14.578
	CTB Beverwijk	57.000	63.818	69.348	74.328	97.756
	CTU Utrecht	54.040	65.253	70.710	84.873	110.365
	CTVrede Amsterdam	76.000	91.527	99.416	118.340	154.204
	CTVrede Zaandam	36.000	39.919	43.186	45.996	59.847
	MEO Velsen-Noord	12.000	13.435	14.600	18.685	20.580
	SCS Amsterdam	18.000	20.153	23.546	28.027	30.870
	USA Amsterdam	32.000	38.538	41.859	49.827	64.928
Nijmegen-Maas	BT Born	87.500	105.411	114.793	135.168	176.992
	CT Cuijk	10.000	12.258	13.303	16.048	20.783
	CT Nijmegen	68.000	100.105	110.684	151.155	197.895
	CTS Stein	4.000	4.819	5.247	6.179	8.091
	CTU Tiel	32.000	39.225	42.569	51.354	66.505
	LCG Gorinchem	35.000	40.839	45.165	50.446	66.557
	OOC Oss	40.000	49.031	53.211	64.192	83.131
	TCT Venlo	34.400	40.794	44.334	51.083	66.218
	WIT Wanssum	76.000	90.126	97.945	112.858	146.295
Noord-Nederland	BSC Groningen	30.000	36.114	39.272	46.426	60.240
	CT Heerenveen	12.000	14.551	15.775	18.844	24.431
	CTU Kampen	25.000	30.432	33.096	39.796	52.014
	HOV Harlingen	22.000	26.676	28.920	34.548	44.790
	MCS Westerbroek	24.000	28.892	31.418	37.142	48.192
	MCS Leeuwarden	15.000	18.188	19.718	23.556	30.538
	MCS Meppel	37.000	45.112	49.306	57.122	75.190
	ROC Kampen	20.000	24.344	26.476	31.836	41.610
	Wijnne & Barends Delfzijl	2.500	2.994	3.298	3.810	5.024

Sailing area	Inland Terminal	0%-Growth (TEU)	RC 2015 (TEU)	SE 2015 (TEU)	RC 2025 (TEU)	SE 2025 (TEU)
West-Brabant	CT Den Bosch	84.000	102.964	111.744	134.803	174.576
	BTT Tilburg	55.000	67.151	72.658	87.957	113.360
	BTT Vossenberg	40.000	48.836	52.842	63.968	82.442
	CCT + MCT Moerdijk	90.000	167.990	188.774	289.739	383.705
	DMT Moerdijk	60.000	111.992	125.848	193.158	255.802
	IT Veghel	45.000	55.159	59.863	72.216	93.523
	MCT Bergen op Zoom	56.000	104.527	117.460	180.282	238.749
	OCT Oosterhout	104.000	194.122	218.138	334.809	443.392
	ROC Waalwijk	50.000	61.288	66.053	79.960	103.053

Appendix 12: Waterway accessibility of inland terminals

Sailing area	Inland terminal	CEMT-class	Maximum vessel size (TEU)
Groot-Amsterdam	CSY Ijmuiden	V	208
	CTB Beverwijk	V	208
	CTU Utrecht	V	208
	CTVrede Amsterdam	VI	408
	CTVrede Zaandam [1]	VI	90
	MEO Velsen-Noord	VI	408
	SCS Amsterdam	VI	408
	USA Amsterdam	VI	408
Nijmegen-Maas	BT Born	V	208
	CT Cuijk	V	208
	CT Nijmegen	VI	408
	CTS Stein	V	208
	CTU Tiel	VI	408
	LCG Gorinchem [1]	VI	208
	OOC Oss	V	208
	TCT Venlo	V	208
	WIT Wanssum	V	208
Noord-Nederland	BSC Groningen	V	208
	CT Heerenveen	IV	90
	CTU Kampen	V	208
	HOV Harlingen	V	208
	MCS Westerbroek	IV	90
	MCS Leeuwarden	IV	90
	MCS Meppel	V	208
	ROC Kampen [1]	V	90
	Wijnne & Barends Delfzijl	V	208
West-Brabant	CT Den Bosch	IV	90
	BTT Tilburg	II	24
	BTT Vossenberg	IV	90
	CCT + MCT Moerdijk	VI	408
	DMT Moerdijk	VI	408
	IT Veghel	II	24
	MCT Bergen op Zoom	V	208
	OCT Oosterhout	V	208
	ROC Waalwijk	III	48

Notes:

1: One of the limitations of the simulation tool is that the length of the quay influences the maximum vessel size that can call at an inland terminal. For example, CTVrede Zaandam is located along a CEMT-class VI waterway. The quay of this terminal is just 100 meter. So, this terminal is not accessible for barges in class Va in the model (length: 95-110). The same applies to ROC Kampen (100 meter) and LCG Gorinchem (135 meter).

Appendix 13: Operational characteristics of container terminals in the Port of Rotterdam

Container Terminal	Quay (m)	Plot (m^2)	Stack (TEU)	Days/Week	Hours/Days	Cranes	Reach st.	Sources
Rotterdam World Gateway	1.700	1.080.000	108.000[11]	7	24	4[2]	16[2]	RWG Port of Rotterdam Authority (2013)
APM Terminals Maasvlakte II	1.500	600.000	60.000[11]	7	24	3[2]	9[2]	APM Terminals Maasvlakte II Port of Rotterdam Authority (2013)
ECT Euromax Terminal	1.500	840.000	52.200	7	24	4[2]	16[2]	ECT Port of Rotterdam Authority (2013)
RCT Hartelhaven (Kramer)	387	170.000	17.000[11]	7	24	2	14	Kramer Group InlandLinks (2013) Port of Rotterdam Authority (2013)
APM Terminals Maasvlakte I	1.600	1.000.000	100.000[11]	7	24	4[2]	24[2]	APM Terminals Port of Rotterdam Authority (2013)
DCS Amazonehaven (Kramer)	260	25.000	2.500[11]	7	24	1	2	Kramer Group Port of Rotterdam Authority (2013)
ECT Delta Terminal	3.600	2.650.000	265.000[11]	7	24	5[2]	25[2]	ECT Port of Rotterdam Authority (2013)
ECT Delta Barge Feeder Terminal	800	75.000	7.500[11]	7	24	3	6[1]	ECT Port of Rotterdam Authority (2013)
ECT Hartelhaven	370	72.000	7.200[11]	7	24	3	6[1]	Port of Rotterdam Authority (2013)

Container Terminal	Quay (m)	Plot (m²)	Stack (TEU)	Days/Week	Hours/Days	Cranes	Reach st.	Sources
Uniport Multipurpose Terminals	2.400	540.000	28.900	7	24	3[2]	9[2]	Uniport Port of Rotterdam Authority (2013)
Barge Center Waalhaven	225	64.000	4.000	6	16	2	5	Waalhaven Group InlandLinks (2013) Port of Rotterdam Authority (2013)
Interforest Terminal	680	180.000	18.000[11]	5[12]	16[12]	1[2]	4[1]	VRTO (n.d.) Port of Rotterdam Authority (2013)
CTVrede Steinweg Beatrixhaven	1.717	262.300	26.230[11]	5	9	3	7	InlandLinks (2013) CTVrede Steinweg
Pernis Combi Terminal (PCT) [3]	140	45.000	4.500[11]	7	18	1	3	InlandLinks (2013) PCT
ECT City Terminal	1.400	593.000	59.300[11]	7	24	3[2]	12[2]	ECT Port of Rotterdam Authority (2013)
Rotterdam Shortsea Terminals	1.800	460.000	46.000[11]	7	24	4[2]	16[1]	RST Port of Rotterdam Authority (2013)

Notes:

1: No information has been found about the number of reach stackers. The following is assumed:

- Container terminals: 1 crane = 4 reach stackers
- Barge terminals + Empty depots: 1 crane = 2 reach stackers

11: No information has been found about the stack capacity (TEU). The following is assumed: plot size (m^2) / 10

12: No information has been found about the opening hours of the Interforest Terminal. The following is assumed: 5 days + 16 hours

2: A low number of total equipment is dedicated to barges. It is assumed that 25% of total equipment is used for barge handling.

3: Because of a programming error in the simulation tool, Pernis Combi Terminal (PCT) is excluded from the research at a later stage.

Appendix 14: Operational characteristics of empty depots in the Port of Rotterdam

Empty depot	Quay (m)	Plot (m^2)	Stack (TEU)	Days/Week	Hours/Days	Cranes	Reach st.	Sources
Mainport Rotterdam Services [3]	100	90.000	10.000	5	16	1	3	MRS | Port of Rotterdam Authority (2013)
Waalhaven Botlek Terminal	300	101.000	8.000	5	16	2	4	Waalhaven Group InlandLinks (2013) | Port of Rotterdam Authority (2013)
Alconet	120	40.000	4.500	5	13	1	2[1]	Holland Reefer Services Alconet | Port of Rotterdam Authority (2013)
Medrepair Barge Center[3]	130	20.000	1.500	5	9	1	2[1]	MSC | Port of Rotterdam Authority (2013)
United Waalhaven Terminals [3]	185	83.000	7.000	5	16	1	5	Waalhaven Group | Port of Rotterdam Authority (2013)
United Waalhaven Terminals	215	180.000	21.000	5	16	2	9	Waalhaven Group | Port of Rotterdam Authority (2013)
Cetem Containers	140	95.000	15.000	5	14	2	2	Cetem | Port of Rotterdam Authority (2013)
Progeco Holland [3] *Location: Eemhavenweg*	170	38.000	7.000	5	13	2	5	Progeco Holland | Port of Rotterdam Authority (2013)
Port Container Services	158	75.000	13.500	5[2]	16[2]	1	2[1]	PCS | Port of Rotterdam Authority (2013)

<u>Notes:</u>

1: No information has been found about the number of reach stackers. The following is assumed: 1 crane = 2 reach stackers.

2: No information has been found about the opening hours of Port Container Services. The following is assumed: 5 days + 16 hours

3: Because of a programming error in the simulation tool, these terminals are excluded from the research at a later stage.

Appendix 15: Operational characteristics of inland terminals

Noord-Nederland

Inland Terminal	Quay (m)	Plot (m²)	Stack (TEU)	Days/Week	Hours/Day	Cranes	Reach st.	Sources
CTU Kampen	200	23.000	2.500	7	24	1	1	Etienne Morrien (personal communication, October 10, 2013)
BSC Groningen	139	8.000	1.200	6	16	1	1	InlandLinks (2013)
CT Heerenveen	110	6.000	1.000	5	10	0	1	InlandLinks (2013)
HOV Harlingen	440	20.000	1.000	7	24	1	2	InlandLinks (2013) HOV Harlingen
MCS Leeuwarden	120	16.000	1.600[1]	5	16	1	1	InlandLinks (2013)
MCS Westerbroek	185	30.000	3.500	6	16	1	2	InlandLinks (2013)
MCS Meppel	140	22.025	15.000	5	11	1	2	InlandLinks (2013)
ROC Kampen	100	15.000	1.500	6	23	0	2	InlandLinks (2013)
Wijnne & Barends Delfzijl	200	15.000	500	6	16	1	1	Wijnne & Barends

Groot-Amsterdam

Inland Terminal	Quay (m)	Plot (m^2)	Stack (TEU)	Days/Week	Hours/Day	Cranes	Reach st.	Sources
CSY Ijmuiden	340	8.000	1.000	5	16	0	1	Ter Haak Group
CTVrede Zaandam	100	15.000	1.500[1]	5	16	1	3	InlandLinks (2013) CTVrede - Steinweg
CTB Beverwijk	180	15.000	1.500	7	16	1	2	CTB | Klaasjan Kolle (personal communication, October 8, 2013)
CTU Utrecht	180	22.000	3.000	7	24	1	1	InlandLinks (2013) | CTU
CTVrede Amsterdam	280	40.000	4.000[1]	5	16	2	4	InlandLinks (2013) CTVrede - Steinweg
MEO Velsen-Noord	600	95.000	9.500[1]	5	10	1	2	InlandLinks (2013)
SCS Amsterdam	236	10.000	1.800	5	11	1	1	SCS Multiport
USA Amsterdam	150	30.000	3.000[1]	5	18	1	1	Ter Haak Group

Nijmegen-Maas

Inland Terminal	Quay (m)	Plot (m²)	Stack (TEU)	Days/Week	Hours/Day	Cranes	Reach st.	Sources
BT Born	490	120.000	10.000	6	24	4	3	InlandLinks (2013) Waalhaven Group
CT Cuijk	150	5.000	500[1]	5	16	0	1	Internal notes
CTS Stein	1.000	60.000	6.000[1]	5	16	1	2	Meulenberg C. Rademakers (personal communication, October 9, 2013)
CT Nijmegen	175	33.000	3.300[1]	7	24	1	3	InlandLinks (2013) Walter Kusters (personal communication, October 1, 2013)
CTU Tiel	200	55.000	5.500[1]	5	17	1	1	InlandLinks (2013) CTU
LCG Gorinchem	135	10.000	25.000	6	16	1	3	Logistiek Centrum Gorinchem InlandLinks (2013) Vincent Heuvelman (personal communication, October 8, 2013)
OOC Oss	550	70.000	2.700	6	16	1	1	InlandLinks (2013) Osse Overslag Centrale
TCT Venlo	155	30.000	1.800	7	24	1	4	ECT
WIT Wanssum	350	45.000	4.500	5	12	2	3	InlandLinks (2013) Port of Rotterdam Authority (2009)

West-Brabant

Inland Terminal	Quay (m)	Plot (m^2)	Stack (TEU)	Days/Week	Hours/Day	Cranes	Reach st.	Sources
BTT Tilburg	500	60.000	3.000	5	16	1	3	InlandLinks (2013) GVT Group op Logistics
BTT Vossenberg	250	35.000	2.000	5	16	1	2	InlandLinks (2013) GVT Group op Logistics
CCT + MCT Moerdijk [2]	1.600	380.000	32.000	7	24	6	12	CCT Moerdijk MCT Moerdijk
CT Den Bosch	300	45.000	6.000	5	17	2	3	InlandLinks (2013) Gemeente 's-Hertogenbosch (n.d.) Erik Erprath (personal communication, October 11, 2013)
DMT Moerdijk	600	192.000	15.000	5	9	2	4	Delta Marine Terminal InlandLinks (2013)
IT Veghel	320	35.000	2.000	6	18	0	3	InlandLinks (2013) Inland Terminal Veghel
MCT Bergen op Zoom	125	12.500	2.500	7	24	0	3	InlandLinks (2013)
OCT Oosterhout	345	30.000	3.000[1]	7	24	2	2	InlandLinks (2013) OCT
ROC Waalwijk	190	13.000	700	5	17	1	1	InlandLinks (2013)

Notes:

1: No information has been found about the stack capacity (TEU). The following is assumed: plot size (m^2) / 10

2: CCT + MCT Moerdijk can be split up into two parts. MCT is a dedicated container terminal, while CCT Moerdijk also handles project cargo, steal, etc. The website of CCT + MCT Moerdijk provides detailed information about the handling equipment that is available at both terminals. It is assumed that 50% of the equipment of CCT is suitable for the loading and unloading of container barges.

Appendix 16: Ownership structure of inland terminals

Sailing area	Terminal	Ownership
Noord-Nederland	Wijnne & Barends Delfzijl	Wijnne & Barends
	BSC Groningen	HCL + IMS
	HOV Harlingen	HCL + IMS
	CT Heerenveen	HCL + IMS + Van der Werff Logistics
	CTU Kampen	CTU / Theo Pouw Group
	ROC Kampen [1]	ROC Kampen Exploitatie
	MCS Leeuwarden	MCS
	MCS Meppel	MCS
	MCS Westerbroek	MCS
Groot-Amsterdam	CTVrede Amsterdam	CTVrede-Steinweg
	SCS Amsterdam	SCS
	USA Amsterdam	Ter Haak Group
	CTB Beverwijk	Schavemaker Logistics & Transport
	CSY Ijmuiden	Ter Haak Group
	CTU Utrecht	CTU / Theo Pouw Group
	MEO Velsen-Noord	TMA Group
	CTVrede Zaandam	CTVrede-Steinweg
Nijmegen-Maas	BT Born	Waalhaven Group
	CT Cuijk	Van Berkel Group + BIM
	LCG Gorinchem	HTS Group
	CT Nijmegen	BCTN
	OOC Oss	Nooijen Groep
	CTS Stein	Meulenberg Transport + WPS Group
	CTU Tiel	CTU / Theo Pouw Group
	TCT Venlo	ECT
	WIT Wanssum	BCTN
West-Brabant	MCT Bergen op Zoom	Mepavex Logistics
	CT Den Bosch	BCTN
	CCT + MCT Moerdijk	ECT + CCT
	DMT Moerdijk	C. Steinweg-Handelsveem
	OCT Oosterhout	Rietveld Transport & Logistics + BIM
	BTT Tilburg	GVT Group of Logistics + BIM
	IT Veghel	Van Berkel Group + BIM
	BTT Vossenberg	GVT Group of Logistics + BIM
	ROC Waalwijk	Van der Linden Transport + BIM

Notes:
1: ROC Kampen cooperates with HCL. They offer a joint liner service to the Port of Rotterdam.

Source: Websites of the terminals + Ab Ovo, TNO and TU Delft (subtracted from simulation tool)

Appendix 17: I/C-ratio of inland terminals

Noord-Nederland

Inland Terminal	Volume (TEU)	Capacity (TEU)	% Used	Source Capacity
BSC Groningen	30.000	90.000	33%	TNO et al. (2012)
CT Heerenveen	12.000	20.000	60%	Defares (2011)
CTU Kampen [1]	25.000			
HOV Harlingen	22.000	40.000	55%	Defares (2011)
MCS Westerbroek	24.000	150.000	16%	Defares (2011)
MCS Leeuwarden [1]	15.000			
MCS Meppel	37.000	60.000	62%	Defares (2011)
ROC Kampen	20.000	25.000	80%	TNO et al. (2012)
Wijnne & Barends Delfzijl	2.500	20.000	13%	Defares (2011)

Groot-Amsterdam

Inland Terminal	Volume (TEU)	Capacity (TEU)	% Used	Source Capacity
CTB Beverwijk	57.000	90.000	63%	Defares (2011)
CSY Ijmuiden	8.500	24.000	35%	Defares (2011)
CTU Utrecht	67.550	175.000	39%	InlandLinks (2013)
CTVrede Amsterdam	95.000	400.000	24%	Defares (2011)
CTVrede Zaandam	45.000	90.000	50%	TNO et al. (2012)
MEO Velsen-Noord	15.000	25.000	60%	InlandLinks (2013)
SCS Amsterdam	30.000	100.000	30%	Defares (2011)
USA Amsterdam	40.000	100.000	40%	Defares (2011)

Nijmegen-Maas

Inland Terminal	Volume (TEU)	Capacity (TEU)	% Used	Source Capacity
BT Born [3]	125.000	280.000	45%	Provincie Limburg (2012)
CT Cuijk [1]	10.000			
CT Nijmegen	85.000	140.000	61%	Defares (2011)
CTS Stein [3]	20.000	100.000	20%	Provincie Limburg (2012)
CTU Tiel	40.000	100.000	40%	InlandLinks (2013)
LCG Gorinchem	50.000	75.000	67%	InlandLinks (2013)
OOC Oss [2]	100.000	150.000	67%	TNO et al. (2012)
TCT Venlo [3]	43.000	56.000	77%	Provincie Limburg (2012)
WIT Wanssum	95.000	140.000	68%	Defares (2011)

West-Brabant

Inland Terminal	Volume (TEU)	Capacity (TEU)	% Used	Source Capacity
CT Den Bosch	120.000	190.000	63%	Defares (2011)
BTT Tilburg [2]	143.000	250.000	57%	TNO et al. (2012)
BTT Vossenberg	40.000	80.000	50%	Nieuwsblad Transport (2012)
CCT + MCT Moerdijk	150.000	1.000.000	15%	TNO et al. (2012)
DMT Moerdijk	120.000	400.000	30%	Defares (2011)
IT Veghel	50.000	80.000	63%	Defares (2011)
MCT Bergen op Zoom	70.000	125.000	56%	TNO et al. (2012)
OCT Oosterhout	130.000	155.000	84%	TNO et al. (2012)
ROC Waalwijk	50.000	60.000	83%	TNO et al. (2012)

Notes:

1: Terminal capacity (TEU) is unknown

2: Terminal capacity (TEU) and Volume (TEU) is including rail

3: Terminal capacity (TEU) and Volume (TEU) is excluding rail

Appendix 18: I/C-ratio classification of inland terminals

I/C-ratio: 0.0 - 0.40	I/C-ratio: 0.41 - 0.65	I/C-ratio: 0.66 - 0.90
BSC Groningen	BT Born	LCG Gorinchem
CCT + MCT Moerdijk	CT Den Bosch	OCT Oosterhout
CSY Ijmuiden	BTT Tilburg	OOC Oss
CTS Stein	BTT Vossenberg	ROC Kampen
CTVrede Amsterdam	CTB Beverwijk	ROC Waalwijk
CTU Tiel	CT Heerenveen	TCT Venlo
CTU Utrecht	CT Nijmegen	
DMT Moerdijk	CTVrede Zaandam	
MCS Westerbroek	HOV Harlingen	
SCS Amsterdam	IT Veghel	
USA Amsterdam	MCT Bergen op Zoom	
Wijnne & Barends Delfzijl	MCS Meppel	
	MEO Velsen-Noord	
	WIT Wanssum	

Notes:

1: There are no inland terminals in the Netherlands with an I/C-ratio between 0.91 and 1.00.

2: CTU Kampen, MCS Leeuwarden and CT Cuijk are not included in the table. The capacity of these terminals is unknown, so it is not possible to calculate the I/C-ratio for these terminals.

Appendix 19: Transportation costs per TEU/km in 0%-Growth scenario

Inland Terminal	Volume PoR (TEU)	Efficiency (%)	Vessel size (TEU)	Distance (km)	€ per TEU/km
Wijnne & Barends Delfzijl	2.500	55%	24	309	€ 1.30
LCG Gorinchem	35.000	75%	90	50	€ 1.83
CCT + MCT Moerdijk	90.000	74%	208	40	€ 2.12
DMT Moerdijk	60.000	77%	208	41	€ 2.05
CTS Stein	4.000	58%	24	236	€ 1.68
CSY Ijmuiden	8.500	87%	24	127	€ 1.34
CT Cuijk	10.000	89%	24	125	€ 1.56
CTU Kampen	25.000	71%	90	185	€ 0.93
SCS Amsterdam	18.000	83%	48	127	€ 1.31
MEO Velsen-Noord	12.000	83%	48	132	€ 1.29
CTU Utrecht	54.040	83%	208	75	€ 1.23
CTU Tiel	32.000	86%	90	96	€ 1.42
OOC Oss	40.000	85%	90	102	€ 1.41
ROC Kampen	20.000	93%	48	187	€ 0.85
MCS Leeuwarden	15.000	89%	48	245	€ 0.84
OCT Oosterhout	104.000	78%	208	56	€ 1.69
BTT Tilburg	55.000	94%	24	79	€ 1.62
BTT Vossenberg	40.000	85%	90	70	€ 1.62
ROC Waalwijk	50.000	97%	48	68	€ 1.60
USA Amsterdam	32.000	73%	90	125	€ 1.12
CT Heerenveen	12.000	95%	48	227	€ 0.78
IT Veghel	45.000	92%	24	103	€ 1.57
CT Nijmegen	68.000	88%	208	120	€ 1.28
CTVrede Zaandam	36.000	78%	90	119	€ 1.08
CT Den Bosch	84.000	87%	90	84	€ 1.47
BSC Groningen	30.000	82%	90	281	€ 0.71
CTVrede Amsterdam	76.000	80%	208	124	€ 0.99
TCT Venlo	34.400	86%	90	179	€ 1.13
MCS Westerbroek	24.000	85%	90	288	€ 0.67
CTB Beverwijk	57.000	84%	208	133	€ 0.92
MCS Meppel	37.000	93%	90	210	€ 0.65
HOV Harlingen	22.000	91%	90	235	€ 0.65
WIT Wanssum	76.000	85%	208	157	€ 1.06
MCT Bergen op Zoom	56.000	95%	208	88	€ 1.14
BT Born	87.500	89%	208	226	€ 0.82

Appendix 20: Increasing container volumes

Noord-Nederland

Performance indicator	Unit of analysis	RC 2015	RC 2025	SE 2015	SE 2025
Frequency	Number	0.5	0.8	0.3	1.0
Reliability	Hours	-0.5	-0.6	-0.7	-0.6
Transport costs	%	-1.0%	-7.4%	-6.0%	-9.0%
Sustainability	%	-1.5%	-10.3%	-8.4%	-13.6%
Transit time	Hours	-5.2	-27.1	-8.4	3.7

Nijmegen-Maas

Performance indicator	Unit of analysis	RC 2015	RC 2025	SE 2015	SE 2025
Frequency	Number	-0.1	-0.3	0.3	0.8
Reliability	Hours	1.0	3.7	2.4	6.8
Transport costs	%	-1.4%	-8.1%	-4.5%	-10.6%
Sustainability	%	-1.5%	-10.5%	-5.2%	-14.0%
Transit time	Hours	11.7	29.7	9.4	25.4

Appendix 21: Performance indicators per sailing area

Noord-Nederland

0%-Growth scenario

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	3.2	4.9	200.1	649.8	153.5
Line network	7.6	6.1	166.1	501.7	141.5
Hub-and-spoke network	3.6	6.4	171.6	333.7	211.1

RC-scenario 2015

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	3.7	4.3	198.1	640.1	148.3
Line network	9.0	7.0	156.2	457.3	132.5
Hub-and-spoke network	3.9	7.3	163.8	305.6	203.7

SE-scenario 2015

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	3.5	4.1	188.0	595.3	145.1
Line network	9.9	7.9	155.8	455.7	132.4
Hub-and-spoke network	4.1	8.6	158.0	284.8	194.8

RC-scenario 2025

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	4.0	4.3	185.2	582.9	126.3
Line network	11.5	9.0	146.8	415.6	123.9
Hub-and-spoke network	3.5	9.6	150.7	260.1	210.4

SE-scenario 2025

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	4.2	4.2	182.0	561.7	157.1
Line network	14.9	10.3	145.8	409.3	122.2
Hub-and-spoke network	2.6	11.2	162.4	303.0	273.6

Groot-Amsterdam

0%-Growth scenario

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	3.8	3.0	139.1	433.3	120.8
Line network	8.5	4.0	108.5	291.9	124.8
Hub-and-spoke network	4.2	11.0	120.7	228.5	193.0

RC-scenario 2015

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	4.3	3.3	134.3	409.8	117.8
Line network	10.2	4.5	108.9	292.5	124.3
Hub-and-spoke network	5.8	11.5	120.8	229.4	186.5

SE-scenario 2015

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	4.3	3.2	137.2	410.8	127.1
Line network	11.0	4.7	110.5	300.1	128.3
Hub-and-spoke network	4.9	12.1	121.7	231.0	196.2

RC-scenario 2025

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	4.3	3.4	134.7	396.5	132.3
Line network	12.4	4.8	104.6	275.0	123.4
Hub-and-spoke network	5.4	14.0	117.5	213.4	195.3

SE-scenario 2025

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	4.9	3.9	130.9	393.4	134.3
Line network	16.2	5.3	104.7	274.8	123.2
Hub-and-spoke network	4.8	17.5	121.4	226.0	230.2

Nijmegen-Maas

0%-Growth scenario

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	4.1	7.2	185.5	623.9	179.3
Line network	6.3	22.9	153.4	466.2	221.5

RC-scenario 2015

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	4.0	8.2	182.9	614.5	191.0
Line network	7.9	26.7	146.6	445.0	213.5

SE-scenario 2015

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	4.3	9.6	177.2	591.5	188.7
Line network	8.7	27.8	144.7	435.3	208.5

RC-scenario 2025

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	3.8	10.9	170.6	558.4	209.0
Line network	10.3	31.7	141.1	419.5	203.8

SE-scenario 2025

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	4.9	14.0	165.8	536.4	204.7
Line network	13.2	36.1	135.8	395.5	197.3

West-Brabant

0%-Growth scenario

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	9.6	2.8	111.1	322.0	101.2
Line network	57.2	6.1	108.6	280.4	79.6
Hub-and-spoke network	11.3	5.0	110.3	161.9	131.9
Trunk-feeder network	9.5	3.7	105.8	250.8	126.3

RC-scenario 2015

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	11.9	5.0	108.0	295.0	108.1
Line network	81.2	8.5	99.1	235.3	69.9
Hub-and-spoke network	14.3	7.8	103.8	131.1	120.5
Trunk-feeder network	12.2	5.6	102.7	229.4	124.4

SE-scenario 2015

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	13.0	5.7	105.5	283.5	106.9
Line network	89.8	11.5	98.1	230.3	72.2
Hub-and-spoke network	15.7	7.8	101.9	124.2	116.6
Trunk-feeder network	13.3	6.7	99.0	212.3	123.4

RC-scenario 2025

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	15.6	10.7	105.2	283.3	115.7
Line network	95.8	10.6	102.6	254.0	78.4
Hub-and-spoke network	14.7	9.2	103.0	131.2	137.1
Trunk-feeder network	14.2	10.5	100.0	217.5	132.7

SE-scenario 2025

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	19.3	22.6	101.6	266.3	131.3
Line network	110.1	23.8	105.8	266.7	107.2
Hub-and-spoke network	14.5	7.4	113.9	173.7	168.2
Trunk-feeder network	15.7	21.1	97.6	205.8	149.4

Appendix 22: Performance indicators per inland terminal

<u>Noord-Nederland</u>

Point-to-Point network

0%-Growth scenario

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTU Kampen	3.8	2.9	172.8	557.0	133.7
BSC Groningen	3.9	4.3	200.8	661.8	170.7
CT Heerenveen	2.5	3.4	177.5	593.8	135.1
HOV Harlingen	2.5	4.6	152.4	466.0	132.4
MCS Leeuwarden	3.4	5.3	206.5	726.5	148.7
MCS Westerbroek	3.0	5.6	193.6	629.6	167.8
MCS Meppel	4.2	3.2	136.3	402.3	118.2
ROC Kampen	4.3	3.4	158.7	519.0	116.1
Wijnne & Barends Delfzijl	1.3	11.0	402.0	1291.9	258.4
Noord-Nederland	**3.2**	**4.9**	**200.1**	**649.8**	**153.5**

RC-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTU Kampen	4.0	2.9	153.2	479.1	123.9
BSC Groningen	4.3	4.5	175.1	551.8	154.5
CT Heerenveen	3.3	4.8	203.9	713.0	150.4
HOV Harlingen	3.4	3.5	173.2	555.1	147.9
MCS Leeuwarden	3.9	5.5	180.9	604.3	128.0
MCS Westerbroek	3.8	5.1	206.3	680.6	173.6
MCS Meppel	5.9	3.1	167.3	535.1	140.2
ROC Kampen	2.8	3.3	131.4	377.7	117.7
Wijnne & Barends Delfzijl	1.7	6.3	391.0	1264.0	198.4
Noord-Nederland	**3.7**	**4.3**	**198.1**	**640.1**	**148.3**

SE-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTU Kampen	4.2	3.0	144.3	442.5	120.4
BSC Groningen	4.7	5.8	166.3	510.1	143.0
CT Heerenveen	3.5	4.3	192.6	662.3	144.4
HOV Harlingen	3.6	4.4	163.5	512.2	139.9
MCS Leeuwarden	4.1	4.6	171.0	559.0	121.8
MCS Westerbroek	3.6	5.6	160.4	484.5	140.9
MCS Meppel	2.8	2.1	141.2	400.9	178.5
ROC Kampen	3.6	3.1	162.2	507.9	137.6
Wijnne & Barends Delfzijl	1.9	4.5	390.7	1278.0	179.0
Noord-Nederland	**3.5**	**4.1**	**188.0**	**595.3**	**145.1**

RC-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTU Kampen	5.4	2.7	153.8	480.8	108.7
BSC Groningen	5.7	7.0	172.0	533.3	132.0
CT Heerenveen	3.9	4.7	169.3	552.5	112.0
HOV Harlingen	4.6	4.0	176.3	565.5	130.4
MCS Leeuwarden	3.2	4.0	190.2	622.7	140.2
MCS Westerbroek	4.3	5.2	172.9	540.5	139.6
MCS Meppel	3.1	3.1	128.3	345.0	136.4
ROC Kampen	4.0	3.5	141.9	421.0	101.4
Wijnne & Barends Delfzijl	2.0	4.0	362.1	1184.4	136.2
Noord-Nederland	**4.0**	**4.3**	**185.2**	**582.9**	**126.3**

SE-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTU Kampen	3.1	1.8	133.9	372.5	161.9
BSC Groningen	3.0	6.0	129.8	335.5	166.6
CT Heerenveen	3.1	3.9	173.1	549.9	161.8
HOV Harlingen	5.9	4.3	171.5	542.5	141.9
MCS Leeuwarden	4.2	3.6	193.9	638.9	160.3
MCS Westerbroek	6.2	6.0	190.8	612.8	162.1
MCS Meppel	4.2	3.9	128.3	342.0	158.1
ROC Kampen	5.2	3.7	142.0	422.3	128.8
Wijnne & Barends Delfzijl	2.9	4.9	374.6	1239.0	172.4
Noord-Nederland	**4.2**	**4.2**	**182.0**	**561.7**	**157.1**

Hub-spoke network

0%-Growth scenario

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTU Kampen	3.5	7.3	147.7	274.2	208.5
BSC Groningen	3.8	6.4	166.9	318.6	204.9
CT Heerenveen	3.3	6.2	168.9	332.8	211.5
HOV Harlingen	3.2	6.3	160.2	304.2	213.0
MCS Leeuwarden	3.8	6.6	170.2	341.0	204.7
MCS Westerbroek	3.3	6.5	171.4	329.3	212.0
MCS Meppel	4.7	7.1	151.5	282.2	196.5
ROC Kampen	5.1	6.5	153.1	292.5	194.1
Wijnne & Barends Delfzijl	1.8	5.1	254.8	528.4	255.0
Noord-Nederland	**3.6**	**6.4**	**171.6**	**333.7**	**211.1**

RC-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTU Kampen	4.1	7.6	140.9	249.8	199.1
BSC Groningen	4.3	6.8	158.8	291.0	196.8
CT Heerenveen	3.8	7.1	160.5	304.8	202.0
HOV Harlingen	3.7	7.8	153.6	279.7	203.2
MCS Leeuwarden	4.5	7.7	162.7	315.2	195.5
MCS Westerbroek	3.8	7.0	164.3	304.2	201.8
MCS Meppel	5.6	7.2	144.6	257.9	188.4
ROC Kampen	3.4	7.5	143.7	251.0	206.9
Wijnne & Barends Delfzijl	2.1	7.0	245.2	496.6	239.8
Noord-Nederland	**3.9**	**7.3**	**163.8**	**305.6**	**203.7**

SE-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTU Kampen	4.3	9.4	135.2	229.3	191.0
BSC Groningen	4.6	7.7	152.8	269.9	188.3
CT Heerenveen	4.0	8.3	154.6	283.2	193.4
HOV Harlingen	3.8	9.2	146.9	257.2	195.6
MCS Leeuwarden	4.8	8.4	156.9	294.3	186.8
MCS Westerbroek	4.0	8.4	157.5	281.2	193.8
MCS Meppel	5.9	8.1	139.1	237.7	180.2
ROC Kampen	3.6	8.9	138.2	230.8	198.2
Wijnne & Barends Delfzijl	2.3	8.7	241.0	479.7	225.6
Noord-Nederland	**4.1**	**8.6**	**158.0**	**284.8**	**194.8**

RC-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTU Kampen	4.3	9.9	131.9	217.1	198.1
BSC Groningen	4.2	8.6	147.1	254.6	199.4
CT Heerenveen	3.7	9.6	147.4	261.7	204.3
HOV Harlingen	3.8	10.1	142.1	241.7	204.0
MCS Leeuwarden	2.8	9.4	146.8	252.6	219.5
MCS Westerbroek	3.8	8.9	151.1	263.4	203.4
MCS Meppel	3.0	10.2	137.4	208.3	215.1
ROC Kampen	3.6	9.6	134.5	217.7	205.7
Wijnne & Barends Delfzijl	2.0	9.7	217.8	423.7	243.9
Noord-Nederland	**3.5**	**9.6**	**150.7**	**260.1**	**210.4**

SE-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTU Kampen	1.9	11.0	146.4	254.0	287.1
BSC Groningen	2.2	9.7	160.1	281.5	278.1
CT Heerenveen	2.1	10.1	157.7	294.0	280.2
HOV Harlingen	3.4	9.5	155.8	296.1	250.7
MCS Leeuwarden	2.6	9.5	159.6	304.2	266.4
MCS Westerbroek	3.8	21.8	167.2	323.2	289.1
MCS Meppel	2.7	9.6	150.4	260.6	263.6
ROC Kampen	3.2	9.0	147.6	270.6	253.4
Wijnne & Barends Delfzijl	1.8	10.5	216.9	442.9	294.3
Noord-Nederland	**2.6**	**11.2**	**162.4**	**303.0**	**273.6**

Line network

0%-Growth scenario

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
MCS Meppel CTU Kampen ROC Kampen	9.9	5.8	140.9	405.1	117.5
HOV Harlingen CT Heerenveen MCS Leeuwarden	5.9	5.1	164.9	491.5	141.3
Wijnne & Barends Delfzijl MCS Westerbroek BSC Groningen	7.0	7.5	192.5	608.3	165.9
Noord-Nederland	**7.6**	**6.1**	**166.1**	**501.7**	**141.5**

RC-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
MCS Meppel CTU Kampen ROC Kampen	11.8	6.7	135.0	379.8	113.0
HOV Harlingen CT Heerenveen MCS Leeuwarden	7.2	5.1	163.4	483.6	139.2
Wijnne & Barends Delfzijl MCS Westerbroek BSC Groningen	8.1	9.3	170.0	508.4	145.3
Noord-Nederland	**9.0**	**7.0**	**156.2**	**457.3**	**132.5**

SE-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
MCS Meppel CTU Kampen ROC Kampen	13.0	7.7	137.2	389.1	115.7
HOV Harlingen CT Heerenveen MCS Leeuwarden	7.6	6.0	155.0	446.9	131.7
Wijnne & Barends Delfzijl MCS Westerbroek BSC Groningen	8.9	10.0	175.3	531.1	149.7
Noord-Nederland	**9.9**	**7.9**	**155.8**	**455.7**	**132.4**

RC-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
MCS Meppel CTU Kampen ROC Kampen	15.2	9.2	131.2	361.9	110.0
HOV Harlingen CT Heerenveen MCS Leeuwarden	9.0	7.7	151.7	432.4	129.6
Wijnne & Barends Delfzijl MCS Westerbroek BSC Groningen	10.1	10.1	157.6	452.5	132.0
Noord-Nederland	**11.5**	**9.0**	**146.8**	**415.6**	**123.9**

SE-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
MCS Meppel CTU Kampen ROC Kampen	19.5	9.6	124.1	330.1	102.8
HOV Harlingen CT Heerenveen MCS Leeuwarden	11.9	7.9	151.0	426.0	126.4
Wijnne & Barends Delfzijl MCS Westerbroek BSC Groningen	13.4	13.4	162.3	471.9	137.3
Noord-Nederland	**14.9**	**10.3**	**145.8**	**409.3**	**122.2**

Groot-Amsterdam

Point-to-Point network

0%-Growth scenario

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CSY IJmuiden	3.8	3.0	170.6	525.0	89.6
CTVrede Zaandam	4.9	2.9	128.5	391.6	103.3
CTB Beverwijk	3.1	3.5	122.5	343.5	161.5
CTU Utrecht	3.0	1.8	92.5	224.2	112.9
CTVrede Amsterdam	4.3	3.6	122.5	344.6	153.3
SCS Amsterdam	4.3	3.2	166.7	593.9	117.3
USA Amsterdam	4.5	2.3	139.9	438.6	110.3
MEO Velsen-Noord	2.8	3.7	169.7	604.9	118.5
Groot-Amsterdam	**3.8**	**3.0**	**139.1**	**433.3**	**120.8**

RC-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CSY IJmuiden	5.2	2.7	201.0	634.4	97.2
CTVrede Zaandam	5.1	2.6	121.3	362.5	99.2
CTB Beverwijk	3.2	4.4	113.7	306.4	154.6
CTU Utrecht	4.2	1.9	102.4	264.2	120.9
CTVrede Amsterdam	4.7	4.5	109.0	288.4	143.6
SCS Amsterdam	4.7	4.3	146.0	500.3	107.2
USA Amsterdam	4.8	3.0	124.3	375.1	104.3
MEO Velsen-Noord	2.9	3.0	156.3	546.9	115.2
Groot-Amsterdam	**4.3**	**3.3**	**134.3**	**409.8**	**117.8**

SE-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CSY IJmuiden	5.3	2.8	191.9	601.9	94.7
CTVrede Zaandam	6.1	2.4	136.0	423.8	109.1
CTB Beverwijk	4.0	3.7	128.8	369.7	166.6
CTU Utrecht	4.2	2.6	98.1	247.4	119.4
CTVrede Amsterdam	2.6	5.1	122.0	286.9	194.9
SCS Amsterdam	3.0	2.7	132.6	410.5	112.1
USA Amsterdam	6.0	2.9	140.9	443.8	112.0
MEO Velsen-Noord	3.1	3.1	147.0	502.4	107.9
Groot-Amsterdam	**4.3**	**3.2**	**137.2**	**410.8**	**127.1**

RC-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CSY IJmuiden	5.6	2.8	184.6	570.7	90.4
CTVrede Zaandam	6.3	2.6	131.3	404.3	106.3
CTB Beverwijk	4.0	3.9	123.2	347.2	165.4
CTU Utrecht	4.5	2.9	88.1	205.7	111.6
CTVrede Amsterdam	3.3	5.8	129.1	314.5	198.8
SCS Amsterdam	4.2	2.7	149.6	477.6	119.7
USA Amsterdam	3.1	2.5	131.1	377.3	159.3
MEO Velsen-Noord	3.1	3.7	140.5	475.0	107.2
Groot-Amsterdam	**4.3**	**3.4**	**134.7**	**396.5**	**132.3**

SE-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CSY IJmuiden	3.8	3.3	193.1	697.5	131.8
CTVrede Zaandam	7.8	3.2	127.9	392.5	107.2
CTB Beverwijk	5.2	5.1	118.0	324.7	161.5
CTU Utrecht	6.1	3.7	87.7	203.4	110.6
CTVrede Amsterdam	4.3	5.0	126.1	301.6	193.9
SCS Amsterdam	4.6	2.9	130.4	402.2	109.4
USA Amsterdam	3.4	3.7	111.2	297.0	148.1
MEO Velsen-Noord	4.5	4.0	152.6	528.6	111.8
Groot-Amsterdam	**4.9**	**3.9**	**130.9**	**393.4**	**134.3**

Hub-spoke network

0%-Growth scenario

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTVrede Amsterdam	5.9	11.1	102.1	214.6	168.7
CSY IJmuiden	4.5	12.8	132.9	243.8	206.3
CTVrede Zaandam	4.8	12.7	126.4	226.4	203.6
CTB Beverwijk	3.3	13.0	133.7	228.4	219.8
MEO Velsen-Noord	3.2	12.0	127.6	235.2	221.4
SCS Amsterdam	4.7	12.6	124.6	230.2	204.9
USA Amsterdam	4.5	12.4	125.5	225.5	206.2
CTU Utrecht	3.0	1.8	92.5	224.2	112.9
Groot-Amsterdam	**4.2**	**11.0**	**120.7**	**228.5**	**193.0**

RC-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTVrede Amsterdam	6.9	11.6	100.9	209.4	169.5
CSY IJmuiden	5.0	13.1	131.5	238.5	203.1
CTVrede Zaandam	5.6	12.6	125.2	221.3	199.5
CTB Beverwijk	3.7	12.9	132.4	223.1	214.9
MEO Velsen-Noord	6.5	13.2	126.6	232.1	195.4
SCS Amsterdam	9.6	13.9	123.2	226.5	187.0
USA Amsterdam	5.3	12.8	124.2	220.2	201.3
CTU Utrecht	4.2	1.9	102.4	264.2	120.9
Groot-Amsterdam	**5.8**	**11.5**	**120.8**	**229.4**	**186.5**

SE-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTVrede Amsterdam	7.7	12.0	102.3	214.6	174.2
CSY IJmuiden	5.3	13.6	132.8	243.4	205.7
CTVrede Zaandam	5.5	13.8	126.6	226.2	204.8
CTB Beverwijk	4.0	14.2	133.9	228.3	216.6
MEO Velsen-Noord	3.7	13.7	127.2	234.1	219.2
SCS Amsterdam	3.3	13.5	126.9	228.7	224.4
USA Amsterdam	5.4	13.8	125.6	225.3	205.1
CTU Utrecht	4.2	2.6	98.1	247.4	119.4
Groot-Amsterdam	**4.9**	**12.1**	**121.7**	**231.0**	**196.2**

RC-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTVrede Amsterdam	8.5	14.4	98.9	200.5	177.2
CSY IJmuiden	5.8	15.3	129.4	229.5	206.4
CTVrede Zaandam	6.0	15.8	123.2	212.2	205.4
CTB Beverwijk	4.2	15.4	130.5	214.2	217.0
MEO Velsen-Noord	4.0	16.1	123.8	220.0	219.6
SCS Amsterdam	3.8	15.7	123.7	214.5	220.9
USA Amsterdam	6.1	16.6	122.1	211.1	204.7
CTU Utrecht	4.5	2.9	88.1	205.7	111.6
Groot-Amsterdam	**5.4**	**14.0**	**117.5**	**213.4**	**195.3**

SE-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTVrede Amsterdam	9.6	17.5	102.2	216.2	207.1
CSY IJmuiden	2.9	19.0	131.2	238.7	264.8
CTVrede Zaandam	5.3	20.4	127.1	228.0	238.6
CTB Beverwijk	4.0	19.6	134.7	230.0	249.4
MEO Velsen-Noord	3.9	20.5	127.9	235.3	250.6
SCS Amsterdam	3.6	19.7	127.7	230.2	253.5
USA Amsterdam	2.8	19.5	132.8	226.7	267.3
CTU Utrecht	6.1	3.7	87.7	203.4	110.6
Groot-Amsterdam	**4.8**	**17.5**	**121.4**	**226.0**	**230.2**

Line network

0%-Growth scenario

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CSY Ijmuiden MEO Velsen-Noord CTB Beverwijk	4.1	4.3	121.3	335.5	162.1
CTVrede Zaandam CTVrede Amsterdam USA Amsterdam SCS Amsterdam	18.5	6.0	111.9	316.0	99.4
CTU Utrecht	3.0	1.8	92.5	224.2	112.9
Groot-Amsterdam	**8.5**	**4.0**	**108.5**	**291.9**	**124.8**

RC-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CSY Ijmuiden MEO Velsen-Noord CTB Beverwijk	4.4	5.5	113.1	300.6	153.1
CTVrede Zaandam CTVrede Amsterdam USA Amsterdam SCS Amsterdam	22.0	6.0	111.3	312.8	98.8
CTU Utrecht	4.2	1.9	102.4	264.2	120.9
Groot-Amsterdam	**10.2**	**4.5**	**108.9**	**292.5**	**124.3**

SE-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CSY Ijmuiden MEO Velsen-Noord CTB Beverwijk	5.0	5.3	123.0	343.9	166.7
CTVrede Zaandam CTVrede Amsterdam USA Amsterdam SCS Amsterdam	23.8	6.2	110.3	308.9	98.6
CTU Utrecht	4.2	2.6	98.1	247.4	119.4
Groot-Amsterdam	**11.0**	**4.7**	**110.5**	**300.1**	**128.3**

RC-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CSY Ijmuiden MEO Velsen-Noord CTB Beverwijk	5.2	5.0	117.4	319.8	161.4
CTVrede Zaandam CTVrede Amsterdam USA Amsterdam SCS Amsterdam	27.6	6.3	108.3	299.5	97.1
CTU Utrecht	4.5	2.9	88.1	205.7	111.6
Groot-Amsterdam	**12.4**	**4.8**	**104.6**	**275.0**	**123.4**

SE-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CSY Ijmuiden MEO Velsen-Noord CTB Beverwijk	7.1	5.7	121.7	338.2	164.8
CTVrede Zaandam CTVrede Amsterdam USA Amsterdam SCS Amsterdam	35.5	6.5	104.7	282.8	94.3
CTU Utrecht	6.1	3.7	87.7	203.4	110.6
Groot-Amsterdam	**16.2**	**5.3**	**104.7**	**274.8**	**123.2**

Nijmegen-Maas

Point-to-Point network

0%-Growth scenario

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BT Born	4.2	22.3	184.9	607.5	276.7
CT Nijmegen	3.5	9.5	153.1	493.4	235.9
CTU Tiel	4.0	3.3	136.7	450.4	127.0
CT Cuijk	4.4	2.7	195.3	663.8	114.3
CTS Stein	2.3	5.7	396.6	1407.1	218.9
LCG Gorinchem	4.8	1.8	91.6	249.5	69.7
OOC Oss	5.0	3.4	143.8	481.2	133.3
TCT Venlo	4.3	7.1	201.9	723.4	195.4
WIT Wanssum	4.1	8.9	166.0	538.8	242.7
Nijmegen-Maas	**4.1**	**7.2**	**185.5**	**623.9**	**179.3**

RC-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BT Born	5.3	25.1	192.3	637.1	278.2
CT Nijmegen	2.4	10.7	143.8	385.9	276.9
CTU Tiel	5.2	3.4	143.0	476.6	128.7
CT Cuijk	2.9	4.0	218.3	849.4	174.6
CTS Stein	2.6	4.9	378.9	1362.0	192.1
LCG Gorinchem	5.2	2.3	86.1	227.5	64.7
OOC Oss	2.6	4.0	132.3	401.8	189.8
TCT Venlo	5.0	7.0	202.5	727.5	198.2
WIT Wanssum	4.6	12.2	149.0	462.6	215.6
Nijmegen-Maas	**4.0**	**8.2**	**182.9**	**614.5**	**191.0**

SE-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BT Born	5.5	29.6	185.3	607.0	271.5
CT Nijmegen	2.8	13.7	154.6	431.3	291.0
CTU Tiel	5.5	3.5	135.8	444.4	122.7
CT Cuijk	2.9	4.3	203.7	782.4	170.7
CTS Stein	2.6	5.7	362.1	1317.8	190.9
LCG Gorinchem	6.8	1.7	97.4	273.3	73.5
OOC Oss	2.7	4.2	124.9	369.9	184.5
TCT Venlo	5.4	7.5	190.0	669.7	186.7
WIT Wanssum	4.8	16.1	141.2	427.8	206.7
Nijmegen-Maas	**4.3**	**9.6**	**177.2**	**591.5**	**188.7**

RC-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BT Born	6.5	31.0	191.9	635.2	278.1
CT Nijmegen	3.7	20.2	137.3	356.8	270.9
CTU Tiel	2.7	4.3	125.7	374.7	188.0
CT Cuijk	3.8	4.6	218.6	851.5	176.2
CTS Stein	2.6	5.1	325.2	1190.7	192.2
LCG Gorinchem	3.1	1.5	93.0	230.5	106.4
OOC Oss	3.5	4.2	132.1	400.8	190.7
TCT Venlo	2.4	8.8	170.6	559.3	273.9
WIT Wanssum	5.7	18.2	141.0	426.2	204.7
Nijmegen-Maas	**3.8**	**10.9**	**170.6**	**558.4**	**209.0**

SE-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BT Born	8.6	37.7	183.7	596.8	264.9
CT Nijmegen	4.7	27.3	137.5	357.2	284.0
CTU Tiel	3.6	4.1	126.2	375.4	186.5
CT Cuijk	4.8	5.2	210.5	812.7	173.5
CTS Stein	3.5	6.1	320.3	1170.5	188.9
LCG Gorinchem	3.4	2.1	80.8	180.2	99.0
OOC Oss	4.6	5.7	128.3	382.4	182.9
TCT Venlo	3.2	13.9	163.5	525.0	257.0
WIT Wanssum	7.2	23.6	141.4	427.9	205.3
Nijmegen-Maas	**4.9**	**14.0**	**165.8**	**536.4**	**204.7**

Line network

0%-Growth scenario

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTS Stein BT Born TCT Venlo	5.9	32.0	187.6	614.5	278.0
WIT Wanssum CT Cuijk OOC Oss	6.4	20.6	144.7	438.2	208.6
CT Nijmegen CTU Tiel LCG Gorinchem	6.6	15.9	127.9	345.8	178.0
Nijmegen-Maas	**6.3**	**22.9**	**153.4**	**466.2**	**221.5**

RC-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTS Stein BT Born TCT Venlo	7.3	34.7	184.9	601.3	272.0
WIT Wanssum CT Cuijk OOC Oss	7.6	23.2	138.3	409.6	199.0
CT Nijmegen CTU Tiel LCG Gorinchem	8.9	22.2	116.7	324.1	169.4
Nijmegen-Maas	**7.9**	**26.7**	**146.6**	**445.0**	**213.5**

SE-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTS Stein BT Born TCT Venlo	7.9	36.8	185.6	604.1	273.0
WIT Wanssum CT Cuijk OOC Oss	8.3	22.9	139.6	413.7	197.1
CT Nijmegen CTU Tiel LCG Gorinchem	9.7	23.6	108.8	287.9	155.5
Nijmegen-Maas	**8.7**	**27.8**	**144.7**	**435.3**	**208.5**

RC-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTS Stein BT Born TCT Venlo	9.2	39.9	184.6	599.1	268.9
WIT Wanssum CT Cuijk OOC Oss	9.6	26.6	133.4	387.1	190.0
CT Nijmegen CTU Tiel LCG Gorinchem	11.9	28.5	105.3	272.2	152.5
Nijmegen-Maas	**10.3**	**31.7**	**141.1**	**419.5**	**203.8**

SE-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTS Stein BT Born TCT Venlo	11.8	46.0	181.4	584.6	264.6
WIT Wanssum CT Cuijk OOC Oss	12.1	31.1	126.5	355.5	178.3
CT Nijmegen CTU Tiel LCG Gorinchem	15.6	31.3	99.6	246.3	148.9
Nijmegen-Maas	**13.2**	**36.1**	**135.8**	**395.5**	**197.3**

West-Brabant

Point-to-Point network

0%-Growth scenario

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BTT Tilburg	23.4	2.5	128.3	395.2	71.6
BTT Vossenberg	5.0	2.9	113.5	351.1	73.3
CCT + MCT Moerdijk	5.6	1.7	84.8	196.2	89.4
CT Den Bosch	10.3	2.8	123.7	394.3	113.2
DMT Moerdijk	3.6	1.8	84.2	195.1	94.1
IT Veghel	19.8	2.6	161.5	523.2	93.3
MCT Bergen op Zoom	2.7	5.4	100.4	252.9	185.6
OCT Oosterhout	6.1	2.2	94.5	237.6	108.9
ROC Waalwijk	10.3	3.6	108.7	352.1	81.4
West-Brabant	**9.6**	**2.8**	**111.1**	**322.0**	**101.2**

RC-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BTT Tilburg	28.7	2.9	126.6	386.7	70.1
BTT Vossenberg	6.5	2.7	119.7	377.5	103.1
CCT + MCT Moerdijk	4.5	2.1	85.2	145.6	112.6
CT Den Bosch	12.3	3.2	118.2	369.7	108.7
DMT Moerdijk	3.8	1.7	100.9	209.4	133.3
IT Veghel	24.2	3.0	157.0	501.3	90.2
MCT Bergen op Zoom	4.7	22.6	74.5	134.2	177.5
OCT Oosterhout	10.3	3.3	82.7	186.9	97.2
ROC Waalwijk	12.6	3.9	107.1	343.5	80.0
West-Brabant	**11.9**	**5.0**	**108.0**	**295.0**	**108.1**

SE-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BTT Tilburg	31.2	2.8	126.9	387.1	69.9
BTT Vossenberg	6.7	2.6	114.2	354.0	99.9
CCT + MCT Moerdijk	5.6	1.6	92.2	174.4	119.8
CT Den Bosch	12.7	4.1	103.0	299.5	92.3
DMT Moerdijk	4.0	1.4	96.9	193.2	125.2
IT Veghel	26.1	3.2	155.9	496.6	90.0
MCT Bergen op Zoom	5.2	26.8	71.0	117.9	191.9
OCT Oosterhout	11.3	4.9	76.9	161.9	89.3
ROC Waalwijk	14.0	4.0	112.1	367.3	83.9
West-Brabant	**13.0**	**5.7**	**105.5**	**283.5**	**106.9**

RC-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BTT Tilburg	38.0	3.0	127.6	390.3	70.6
BTT Vossenberg	8.2	2.5	115.7	360.5	101.7
CCT + MCT Moerdijk	7.7	2.4	83.5	138.1	108.4
CT Den Bosch	16.0	3.9	113.7	348.7	104.6
DMT Moerdijk	5.5	2.0	90.6	168.4	122.3
IT Veghel	31.2	3.7	150.2	470.0	86.2
MCT Bergen op Zoom	6.0	66.3	60.6	69.4	220.0
OCT Oosterhout	10.8	7.7	88.9	219.9	139.4
ROC Waalwijk	17.2	4.5	115.6	384.4	87.6
West-Brabant	**15.6**	**10.7**	**105.2**	**283.3**	**115.7**

SE-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BTT Tilburg	48.5	3.1	125.0	378.3	69.2
BTT Vossenberg	10.0	2.5	110.6	339.2	100.6
CCT + MCT Moerdijk	10.5	2.1	85.4	145.9	111.6
CT Den Bosch	20.5	5.5	107.8	320.6	98.0
DMT Moerdijk	7.0	2.4	87.2	154.4	120.1
IT Veghel	40.0	4.7	141.3	426.6	79.6
MCT Bergen op Zoom	6.1	133.6	58.1	57.5	295.0
OCT Oosterhout	8.6	41.7	90.1	223.8	226.1
ROC Waalwijk	22.7	7.4	109.1	350.6	81.1
West-Brabant	**19.3**	**22.6**	**101.6**	**266.3**	**131.3**

Hub-spoke network

0%-Growth scenario

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CCT + MCT Moerdijk	15.2	4.5	77.0	130.8	110.5
BTT Tilburg	4.5	4.8	107.3	140.9	147.8
BTT Vossenberg	10.0	5.0	112.8	165.4	127.3
CT Den Bosch	4.1	5.1	120.6	159.8	151.5
DMT Moerdijk	6.6	5.2	112.0	148.6	135.9
IT Veghel	24.1	4.9	115.7	181.0	124.5
MCT Bergen op Zoom	19.2	4.8	125.9	199.3	128.0
OCT Oosterhout	6.4	5.1	112.4	164.8	136.9
ROC Waalwijk	11.9	5.3	109.2	166.8	124.7
West-Brabant	**11.3**	**5.0**	**110.3**	**161.9**	**131.9**

RC-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CCT + MCT Moerdijk	22.4	7.3	70.3	100.8	97.2
BTT Tilburg	4.2	7.6	111.5	110.5	137.5
BTT Vossenberg	13.5	8.1	106.2	138.1	122.2
CT Den Bosch	4.1	7.4	109.4	121.8	138.2
DMT Moerdijk	11.3	8.2	103.9	117.7	126.9
IT Veghel	29.1	8.0	108.3	151.5	114.6
MCT Bergen op Zoom	23.7	7.9	119.1	171.1	118.6
OCT Oosterhout	7.4	7.7	104.3	133.8	119.8
ROC Waalwijk	13.3	7.6	100.7	134.8	109.8
West-Brabant	**14.3**	**7.8**	**103.8**	**131.1**	**120.5**

SE-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CCT + MCT Moerdijk	25.0	7.4	68.6	93.9	93.6
BTT Tilburg	4.5	7.6	109.9	103.6	130.6
BTT Vossenberg	14.6	8.0	104.1	130.8	116.7
CT Den Bosch	4.0	7.5	107.3	114.8	135.2
DMT Moerdijk	12.3	8.0	101.9	110.5	120.9
IT Veghel	31.2	7.9	106.1	143.9	109.8
MCT Bergen op Zoom	25.3	7.8	116.5	162.9	113.5
OCT Oosterhout	7.9	7.7	102.2	126.4	114.8
ROC Waalwijk	16.3	8.1	100.2	130.9	114.3
West-Brabant	**15.7**	**7.8**	**101.9**	**124.2**	**116.6**

RC-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CCT + MCT Moerdijk	28.7	8.2	69.9	101.7	110.6
BTT Tilburg	4.4	8.6	112.3	112.0	148.9
BTT Vossenberg	12.0	10.9	104.6	136.0	138.6
CT Den Bosch	6.2	8.2	109.1	123.8	164.7
DMT Moerdijk	12.4	8.7	103.0	117.9	137.7
IT Veghel	26.4	9.4	107.1	151.1	129.7
MCT Bergen op Zoom	21.8	9.6	117.3	169.8	133.6
OCT Oosterhout	6.8	9.0	103.3	131.6	135.4
ROC Waalwijk	13.9	9.9	100.9	136.7	134.8
West-Brabant	**14.7**	**9.2**	**103.0**	**131.2**	**137.1**

SE-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CCT + MCT Moerdijk	30.6	5.2	80.0	143.1	136.5
BTT Tilburg	4.2	5.8	122.5	153.6	176.7
BTT Vossenberg	11.3	8.1	115.4	178.4	166.2
CT Den Bosch	6.5	5.4	120.5	166.7	188.2
DMT Moerdijk	12.7	9.0	113.6	160.1	176.1
IT Veghel	24.9	7.9	118.3	194.4	163.5
MCT Bergen op Zoom	21.3	8.4	129.2	214.6	168.1
OCT Oosterhout	6.2	6.0	113.8	173.3	163.8
ROC Waalwijk	13.2	11.0	111.8	179.4	174.6
West-Brabant	**14.5**	**7.4**	**113.9**	**173.7**	**168.2**

Line network

0%-Growth scenario

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BTT Tilburg BTT Vossenberg OCT Oosterhout	150.1	7.0	142.9	433.2	91.4
IT Veghel ROC Waalwijk CT Den Bosch	158.0	8.3	118.4	315.7	60.6
MCT Bergen op Zoom DMT Moerdijk CCT + MCT Moerdijk	22.3	56.2	56.1	51.3	169.6
West-Brabant	**110.1**	**23.8**	**105.8**	**266.7**	**107.2**

RC-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BTT Tilburg BTT Vossenberg OCT Oosterhout	145.0	3.6	130.8	381.8	72.8
IT Veghel ROC Waalwijk CT Den Bosch	120.9	7.5	118.9	319.4	61.0
MCT Bergen op Zoom DMT Moerdijk CCT + MCT Moerdijk	21.4	20.6	58.2	60.8	101.4
West-Brabant	**95.8**	**10.6**	**102.6**	**254.0**	**78.4**

SE-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BTT Tilburg BTT Vossenberg OCT Oosterhout	148.7	4.8	108.4	269.6	50.8
IT Veghel ROC Waalwijk CT Den Bosch	100.7	7.6	123.4	341.1	64.9
MCT Bergen op Zoom DMT Moerdijk CCT + MCT Moerdijk	19.9	22.1	62.4	80.4	100.9
West-Brabant	**89.8**	**11.5**	**98.1**	**230.3**	**72.2**

RC-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BTT Tilburg BTT Vossenberg OCT Oosterhout	133.2	4.5	108.3	269.7	50.4
IT Veghel ROC Waalwijk CT Den Bosch	92.8	7.2	123.7	342.7	65.2
MCT Bergen op Zoom DMT Moerdijk CCT + MCT Moerdijk	17.8	14.0	65.2	93.6	94.2
West-Brabant	**81.2**	**8.5**	**99.1**	**235.3**	**69.9**

SE-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BTT Tilburg BTT Vossenberg OCT Oosterhout	86.1	4.3	120.0	326.4	60.4
IT Veghel ROC Waalwijk CT Den Bosch	75.8	6.7	128.2	364.1	73.3
MCT Bergen op Zoom DMT Moerdijk CCT + MCT Moerdijk	9.6	7.2	77.5	150.8	105.0
West-Brabant	**57.2**	**6.1**	**108.6**	**280.4**	**79.6**

Trunk-feeder network

0%-Growth scenario

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
OCT Oosterhout	8.0	3.3	81.4	192.0	104.7
BTT Tilburg	23.4	5.0	111.6	223.8	119.2
IT Veghel	18.5	4.6	124.5	258.5	137.7
BTT Vossenberg	5.0	2.9	113.5	351.1	100.8
CCT + MCT Moerdijk	3.8	1.9	90.8	178.3	132.5
CT Den Bosch	10.3	2.8	123.7	394.3	113.2
DMT Moerdijk	3.6	1.8	84.2	195.1	94.1
MCT Bergen op Zoom	2.7	5.4	100.4	252.9	185.6
ROC Waalwijk	10.4	5.9	121.6	211.1	148.8
West-Brabant	**9.5**	**3.7**	**105.8**	**250.8**	**126.3**

RC-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
OCT Oosterhout	13.5	4.6	79.7	180.6	99.1
BTT Tilburg	28.7	5.2	109.4	212.6	110.8
IT Veghel	22.1	2.8	126.8	268.3	146.2
BTT Vossenberg	6.5	2.7	119.7	377.5	103.1
CCT + MCT Moerdijk	5.9	2.7	82.4	139.7	113.7
CT Den Bosch	12.3	3.2	118.2	369.7	108.7
DMT Moerdijk	3.8	1.7	100.9	209.4	133.3
MCT Bergen op Zoom	4.7	22.6	74.5	134.2	177.5
ROC Waalwijk	12.6	4.7	113.1	172.2	127.0
West-Brabant	**12.2**	**5.6**	**102.7**	**229.4**	**124.4**

SE-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
OCT Oosterhout	14.9	6.6	74.6	157.6	90.1
BTT Tilburg	31.0	7.0	104.1	189.4	101.0
IT Veghel	24.2	5.1	122.1	246.7	143.1
BTT Vossenberg	6.7	2.6	114.2	354.0	99.9
CCT + MCT Moerdijk	6.9	2.2	87.2	159.6	121.5
CT Den Bosch	12.7	4.1	103.0	299.5	92.3
DMT Moerdijk	4.0	1.4	96.9	193.2	125.2
MCT Bergen op Zoom	5.2	26.8	71.0	117.9	191.9
ROC Waalwijk	14.2	4.5	117.8	193.0	145.3
West-Brabant	**13.3**	**6.7**	**99.0**	**212.3**	**123.4**

RC-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
OCT Oosterhout	16.2	3.8	82.6	197.0	113.7
BTT Tilburg	19.6	5.8	112.7	229.3	130.8
IT Veghel	28.9	3.8	121.8	246.1	149.2
BTT Vossenberg	8.2	2.5	115.7	360.5	101.7
CCT + MCT Moerdijk	10.1	2.4	85.9	152.4	116.3
CT Den Bosch	16.0	3.9	113.7	348.7	104.6
DMT Moerdijk	5.5	2.0	90.6	168.4	122.3
MCT Bergen op Zoom	6.0	66.3	60.6	69.4	220.0
ROC Waalwijk	17.3	4.2	116.5	186.0	135.7
West-Brabant	**14.2**	**10.5**	**100.0**	**217.5**	**132.7**

SE-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
OCT Oosterhout	16.3	11.2	90.2	226.9	153.1
BTT Tilburg	10.3	18.5	121.3	260.5	201.9
IT Veghel	37.1	7.2	112.3	203.3	147.2
BTT Vossenberg	10.0	2.5	110.6	339.2	100.6
CCT + MCT Moerdijk	12.6	4.0	80.2	128.3	106.5
CT Den Bosch	20.5	5.5	107.8	320.6	98.0
DMT Moerdijk	7.0	2.4	87.2	154.4	120.1
MCT Bergen op Zoom	6.1	133.6	58.1	57.5	295.0
ROC Waalwijk	21.8	5.0	110.4	161.4	121.9
West-Brabant	**15.7**	**21.1**	**97.6**	**205.8**	**149.4**

Appendix 23: Effect of bundling on transport costs per inland terminal

Noord-Nederland

Line network

Inland Terminal	Volume PoR (TEU)	0%-Growth	RC-scenario 2015	RC-scenario 2025
Wijnne & Barends Delfzijl	2.500	-52%	-57%	-56%
CT Heerenveen	12.000	-7%	-20%	-10%
MCS Leeuwarden	15.000	-20%	-10%	-20%
ROC Kampen	20.000	-11%	3%	-8%
HOV Harlingen	22.000	8%	-6%	-14%
MCS Westerbroek	24.000	-1%	-18%	-9%
CTU Kampen	25.000	-18%	-12%	-15%
BSC Groningen	30.000	-4%	-3%	-8%
MCS Meppel	37.000	3%	-19%	2%
Noord-Nederland	**187.500**	**-17%**	**-21%**	**-21%**

Inland Terminal	Volume PoR (TEU)	0%-Growth	SE-scenario 2015	SE-scenario 2025
Wijnne & Barends Delfzijl	2.500	-52%	-55%	-57%
CT Heerenveen	12.000	-7%	-20%	-13%
MCS Leeuwarden	15.000	-20%	-9%	-22%
ROC Kampen	20.000	-11%	-15%	-13%
HOV Harlingen	22.000	8%	-5%	-12%
MCS Westerbroek	24.000	-1%	9%	-15%
CTU Kampen	25.000	-18%	-5%	-7%
BSC Groningen	30.000	-4%	5%	25%
MCS Meppel	37.000	3%	-3%	-3%
Noord-Nederland	**187.500**	**-17%**	**-17%**	**-20%**

Hub-spoke network

Inland Terminal	Volume PoR (TEU)	0%-Growth	RC-scenario 2015	RC-scenario 2025
Wijnne & Barends Delfzijl	2.500	-37%	-37%	-40%
CT Heerenveen	12.000	-5%	-21%	-13%
MCS Leeuwarden	15.000	-18%	-10%	-23%
ROC Kampen	20.000	-4%	9%	-5%
HOV Harlingen	22.000	5%	-11%	-19%
MCS Westerbroek	24.000	-11%	-20%	-13%
CTU Kampen	25.000	-15%	-8%	-14%
BSC Groningen	30.000	-17%	-9%	-14%
MCS Meppel	37.000	11%	-14%	7%
Noord-Nederland	**187.500**	**-14%**	**-17%**	**-19%**

Inland Terminal	Volume PoR (TEU)	0%-Growth	SE-scenario 2015	SE-scenario 2025
Wijnne & Barends Delfzijl	2.500	-37%	-38%	-42%
CT Heerenveen	12.000	-5%	-20%	-9%
MCS Leeuwarden	15.000	-18%	-8%	-18%
ROC Kampen	20.000	-4%	-15%	4%
HOV Harlingen	22.000	5%	-10%	-9%
MCS Westerbroek	24.000	-11%	-2%	-12%
CTU Kampen	25.000	-15%	-6%	9%
BSC Groningen	30.000	-17%	-8%	23%
MCS Meppel	37.000	11%	-1%	17%
Noord-Nederland	**187.500**	**-14%**	**-16%**	**-11%**

Groot-Amsterdam

Line network

Inland Terminal	Volume PoR (TEU)	0%-Growth	RC-scenario 2015	RC-scenario 2025
CSY IJmuiden	8.500	-29%	-44%	-36%
MEO Velsen-Noord	12.000	-29%	-28%	-16%
SCS Amsterdam	18.000	-33%	-24%	-28%
USA Amsterdam	32.000	-20%	-10%	-17%
CTVrede Zaandam	36.000	-13%	-8%	-17%
CTB Beverwijk	57.000	-1%	-1%	-5%
CTVrede Amsterdam	76.000	-9%	2%	-16%
CTU Utrecht	54.040	-	-	-
Groot-Amsterdam	**293.540**	**-22%**	**-13%**	**-22%**

Inland Terminal	Volume PoR (TEU)	0%-Growth	SE-scenario 2015	SE-scenario 2025
CSY IJmuiden	8.500	-29%	-36%	-37%
MEO Velsen-Noord	12.000	-29%	-16%	-20%
SCS Amsterdam	18.000	-33%	-17%	-20%
USA Amsterdam	32.000	-20%	-22%	-6%
CTVrede Zaandam	36.000	-13%	-19%	-18%
CTB Beverwijk	57.000	-1%	-5%	3%
CTVrede Amsterdam	76.000	-9%	-10%	-17%
CTU Utrecht	54.040	-	-	-
Groot-Amsterdam	**293.540**	**-22%**	**-19%**	**-20%**

Hub-spoke network

Inland Terminal	Volume PoR (TEU)	0%-Growth	RC-scenario 2015	RC-scenario 2025
CSY IJmuiden	8.500	-22%	-35%	-30%
MEO Velsen-Noord	12.000	-25%	-19%	-12%
SCS Amsterdam	18.000	-25%	-16%	-17%
USA Amsterdam	32.000	-10%	0%	-7%
CTVrede Zaandam	36.000	-2%	3%	-6%
CTB Beverwijk	57.000	9%	16%	6%
CTVrede Amsterdam	76.000	-17%	-7%	-23%
CTU Utrecht	54.040	-	-	-
Groot-Amsterdam	**239.540**	**-13%**	**-10%**	**-13%**

Inland Terminal	Volume PoR (TEU)	0%-Growth	SE-scenario 2015	SE-scenario 2025
CSY IJmuiden	8.500	-22%	-31%	-32%
MEO Velsen-Noord	12.000	-25%	-13%	-16%
SCS Amsterdam	18.000	-25%	-4%	-2%
USA Amsterdam	32.000	-10%	-11%	19%
CTVrede Zaandam	36.000	-2%	-7%	-1%
CTB Beverwijk	57.000	9%	4%	14%
CTVrede Amsterdam	76.000	-17%	-16%	-19%
CTU Utrecht	54.040	-	-	-
Groot-Amsterdam	**239.540**	**-13%**	**-11%**	**-7%**

Nijmegen-Maas

Inland Terminal	Volume PoR (TEU)	0%-Growth	RC-scenario 2015	RC-scenario 2025
CTS Stein	4.000	-53%	-51%	-43%
CT Cuijk	10.000	-26%	-37%	-39%
CTU Tiel	32.000	-6%	-18%	-16%
TCT Venlo	34.400	-7%	-9%	8%
LCG Gorinchem	35.000	40%	36%	13%
OOC Oss	40.000	1%	4%	1%
CT Nijmegen	68.000	-16%	-19%	-23%
WIT Wanssum	76.000	-13%	-7%	-5%
BT Born	87.500	1%	-4%	-4%
Nijmegen-Maas	**386.900**	**-17%**	**-20%**	**-17%**

Inland Terminal	Volume PoR (TEU)	0%-Growth	SE-scenario 2015	SE-scenario 2025
CTS Stein	4.000	-53%	-49%	-43%
CT Cuijk	10.000	-26%	-31%	-40%
CTU Tiel	32.000	-6%	-20%	-21%
TCT Venlo	34.400	-7%	-2%	11%
LCG Gorinchem	35.000	40%	12%	23%
OOC Oss	40.000	1%	12%	-1%
CT Nijmegen	68.000	-16%	-30%	-28%
WIT Wanssum	76.000	-13%	-1%	-11%
BT Born	87.500	1%	0%	-1%
Nijmegen-Maas	**386.900**	**-17%**	**-18%**	**-18%**

West-Brabant

Line network

Inland Terminal	Volume PoR (TEU)	0%-Growth	RC-scenario 2015	RC-scenario 2025
BTT Vossenberg	40.000	6%	-10%	13%
IT Veghel	45.000	-21%	-21%	-21%
ROC Waalwijk	50.000	18%	16%	3%
BTT Tilburg	55.000	-6%	-15%	2%
MCT Bergen op Zoom	56.000	-23%	-12%	-4%
DMT Moerdijk	60.000	-8%	-35%	-36%
CT Den Bosch	84.000	4%	5%	5%
CCT + MCT Moerdijk	90.000	-9%	-23%	-30%
OCT Oosterhout	104.000	27%	31%	47%
West-Brabant	**584.000**	**-2%**	**-8%**	**-2%**

Inland Terminal	Volume PoR (TEU)	0%-Growth	SE-scenario 2015	SE-scenario 2025
BTT Vossenberg	40.000	6%	-5%	29%
IT Veghel	45.000	-21%	-21%	-16%
ROC Waalwijk	50.000	18%	10%	9%
BTT Tilburg	55.000	-6%	-15%	14%
MCT Bergen op Zoom	56.000	-23%	-12%	-3%
DMT Moerdijk	60.000	-8%	-36%	-36%
CT Den Bosch	84.000	4%	20%	10%
CCT + MCT Moerdijk	90.000	-9%	-32%	-34%
OCT Oosterhout	104.000	27%	41%	59%
West-Brabant	**584.000**	**-2%**	**-7%**	**4%**

Hub-spoke network

Inland Terminal	Volume PoR (TEU)	0%-Growth	RC-scenario 2015	RC-scenario 2025
BTT Vossenberg	40.000	-1%	-13%	-11%
IT Veghel	45.000	-22%	-24%	-22%
ROC Waalwijk	50.000	0%	-6%	-13%
BTT Tilburg	55.000	-10%	-15%	-16%
MCT Bergen op Zoom	56.000	20%	47%	80%
DMT Moerdijk	60.000	27%	11%	24%
CT Den Bosch	84.000	-9%	-10%	-8%
CCT + MCT Moerdijk	90.000	-9%	-17%	-16%
OCT Oosterhout	104.000	19%	26%	16%
West-Brabant	**584.000**	**-1%**	**-4%**	**-2%**

Inland Terminal	Volume PoR (TEU)	0%-Growth	SE-scenario 2015	SE-scenario 2025
BTT Vossenberg	40.000	-1%	-11%	3%
IT Veghel	45.000	-22%	-25%	-9%
ROC Waalwijk	50.000	0%	-11%	2%
BTT Tilburg	55.000	-10%	-16%	-5%
MCT Bergen op Zoom	56.000	20%	51%	107%
DMT Moerdijk	60.000	27%	13%	40%
CT Den Bosch	84.000	-9%	1%	7%
CCT + MCT Moerdijk	90.000	-9%	-26%	-6%
OCT Oosterhout	104.000	19%	33%	26%
West-Brabant	**584.000**	**-1%**	**-3%**	**12%**

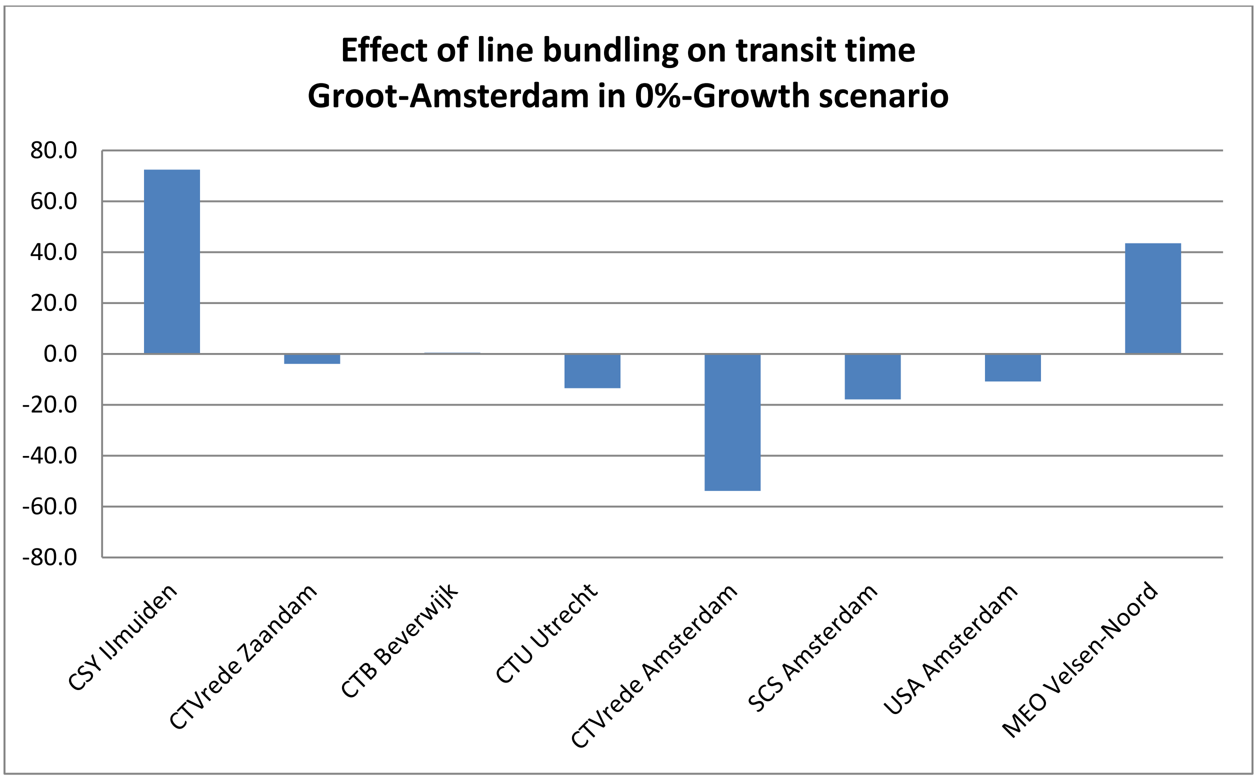
Trunk-feeder network

Inland Terminal	Volume PoR (TEU)	0%-Growth	RC-scenario 2015	RC-scenario 2025
BTT Vossenberg	40.000	-	-	-
IT Veghel	45.000	-23%	-19%	-22%
ROC Waalwijk	50.000	12%	6%	5%
BTT Tilburg	55.000	-13%	-14%	-18%
MCT Bergen op Zoom	56.000	-	-	-
DMT Moerdijk	60.000	-	-	-
CT Den Bosch	84.000	-	-	-
CCT + MCT Moerdijk	90.000	7%	-3%	-5%
OCT Oosterhout	104.000	-14%	-4%	-3%
West-Brabant	**584.000**	**-5%**	**-5%**	**-5%**

Inland Terminal	Volume PoR (TEU)	0%-Growth	SE-scenario 2015	SE-scenario 2025
BTT Vossenberg	40.000	-	-	-
IT Veghel	45.000	-23%	-19%	-21%
ROC Waalwijk	50.000	12%	1%	1%
BTT Tilburg	55.000	-13%	-12%	-3%
MCT Bergen op Zoom	56.000	-	-	-
DMT Moerdijk	60.000	-	-	-
CT Den Bosch	84.000	-	-	-
CCT + MCT Moerdijk	90.000	7%	3%	-6%
OCT Oosterhout	104.000	-14%	-7%	0%
West-Brabant	**584.000**	**-5%**	**-6%**	**-4%**

Appendix 24: Effect of line bundling on transit time in Groot-Amsterdam

Inland Terminal	Distance (km)	Direct service	Line bundling	Difference (in hours)
SCS Amsterdam	127	117.3	99.4	-17.9
USA Amsterdam	125	110.3	99.4	-10.9
CTVrede Zaandam	119	103.3	99.4	-3.9
CTVrede Amsterdam	124	153.3	99.4	-53.9
CSY Ijmuiden	127	89.6	162.1	72.5
CTB Beverwijk	133	161.5	162.1	0.6
MEO Velsen-Noord	132	118.5	162.1	43.6
Groot-Amsterdam	**127**	**120.8**	**122.9**	**-2.1**



Appendix 25: Performance indicators per sailing area under vertical integration

Noord-Nederland

0%-Growth scenario

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	3.5	8.0	217.9	709.7	166.4
Line network	5.6	5.3	165.9	503.0	142.6
Hub-and-spoke network	3.8	7.1	175.3	343.3	204.7

RC-scenario 2015

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	3.7	8.7	211.3	691.8	154.6
Line network	6.8	5.8	159.0	470.8	135.0
Hub-and-spoke network	4.0	5.8	171.5	332.5	203.6

SE-scenario 2015

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	3.6	5.8	198.8	636.1	144.8
Line network	7.4	6.2	161.6	482.4	137.5
Hub-and-spoke network	4.0	6.3	164.0	304.2	195.2

RC-scenario 2025

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	3.6	4.4	199.5	648.7	127.3
Line network	8.5	7.2	149.8	430.5	127.4
Hub-and-spoke network	3.8	6.8	160.1	290.4	195.4

SE-scenario 2025

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	4.0	4.1	192.8	616.9	150.0
Line network	11.2	8.3	146.8	414.7	122.6
Hub-and-spoke network	3.5	10.1	151.3	261.1	209.4

Groot-Amsterdam

0%-Growth scenario

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	4.2	2.6	148.0	459.2	107.6
Line network	7.7	3.7	114.1	321.5	112.5
Hub-and-spoke network	4.3	8.6	129.5	272.5	204.5

RC-scenario 2015

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	4.5	3.1	141.5	436.5	104.0
Line network	8.8	4.0	109.2	303.3	111.9
Hub-and-spoke network	4.9	9.4	120.0	232.2	182.5

SE-scenario 2015

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	4.0	3.1	142.6	436.1	116.6
Line network	8.2	3.7	110.3	298.6	125.3
Hub-and-spoke network	4.4	8.3	124.3	244.1	197.9

RC-scenario 2025

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	4.5	3.1	141.2	432.5	117.1
Line network	9.6	4.1	111.8	304.9	127.9
Hub-and-spoke network	4.9	10.1	125.6	248.9	198.2

SE-scenario 2025

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	4.6	3.1	137.8	415.4	126.2
Line network	12.1	5.0	104.7	275.4	123.1
Hub-and-spoke network	5.4	13.3	119.7	222.7	194.8

Nijmegen-Maas

0%-Growth scenario

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	3.2	6.8	191.1	643.4	186.7
Line network	4.7	16.3	151.4	469.2	226.1

RC-scenario 2015

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	3.8	6.5	184.7	620.5	175.4
Line network	5.8	22.3	151.9	461.0	222.4

SE-scenario 2015

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	4.0	7.2	175.1	582.4	167.9
Line network	6.4	22.9	147.4	439.0	211.3

RC-scenario 2025

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	4.2	8.9	182.9	618.2	186.4
Line network	7.5	25.2	141.8	414.9	203.4

SE-scenario 2025

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	3.7	11.0	172.4	564.2	208.5
Line network	9.9	31.4	140.6	407.7	200.3

West-Brabant

0%-Growth scenario

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	8.0	2.6	112.0	332.2	89.8
Line network	42.5	5.4	107.9	277.2	75.9
Hub-and-spoke network	9.4	4.3	111.2	176.5	137.1
Trunk-feeder network	7.7	4.1	107.9	265.4	117.6

RC-scenario 2015

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	9.1	3.3	107.7	301.3	100.6
Line network	60.6	6.4	101.9	249.1	72.1
Hub-and-spoke network	11.5	5.1	104.2	140.0	118.6
Trunk-feeder network	9.3	4.2	100.9	228.5	117.2

SE-scenario 2015

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	10.0	3.4	105.5	290.5	98.4
Line network	67.0	6.7	100.4	241.7	71.5
Hub-and-spoke network	12.4	5.7	102.9	135.9	116.9
Trunk-feeder network	10.3	4.0	100.3	224.6	114.8

RC-scenario 2025

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	12.1	6.0	104.5	280.8	104.6
Line network	86.9	11.1	95.2	219.0	71.9
Hub-and-spoke network	15.7	8.2	99.3	120.6	114.0
Trunk-feeder network	12.7	6.9	99.6	214.9	119.0

SE-scenario 2025

Network	Frequency	Reliability	Transport costs	Sustainability	Transit time
Point-to-point network	15.0	8.7	101.6	266.7	108.1
Line network	94.0	18.7	102.3	252.9	90.1
Hub-and-spoke network	14.8	10.0	102.2	132.8	139.1
Trunk-feeder network	13.8	8.3	96.3	201.2	121.7

Appendix 26: Performance indicators per inland terminal under vertical integration

<u>Noord-Nederland</u>

Point-to-Point network

0%-Growth scenario

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTU Kampen	4.2	2.9	168.6	572.9	118.2
BSC Groningen	2.8	4.5	200.2	663.0	177.3
CT Heerenveen	4.2	3.8	232.4	730.5	119.0
HOV Harlingen	3.6	5.3	192.2	664.1	138.0
MCS Leeuwarden	5.4	4.3	247.4	786.7	122.9
MCS Westerbroek	3.7	6.2	187.9	621.4	135.7
MCS Meppel	3.6	3.2	165.8	530.0	139.9
ROC Kampen	3.1	3.3	146.8	464.5	108.1
Wijnne & Barends Delfzijl	0.7	38.7	419.5	1354.4	438.5
Noord-Nederland	**3.5**	**8.0**	**217.9**	**709.7**	**166.4**

RC-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTU Kampen	2.7	3.4	141.8	436.1	123.7
BSC Groningen	3.2	5.0	176.3	557.5	156.1
CT Heerenveen	5.4	3.4	246.0	781.9	123.4
HOV Harlingen	4.2	5.3	168.2	551.0	119.6
MCS Leeuwarden	3.2	4.2	222.0	796.4	156.4
MCS Westerbroek	4.7	7.5	200.3	676.3	142.6
MCS Meppel	4.8	2.8	174.6	562.2	140.7
ROC Kampen	4.1	3.5	169.8	567.9	121.0
Wijnne & Barends Delfzijl	1.1	43.5	403.1	1296.5	308.3
Noord-Nederland	**3.7**	**8.7**	**211.3**	**691.8**	**154.6**

SE-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTU Kampen	2.9	3.2	134.1	399.4	114.0
BSC Groningen	3.3	5.8	167.0	518.9	150.2
CT Heerenveen	5.7	3.6	233.3	732.4	118.5
HOV Harlingen	4.5	4.5	159.1	507.9	112.4
MCS Leeuwarden	3.4	4.4	209.1	736.5	148.4
MCS Westerbroek	2.9	4.9	196.2	641.9	170.7
MCS Meppel	4.3	3.6	136.4	400.6	116.2
ROC Kampen	4.3	3.9	158.8	519.5	116.7
Wijnne & Barends Delfzijl	1.3	18.4	395.1	1267.9	256.3
Noord-Nederland	**3.6**	**5.8**	**198.8**	**636.1**	**144.8**

RC-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTU Kampen	4.0	2.8	154.9	485.8	109.8
BSC Groningen	4.3	5.0	180.7	572.8	140.0
CT Heerenveen	3.2	4.6	209.8	742.5	138.2
HOV Harlingen	3.3	4.1	177.1	572.2	134.5
MCS Leeuwarden	4.3	4.3	225.5	809.3	143.4
MCS Westerbroek	3.3	5.0	174.0	543.4	138.4
MCS Meppel	5.3	3.7	149.3	456.4	112.0
ROC Kampen	2.8	3.1	133.2	387.1	100.1
Wijnne & Barends Delfzijl	1.5	7.3	390.9	1268.8	129.3
Noord-Nederland	**3.6**	**4.4**	**199.5**	**648.7**	**127.3**

SE-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTU Kampen	5.4	2.7	155.4	485.4	124.4
BSC Groningen	5.5	6.0	175.3	548.6	150.9
CT Heerenveen	4.3	4.4	212.2	749.9	154.3
HOV Harlingen	4.6	3.8	180.1	578.7	145.6
MCS Leeuwarden	3.2	3.6	193.9	636.4	158.9
MCS Westerbroek	4.4	5.7	177.0	554.6	151.9
MCS Meppel	3.0	3.0	129.4	351.2	165.6
ROC Kampen	3.9	3.3	143.6	429.2	127.6
Wijnne & Barends Delfzijl	2.0	4.0	368.6	1218.1	170.4
Noord-Nederland	**4.0**	**4.1**	**192.8**	**616.9**	**150.0**

Hub-spoke network

0%-Growth scenario

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTU Kampen	4.6	8.3	149.8	287.9	190.1
BSC Groningen	3.1	7.3	169.3	323.1	207.6
CT Heerenveen	4.3	7.5	178.6	345.4	192.2
HOV Harlingen	4.2	7.5	164.4	326.4	193.8
MCS Leeuwarden	5.0	6.6	180.5	354.7	187.0
MCS Westerbroek	4.2	6.0	177.2	357.8	193.5
MCS Meppel	3.7	7.5	152.3	282.5	198.4
ROC Kampen	3.9	7.5	153.4	291.7	196.2
Wijnne & Barends Delfzijl	1.3	5.7	252.1	520.7	283.9
Noord-Nederland	**3.8**	**7.1**	**175.3**	**343.3**	**204.7**

RC-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTU Kampen	3.2	6.7	145.7	266.1	208.1
BSC Groningen	3.6	6.1	166.6	315.1	202.3
CT Heerenveen	5.1	5.4	175.7	336.8	188.8
HOV Harlingen	4.8	6.0	161.2	316.7	190.9
MCS Leeuwarden	3.6	5.9	169.3	336.3	202.8
MCS Westerbroek	4.8	4.4	173.1	345.8	191.0
MCS Meppel	4.6	6.2	150.9	277.4	192.7
ROC Kampen	4.6	6.4	150.6	283.5	192.7
Wijnne & Barends Delfzijl	1.6	5.3	250.5	514.8	263.5
Noord-Nederland	**4.0**	**5.8**	**171.5**	**332.5**	**203.6**

SE-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTU Kampen	3.4	6.8	139.5	243.1	197.6
BSC Groningen	3.8	6.4	160.1	290.4	191.9
CT Heerenveen	5.3	5.9	168.6	311.3	179.3
HOV Harlingen	5.1	6.1	155.1	293.4	180.6
MCS Leeuwarden	3.7	6.6	161.5	308.6	193.4
MCS Westerbroek	3.2	6.4	164.0	299.9	200.0
MCS Meppel	4.8	6.6	144.6	253.9	182.8
ROC Kampen	4.8	6.6	144.5	259.9	182.7
Wijnne & Barends Delfzijl	1.7	5.4	238.3	477.3	248.8
Noord-Nederland	**4.0**	**6.3**	**164.0**	**304.2**	**195.2**

RC-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTU Kampen	4.1	7.5	137.4	235.1	189.9
BSC Groningen	4.3	6.4	155.8	277.2	188.0
CT Heerenveen	3.7	7.2	156.3	288.0	194.6
HOV Harlingen	3.6	7.0	149.5	263.6	195.6
MCS Leeuwarden	4.4	7.3	159.1	299.9	186.9
MCS Westerbroek	3.8	6.5	161.3	290.5	193.1
MCS Meppel	5.4	6.7	141.7	244.4	179.5
ROC Kampen	3.4	6.9	140.3	236.6	197.8
Wijnne & Barends Delfzijl	2.0	6.0	240.0	478.4	233.6
Noord-Nederland	**3.8**	**6.8**	**160.1**	**290.4**	**195.4**

SE-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTU Kampen	4.3	11.2	131.3	215.1	198.4
BSC Groningen	4.3	9.3	146.8	253.1	199.1
CT Heerenveen	3.9	10.2	148.3	263.9	202.6
HOV Harlingen	3.9	10.2	142.6	242.4	203.2
MCS Leeuwarden	2.9	10.2	148.5	256.3	216.9
MCS Westerbroek	3.8	9.7	150.2	260.7	204.3
MCS Meppel	3.0	10.3	136.8	206.6	215.2
ROC Kampen	3.7	10.1	134.2	216.6	205.5
Wijnne & Barends Delfzijl	2.1	9.7	222.9	435.3	238.8
Noord-Nederland	**3.5**	**10.1**	**151.3**	**261.1**	**209.4**

Line network

0%-Growth scenario

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
MCS Meppel CTU Kampen ROC Kampen	7.3	5.0	137.2	391.0	115.4
HOV Harlingen CT Heerenveen MCS Leeuwarden	4.5	4.0	172.9	529.0	150.3
Wijnne & Barends Delfzijl MCS Westerbroek BSC Groningen	5.1	6.9	187.7	589.1	162.0
Noord-Nederland	**5.6**	**5.3**	**165.9**	**503.0**	**142.6**

RC-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
MCS Meppel CTU Kampen ROC Kampen	8.8	5.7	135.8	384.1	113.6
HOV Harlingen CT Heerenveen MCS Leeuwarden	5.6	5.0	176.1	538.4	148.8
Wijnne & Barends Delfzijl MCS Westerbroek BSC Groningen	5.8	6.7	165.2	489.9	142.5
Noord-Nederland	**6.8**	**5.8**	**159.0**	**470.8**	**135.0**

SE-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
MCS Meppel CTU Kampen ROC Kampen	9.8	5.8	141.8	409.9	118.8
HOV Harlingen CT Heerenveen MCS Leeuwarden	5.8	4.6	166.9	500.4	142.6
Wijnne & Barends Delfzijl MCS Westerbroek BSC Groningen	6.6	8.3	176.2	536.8	151.2
Noord-Nederland	**7.4**	**6.2**	**161.6**	**482.4**	**137.5**

RC-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
MCS Meppel CTU Kampen ROC Kampen	11.1	7.2	127.3	345.0	105.2
HOV Harlingen CT Heerenveen MCS Leeuwarden	6.6	5.4	148.2	418.8	126.3
Wijnne & Barends Delfzijl MCS Westerbroek BSC Groningen	7.8	9.1	173.9	527.8	150.6
Noord-Nederland	**8.5**	**7.2**	**149.8**	**430.5**	**127.4**

SE-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
MCS Meppel CTU Kampen ROC Kampen	14.8	8.1	125.2	334.1	101.8
HOV Harlingen CT Heerenveen MCS Leeuwarden	8.9	6.8	155.2	446.5	131.2
Wijnne & Barends Delfzijl MCS Westerbroek BSC Groningen	9.9	10.1	160.1	463.4	134.7
Noord-Nederland	**11.2**	**8.3**	**146.8**	**414.7**	**122.6**

Groot-Amsterdam

Point-to-Point network

0%-Growth scenario

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CSY Ijmuiden	3.5	2.3	203.6	637.1	96.0
CTVrede Zaandam	3.5	2.7	121.5	360.8	96.7
CTB Beverwijk	5.8	2.8	142.4	450.9	116.0
CTU Utrecht	6.3	1.7	109.9	317.7	80.6
CTVrede Amsterdam	3.2	3.0	122.9	346.7	155.3
SCS Amsterdam	3.0	3.3	155.3	544.0	113.3
USA Amsterdam	3.1	2.6	130.6	399.8	107.2
MEO Velsen-Noord	5.3	2.7	197.6	616.3	95.9
Groot-Amsterdam	**4.2**	**2.6**	**148.0**	**459.2**	**107.6**

RC-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CSY Ijmuiden	3.6	3.4	190.1	588.6	92.5
CTVrede Zaandam	3.5	3.3	113.9	331.7	95.3
CTB Beverwijk	6.0	3.3	132.4	409.2	111.3
CTU Utrecht	6.5	2.1	100.0	280.1	77.7
CTVrede Amsterdam	3.5	3.4	109.5	289.5	141.3
SCS Amsterdam	4.2	3.1	178.4	644.4	120.5
USA Amsterdam	3.4	3.4	117.2	345.0	98.8
MEO Velsen-Noord	5.3	2.7	190.3	603.9	94.5
Groot-Amsterdam	**4.5**	**3.1**	**141.5**	**436.5**	**104.0**

SE-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CSY Ijmuiden	3.7	2.9	181.0	560.0	91.1
CTVrede Zaandam	4.7	2.5	136.6	424.1	106.8
CTB Beverwijk	3.0	3.5	131.1	378.3	164.1
CTU Utrecht	3.0	1.8	93.6	228.7	112.8
CTVrede Amsterdam	3.6	5.1	104.1	267.2	137.5
SCS Amsterdam	4.2	2.9	168.7	604.5	119.7
USA Amsterdam	4.5	3.1	141.8	446.6	111.3
MEO Velsen-Noord	5.6	2.9	183.7	579.2	89.9
Groot-Amsterdam	**4.0**	**3.1**	**142.6**	**436.1**	**116.6**

RC-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CSY IJmuiden	3.7	3.3	174.3	537.5	89.8
CTVrede Zaandam	4.8	2.5	131.6	404.3	105.4
CTB Beverwijk	3.2	3.8	124.3	349.4	158.3
CTU Utrecht	4.2	2.2	103.3	267.0	120.4
CTVrede Amsterdam	4.7	4.8	111.3	297.2	142.7
SCS Amsterdam	5.4	2.8	181.7	662.1	124.7
USA Amsterdam	4.7	2.9	127.7	390.8	107.0
MEO Velsen-Noord	5.7	2.9	175.8	552.0	88.8
Groot-Amsterdam	**4.5**	**3.1**	**141.2**	**432.5**	**117.1**

SE-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CSY IJmuiden	5.3	2.4	186.9	587.2	94.0
CTVrede Zaandam	6.2	2.5	134.2	416.9	107.6
CTB Beverwijk	4.1	3.5	124.3	350.9	164.1
CTU Utrecht	4.4	2.9	89.3	210.6	112.9
CTVrede Amsterdam	3.4	4.5	131.4	322.6	195.5
SCS Amsterdam	3.3	3.1	122.0	362.6	99.9
USA Amsterdam	6.2	3.1	128.3	393.8	109.0
MEO Velsen-Noord	3.9	2.8	186.1	678.8	126.8
Groot-Amsterdam	**4.6**	**3.1**	**137.8**	**415.4**	**126.2**

Hub-spoke network

0%-Growth scenario

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTVrede Amsterdam	4.5	7.1	110.2	250.3	185.6
CSY IJmuiden	3.6	9.6	142.0	281.1	232.7
CTVrede Zaandam	3.7	9.4	134.6	262.2	230.8
CTB Beverwijk	5.1	11.3	136.6	267.0	218.7
MEO Velsen-Noord	4.5	11.1	136.5	273.8	223.2
SCS Amsterdam	3.7	9.3	132.9	266.4	231.2
USA Amsterdam	3.5	9.2	133.6	261.3	233.4
CTU Utrecht	6.3	1.7	109.9	317.7	80.6
Groot-Amsterdam	**4.3**	**8.6**	**129.5**	**272.5**	**204.5**

RC-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTVrede Amsterdam	5.0	8.5	100.8	209.7	165.4
CSY IJmuiden	4.0	10.0	132.4	240.6	207.1
CTVrede Zaandam	4.2	10.5	125.2	221.6	205.6
CTB Beverwijk	5.6	12.2	127.1	226.3	195.3
MEO Velsen-Noord	5.2	11.3	127.0	233.4	198.1
SCS Amsterdam	4.2	10.4	123.3	225.4	205.2
USA Amsterdam	4.2	10.4	124.2	220.6	205.9
CTU Utrecht	6.5	2.1	100.0	280.1	77.7
Groot-Amsterdam	**4.9**	**9.4**	**120.0**	**232.2**	**182.5**

SE-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTVrede Amsterdam	5.6	7.4	106.0	231.1	177.0
CSY IJmuiden	4.3	9.3	137.3	261.6	215.7
CTVrede Zaandam	4.5	9.3	130.3	243.0	213.9
CTB Beverwijk	3.2	9.8	137.8	245.3	228.9
MEO Velsen-Noord	5.4	9.8	131.9	254.4	207.8
SCS Amsterdam	4.7	9.9	128.4	246.9	213.0
USA Amsterdam	4.5	9.2	129.4	242.0	214.3
CTU Utrecht	3.0	1.8	93.6	228.7	112.8
Groot-Amsterdam	**4.4**	**8.3**	**124.3**	**244.1**	**197.9**

RC-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTVrede Amsterdam	6.5	9.7	106.2	231.3	178.6
CSY IJmuiden	4.6	11.4	137.2	261.4	215.3
CTVrede Zaandam	4.9	11.5	130.6	243.3	212.8
CTB Beverwijk	3.4	11.2	138.0	245.4	227.6
MEO Velsen-Noord	5.7	11.6	131.9	254.2	208.1
SCS Amsterdam	5.2	11.5	128.4	246.7	210.9
USA Amsterdam	5.1	11.4	129.5	242.1	211.6
CTU Utrecht	4.2	2.2	103.3	267.0	120.4
Groot-Amsterdam	**4.9**	**10.1**	**125.6**	**248.9**	**198.2**

SE-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTVrede Amsterdam	8.5	13.7	101.2	210.2	176.9
CSY IJmuiden	5.9	14.8	132.0	239.9	205.4
CTVrede Zaandam	5.9	14.8	125.6	221.9	205.2
CTB Beverwijk	4.3	15.0	133.0	224.0	216.5
MEO Velsen-Noord	4.1	15.4	126.3	230.1	218.2
SCS Amsterdam	3.9	14.8	126.0	224.3	220.0
USA Amsterdam	6.3	14.8	124.7	220.9	203.6
CTU Utrecht	4.4	2.9	89.3	210.6	112.9
Groot-Amsterdam	**5.4**	**13.3**	**119.7**	**222.7**	**194.8**

Line network

0%-Growth scenario

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CSY Ijmuiden MEO Velsen-Noord CTB Beverwijk	3.2	3.9	121.8	336.4	159.5
CTVrede Zaandam CTVrede Amsterdam USA Amsterdam SCS Amsterdam	13.8	5.4	110.5	310.3	97.4
CTU Utrecht	6.3	1.7	109.9	317.7	80.6
Groot-Amsterdam	**7.7**	**3.7**	**114.1**	**321.5**	**112.5**

RC-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CSY Ijmuiden MEO Velsen-Noord CTB Beverwijk	3.2	4.4	113.5	303.8	156.9
CTVrede Zaandam CTVrede Amsterdam USA Amsterdam SCS Amsterdam	16.6	5.5	114.0	325.8	101.0
CTU Utrecht	6.5	2.1	100.0	280.1	77.7
Groot-Amsterdam	**8.8**	**4.0**	**109.2**	**303.3**	**111.9**

SE-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CSY Ijmuiden MEO Velsen-Noord CTB Beverwijk	4.0	3.9	128.8	366.9	167.9
CTVrede Zaandam CTVrede Amsterdam USA Amsterdam SCS Amsterdam	17.6	5.5	108.3	300.2	95.3
CTU Utrecht	3.0	1.8	93.6	228.7	112.8
Groot-Amsterdam	**8.2**	**3.7**	**110.3**	**298.6**	**125.3**

RC-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CSY Ijmuiden MEO Velsen-Noord CTB Beverwijk	4.0	4.2	122.8	342.4	165.6
CTVrede Zaandam CTVrede Amsterdam USA Amsterdam SCS Amsterdam	20.6	5.8	109.4	305.3	97.7
CTU Utrecht	4.2	2.2	103.3	267.0	120.4
Groot-Amsterdam	**9.6**	**4.1**	**111.8**	**304.9**	**127.9**

SE-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CSY Ijmuiden MEO Velsen-Noord CTB Beverwijk	5.2	6.0	118.7	325.0	161.9
CTVrede Zaandam CTVrede Amsterdam USA Amsterdam SCS Amsterdam	26.6	6.0	106.3	290.5	94.4
CTU Utrecht	4.4	2.9	89.3	210.6	112.9
Groot-Amsterdam	**12.1**	**5.0**	**104.7**	**275.4**	**123.1**

<u>**Nijmegen-Maas**</u>

Point-to-Point network

0%-Growth scenario

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BT Born	3.3	14.6	199.1	673.7	306.6
CT Nijmegen	2.8	6.6	161.5	530.7	241.5
CTU Tiel	2.7	2.8	130.1	422.8	124.1
CT Cuijk	4.3	2.7	228.9	772.0	116.3
CTS Stein	1.3	16.2	384.9	1351.8	246.9
LCG Gorinchem	4.5	0.6	101.6	283.4	73.7
OOC Oss	3.8	3.5	144.5	483.0	131.4
TCT Venlo	3.2	6.4	214.4	780.3	204.8
WIT Wanssum	2.8	8.1	155.2	492.9	235.1
Nijmegen-Maas	**3.2**	**6.8**	**191.1**	**643.4**	**186.7**

RC-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BT Born	4.0	18.9	197.4	661.9	289.2
CT Nijmegen	3.8	9.8	141.8	441.7	216.3
CTU Tiel	3.8	3.3	144.0	482.2	131.3
CT Cuijk	4.3	2.5	206.9	709.4	116.7
CTS Stein	1.8	3.7	374.8	1324.2	189.3
LCG Gorinchem	4.8	1.1	98.5	275.4	69.7
OOC Oss	4.9	3.0	150.8	510.0	135.9
TCT Venlo	3.5	6.4	188.1	664.4	190.0
WIT Wanssum	3.5	9.5	160.4	515.6	240.1
Nijmegen-Maas	**3.8**	**6.5**	**184.7**	**620.5**	**175.4**

SE-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BT Born	4.1	22.1	189.1	626.0	282.5
CT Nijmegen	4.2	10.7	132.6	399.7	200.7
CTU Tiel	4.0	3.1	137.1	452.0	126.6
CT Cuijk	4.4	2.5	194.9	661.9	114.7
CTS Stein	1.8	5.2	358.3	1286.0	184.5
LCG Gorinchem	4.7	1.8	92.6	254.4	71.7
OOC Oss	5.1	3.1	143.4	478.0	130.5
TCT Venlo	3.7	6.8	177.1	614.2	180.1
WIT Wanssum	3.8	9.4	150.4	469.2	219.4
Nijmegen-Maas	**4.0**	**7.2**	**175.1**	**582.4**	**167.9**

RC-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BT Born	4.9	26.4	182.2	594.7	274.3
CT Nijmegen	2.8	15.8	154.1	430.2	298.3
CTU Tiel	5.1	2.9	145.3	487.3	130.3
CT Cuijk	2.8	4.2	222.7	874.5	181.7
CTS Stein	2.5	6.0	381.8	1373.9	199.7
LCG Gorinchem	4.9	2.0	88.8	239.2	68.1
OOC Oss	6.2	3.4	147.1	495.5	135.0
TCT Venlo	4.4	8.1	186.9	658.5	187.8
WIT Wanssum	4.1	11.7	137.0	410.1	202.6
Nijmegen-Maas	**4.2**	**8.9**	**182.9**	**618.2**	**186.4**

SE-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BT Born	6.4	31.3	178.8	577.0	262.0
CT Nijmegen	3.5	21.3	144.6	387.8	279.6
CTU Tiel	2.6	3.7	128.5	387.7	194.4
CT Cuijk	3.9	4.4	223.7	870.4	171.7
CTS Stein	2.7	6.1	330.6	1198.9	183.6
LCG Gorinchem	3.1	1.9	92.6	228.5	107.6
OOC Oss	3.4	4.1	135.1	414.5	196.9
TCT Venlo	2.5	9.4	173.6	570.6	269.1
WIT Wanssum	5.5	16.5	144.5	442.6	211.3
Nijmegen-Maas	**3.7**	**11.0**	**172.4**	**564.2**	**208.5**

Line network

0%-Growth scenario

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTS Stein BT Born TCT Venlo	4.5	25.6	192.7	640.9	293.6
WIT Wanssum CT Cuijk OOC Oss	4.7	13.3	144.0	436.5	209.7
CT Nijmegen CTU Tiel LCG Gorinchem	4.8	10.0	117.5	330.1	174.9
Nijmegen-Maas	**4.7**	**16.3**	**151.4**	**469.2**	**226.1**

RC-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTS Stein BT Born TCT Venlo	5.3	30.3	185.6	608.0	280.1
WIT Wanssum CT Cuijk OOC Oss	5.6	18.8	142.6	430.1	207.6
CT Nijmegen CTU Tiel LCG Gorinchem	6.5	17.8	127.6	344.9	179.6
Nijmegen-Maas	**5.8**	**22.3**	**151.9**	**461.0**	**222.4**

SE-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTS Stein BT Born TCT Venlo	6.0	30.5	186.8	609.9	274.6
WIT Wanssum CT Cuijk OOC Oss	6.0	20.8	135.1	396.1	195.0
CT Nijmegen CTU Tiel LCG Gorinchem	7.1	17.5	120.2	311.2	164.2
Nijmegen-Maas	**6.4**	**22.9**	**147.4**	**439.0**	**211.3**

RC-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTS Stein BT Born TCT Venlo	6.7	35.5	182.9	594.3	270.7
WIT Wanssum CT Cuijk OOC Oss	7.1	22.0	131.7	380.5	189.6
CT Nijmegen CTU Tiel LCG Gorinchem	8.9	18.1	110.9	269.9	150.0
Nijmegen-Maas	**7.5**	**25.2**	**141.8**	**414.9**	**203.4**

SE-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CTS Stein BT Born TCT Venlo	8.8	41.2	179.1	575.4	262.5
WIT Wanssum CT Cuijk OOC Oss	9.1	27.7	129.1	367.9	183.6
CT Nijmegen CTU Tiel LCG Gorinchem	11.8	25.3	113.6	279.7	154.6
Nijmegen-Maas	**9.9**	**31.4**	**140.6**	**407.7**	**200.3**

West-Brabant

Point-to-Point network

0%-Growth scenario

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BTT Tilburg	18.1	2.5	134.3	421.4	74.3
BTT Vossenberg	3.4	2.5	107.6	327.0	73.3
CCT + MCT Moerdijk	3.8	1.6	80.6	179.7	87.4
CT Den Bosch	7.6	2.9	120.2	378.8	110.0
DMT Moerdijk	7.0	1.2	92.7	254.9	71.8
IT Veghel	14.7	2.8	158.7	510.4	91.3
MCT Bergen op Zoom	4.8	3.7	106.3	303.2	104.6
OCT Oosterhout	4.6	2.7	94.5	237.7	109.1
ROC Waalwijk	7.8	3.4	113.6	376.2	86.3
West-Brabant	**8.0**	**2.6**	**112.0**	**332.2**	**89.8**

RC-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BTT Tilburg	21.4	2.5	127.3	390.6	70.6
BTT Vossenberg	4.8	2.8	120.4	380.5	103.9
CCT + MCT Moerdijk	4.2	1.5	97.4	194.5	120.4
CT Den Bosch	9.3	2.8	118.7	372.0	108.4
DMT Moerdijk	4.1	1.6	72.1	144.1	82.0
IT Veghel	18.1	3.0	160.4	518.3	92.6
MCT Bergen op Zoom	3.4	9.0	79.7	158.3	146.5
OCT Oosterhout	7.1	3.1	78.5	169.6	93.8
ROC Waalwijk	9.6	3.4	115.1	383.4	87.4
West-Brabant	**9.1**	**3.3**	**107.7**	**301.3**	**100.6**

SE-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BTT Tilburg	23.5	2.3	129.3	398.9	71.4
BTT Vossenberg	4.9	2.6	114.5	356.0	101.7
CCT + MCT Moerdijk	4.3	1.9	92.3	173.9	116.2
CT Den Bosch	9.8	3.4	112.3	342.7	102.1
DMT Moerdijk	5.5	1.5	82.7	188.9	92.1
IT Veghel	19.2	3.1	151.9	478.8	87.0
MCT Bergen op Zoom	3.7	9.1	74.8	135.7	134.8
OCT Oosterhout	8.5	2.9	82.4	186.1	98.7
ROC Waalwijk	10.3	3.8	109.2	353.7	81.5
West-Brabant	**10.0**	**3.4**	**105.5**	**290.5**	**98.4**

RC-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BTT Tilburg	28.3	2.7	128.3	394.3	71.2
BTT Vossenberg	6.4	2.7	120.8	382.8	104.4
CCT + MCT Moerdijk	5.9	2.3	86.3	150.0	113.7
CT Den Bosch	11.7	3.7	109.6	330.4	100.3
DMT Moerdijk	4.1	2.2	90.8	169.3	123.7
IT Veghel	23.2	3.4	150.8	474.1	86.7
MCT Bergen op Zoom	5.2	29.3	66.6	97.3	160.0
OCT Oosterhout	11.6	3.6	79.5	179.9	100.9
ROC Waalwijk	12.4	3.9	108.2	349.0	80.8
West-Brabant	**12.1**	**6.0**	**104.5**	**280.8**	**104.6**

SE-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BTT Tilburg	36.3	3.1	125.2	379.5	69.3
BTT Vossenberg	7.2	2.9	103.3	306.2	93.4
CCT + MCT Moerdijk	7.7	2.4	83.7	139.2	109.0
CT Den Bosch	15.3	4.7	108.8	325.9	98.5
DMT Moerdijk	5.5	1.9	91.1	170.1	121.0
IT Veghel	29.6	4.1	140.9	427.1	79.4
MCT Bergen op Zoom	5.8	43.8	61.0	71.3	169.6
OCT Oosterhout	11.0	11.3	89.8	223.9	150.8
ROC Waalwijk	16.4	4.3	110.1	357.4	81.8
West-Brabant	**15.0**	**8.7**	**101.6**	**266.7**	**108.1**

Hub-spoke network

0%-Growth scenario

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CCT + MCT Moerdijk	11.6	3.7	79.7	143.1	115.0
BTT Tilburg	18.1	4.8	118.8	194.1	133.5
BTT Vossenberg	5.0	4.0	115.5	178.1	148.7
CT Den Bosch	8.2	4.3	116.5	180.3	135.4
DMT Moerdijk	6.5	4.3	104.3	153.9	140.7
IT Veghel	15.0	4.6	129.7	214.5	137.3
MCT Bergen op Zoom	6.1	4.5	113.2	183.0	142.5
OCT Oosterhout	5.2	4.1	110.5	161.2	147.6
ROC Waalwijk	9.3	4.5	112.6	180.5	133.0
West-Brabant	**9.4**	**4.3**	**111.2**	**176.5**	**137.1**

RC-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CCT + MCT Moerdijk	16.9	4.5	71.9	108.3	99.1
BTT Tilburg	22.0	5.4	111.0	159.5	114.4
BTT Vossenberg	5.9	5.2	107.5	143.0	127.4
CT Den Bosch	9.6	5.1	108.2	144.4	116.6
DMT Moerdijk	6.0	5.2	102.0	118.4	127.1
IT Veghel	17.9	5.2	121.8	179.3	117.9
MCT Bergen op Zoom	5.5	5.1	108.4	136.4	129.8
OCT Oosterhout	7.6	4.8	101.7	124.6	121.2
ROC Waalwijk	11.6	5.2	105.0	146.3	113.6
West-Brabant	**11.5**	**5.1**	**104.2**	**140.0**	**118.6**

SE-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CCT + MCT Moerdijk	19.0	5.1	71.3	105.1	96.9
BTT Tilburg	23.2	5.9	109.6	155.0	111.4
BTT Vossenberg	6.4	5.5	106.4	139.5	123.1
CT Den Bosch	10.0	5.6	106.8	139.8	113.8
DMT Moerdijk	6.3	5.7	101.1	115.1	123.4
IT Veghel	18.8	5.6	120.0	173.5	114.9
MCT Bergen op Zoom	5.7	5.7	106.7	131.6	126.6
OCT Oosterhout	10.0	6.7	101.1	122.5	130.5
ROC Waalwijk	11.8	5.8	103.3	141.4	111.1
West-Brabant	**12.4**	**5.7**	**102.9**	**135.9**	**116.9**

RC-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CCT + MCT Moerdijk	27.3	7.8	67.1	89.4	92.3
BTT Tilburg	28.6	8.2	104.5	139.9	109.9
BTT Vossenberg	7.6	8.1	101.0	123.1	114.5
CT Den Bosch	13.8	8.4	102.9	127.6	116.7
DMT Moerdijk	4.9	8.1	108.3	99.0	126.8
IT Veghel	23.8	8.2	115.7	160.8	113.5
MCT Bergen op Zoom	9.1	8.6	101.7	116.5	129.2
OCT Oosterhout	13.0	8.1	95.5	105.4	118.2
ROC Waalwijk	13.1	8.0	97.2	123.3	105.1
West-Brabant	**15.7**	**8.2**	**99.3**	**120.6**	**114.0**

SE-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
CCT + MCT Moerdijk	28.5	8.3	69.8	102.5	111.5
BTT Tilburg	25.5	9.7	107.3	152.4	131.3
BTT Vossenberg	6.6	9.3	103.4	132.7	137.0
CT Den Bosch	11.6	11.0	104.8	137.4	140.4
DMT Moerdijk	4.3	8.8	112.1	112.8	150.5
IT Veghel	22.0	11.5	118.5	173.1	142.0
MCT Bergen op Zoom	7.9	10.7	103.5	126.8	154.0
OCT Oosterhout	13.5	10.2	99.0	119.3	148.9
ROC Waalwijk	13.3	10.4	101.1	137.7	136.7
West-Brabant	**14.8**	**10.0**	**102.2**	**132.8**	**139.1**

Line network

0%-Growth scenario

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BTT Tilburg BTT Vossenberg OCT Oosterhout	63.9	3.9	120.0	326.4	60.4
IT Veghel ROC Waalwijk CT Den Bosch	56.6	6.3	128.2	364.1	73.3
MCT Bergen op Zoom DMT Moerdijk CCT + MCT Moerdijk	7.1	6.1	75.4	141.0	94.0
West-Brabant	**42.5**	**5.4**	**107.9**	**277.2**	**75.9**

RC-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BTT Tilburg BTT Vossenberg OCT Oosterhout	99.5	4.0	108.7	272.4	50.6
IT Veghel ROC Waalwijk CT Den Bosch	69.1	6.7	124.5	347.6	65.6
MCT Bergen op Zoom DMT Moerdijk CCT + MCT Moerdijk	13.3	8.6	72.4	127.2	100.2
West-Brabant	**60.6**	**6.4**	**101.9**	**249.1**	**72.1**

SE-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BTT Tilburg BTT Vossenberg OCT Oosterhout	111.1	4.3	109.6	275.8	51.4
IT Veghel ROC Waalwijk CT Den Bosch	74.8	6.7	121.3	331.7	62.8
MCT Bergen op Zoom DMT Moerdijk CCT + MCT Moerdijk	15.0	9.2	70.4	117.5	100.4
West-Brabant	**67.0**	**6.7**	**100.4**	**241.7**	**71.5**

RC-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BTT Tilburg BTT Vossenberg OCT Oosterhout	149.2	5.7	108.1	273.2	52.9
IT Veghel ROC Waalwijk CT Den Bosch	90.2	7.0	119.4	323.0	61.4
MCT Bergen op Zoom DMT Moerdijk CCT + MCT Moerdijk	21.4	20.6	58.2	60.8	101.4
West-Brabant	**86.9**	**11.1**	**95.2**	**219.0**	**71.9**

SE-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
BTT Tilburg BTT Vossenberg OCT Oosterhout	142.9	3.6	130.5	381.2	72.7
IT Veghel ROC Waalwijk CT Den Bosch	117.1	7.5	119.6	322.9	61.6
MCT Bergen op Zoom DMT Moerdijk CCT + MCT Moerdijk	21.9	45.1	56.9	54.8	136.0
West-Brabant	**94.0**	**18.7**	**102.3**	**252.9**	**90.1**

Trunk-feeder network

0%-Growth scenario

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
OCT Oosterhout	6.1	2.8	85.1	207.9	109.2
BTT Tilburg	16.8	4.9	115.5	238.9	119.2
IT Veghel	13.8	8.5	141.0	328.7	160.5
BTT Vossenberg	3.4	2.5	107.6	327.0	98.5
CCT + MCT Moerdijk	2.5	1.8	85.8	158.5	131.5
CT Den Bosch	7.6	2.9	120.2	378.8	110.0
DMT Moerdijk	7.0	1.2	92.7	254.9	71.8
MCT Bergen op Zoom	4.8	3.7	106.3	303.2	104.6
ROC Waalwijk	7.7	8.9	116.5	191.0	153.3
West-Brabant	**7.7**	**4.1**	**107.9**	**265.4**	**117.6**

RC-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
OCT Oosterhout	10.0	3.3	80.7	185.6	100.9
BTT Tilburg	21.8	5.1	110.8	217.8	116.3
IT Veghel	16.7	4.9	130.1	282.9	150.0
BTT Vossenberg	4.8	2.8	120.4	380.5	103.9
CCT + MCT Moerdijk	4.4	2.5	82.7	141.3	114.4
CT Den Bosch	9.3	2.8	118.7	372.0	108.4
DMT Moerdijk	4.1	1.6	72.1	144.1	82.0
MCT Bergen op Zoom	3.4	9.0	79.7	158.3	146.5
ROC Waalwijk	9.5	6.2	113.4	174.0	132.1
West-Brabant	**9.3**	**4.2**	**100.9**	**228.5**	**117.2**

SE-scenario 2015

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
OCT Oosterhout	10.8	3.5	76.0	164.5	93.2
BTT Tilburg	23.7	4.5	106.1	196.9	107.4
IT Veghel	18.2	4.4	125.3	260.7	139.9
BTT Vossenberg	4.9	2.6	114.5	356.0	101.7
CCT + MCT Moerdijk	5.4	1.8	90.1	171.8	123.0
CT Den Bosch	9.8	3.4	112.3	342.7	102.1
DMT Moerdijk	5.5	1.5	82.7	188.9	92.1
MCT Bergen op Zoom	3.7	9.1	74.8	135.7	134.8
ROC Waalwijk	10.4	5.1	121.0	204.7	139.2
West-Brabant	**10.3**	**4.0**	**100.3**	**224.6**	**114.8**

RC-scenario 2025

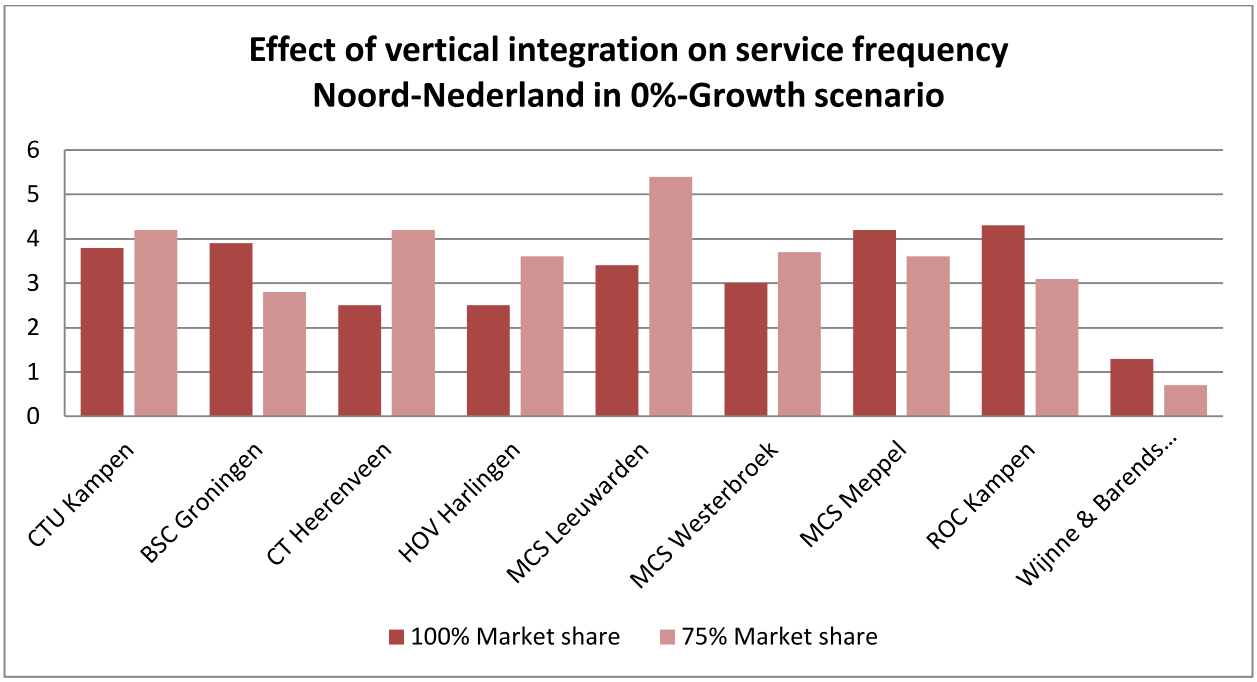
Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
OCT Oosterhout	16.5	7.4	75.0	159.0	91.5
BTT Tilburg	28.8	7.6	104.8	191.4	103.2
IT Veghel	21.7	2.9	129.8	281.3	147.8
BTT Vossenberg	6.4	2.7	120.8	382.8	104.4
CCT + MCT Moerdijk	7.4	2.5	83.9	144.8	113.4
CT Den Bosch	11.7	3.7	109.6	330.4	100.3
DMT Moerdijk	4.1	2.2	90.8	169.3	123.7
MCT Bergen op Zoom	5.2	29.3	66.6	97.3	160.0
ROC Waalwijk	12.6	4.0	114.8	177.8	126.7
West-Brabant	**12.7**	**6.9**	**99.6**	**214.9**	**119.0**

SE-scenario 2025

Inland Terminal	Frequency	Reliability	Transport costs	Sustainability	Transit time
OCT Oosterhout	16.2	3.8	83.0	198.9	113.6
BTT Tilburg	20.3	5.5	113.1	231.1	130.2
IT Veghel	27.8	5.0	114.6	214.0	132.7
BTT Vossenberg	7.2	2.9	103.3	306.2	93.4
CCT + MCT Moerdijk	9.3	2.9	80.5	129.9	108.0
CT Den Bosch	15.3	4.7	108.8	325.9	98.5
DMT Moerdijk	5.5	1.9	91.1	170.1	121.0
MCT Bergen op Zoom	5.8	43.8	61.0	71.3	169.6
ROC Waalwijk	16.8	4.5	111.2	163.7	128.0
West-Brabant	**13.8**	**8.3**	**96.3**	**201.2**	**121.7**

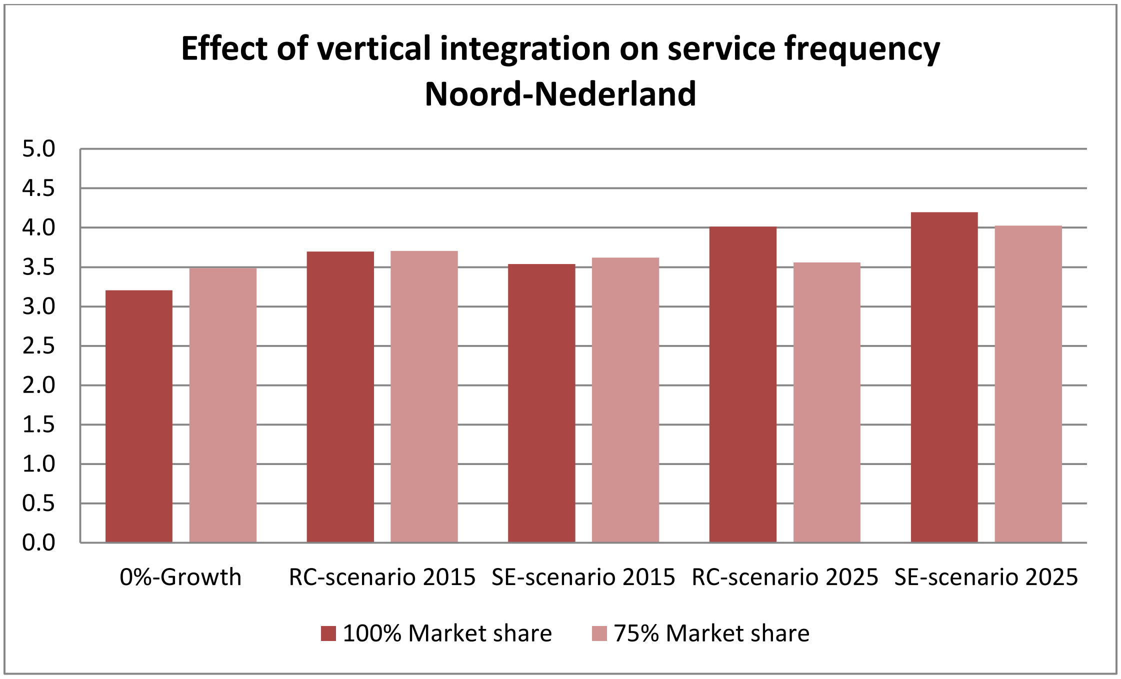
Appendix 27: Effect of vertical integration of service frequency in Noord-Nederland

Inland Terminal	100% Share	Vessel size	75% Share	Vessel size	Difference
CTU Kampen	3.8	90	4.2	48	0.5
BSC Groningen	3.9	90	2.8	90	-1.1
CT Heerenveen	2.5	48	4.2	24	1.7
HOV Harlingen	2.5	90	3.6	48	1.1
MCS Leeuwarden	3.4	48	5.4	24	2.1
MCS Westerbroek	3.0	90	3.7	48	0.7
MCS Meppel	4.2	90	3.6	90	-0.7
ROC Kampen	4.3	48	3.1	48	-1.2
Wijnne & Barends Delfzijl	1.3	24	0.7	24	-0.6

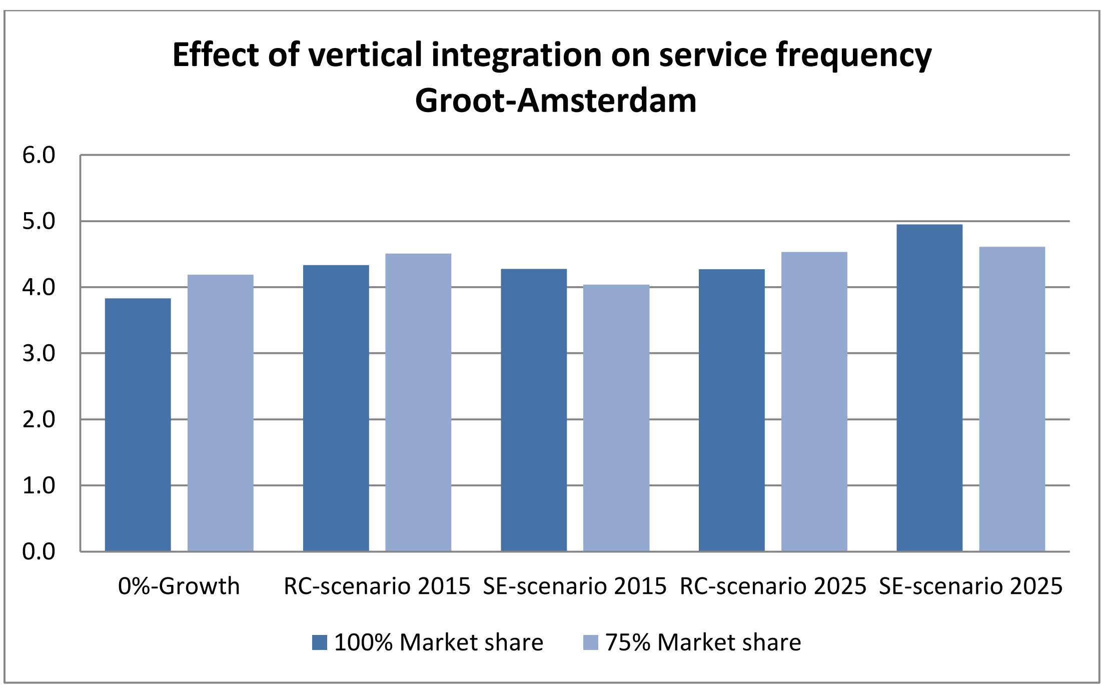


Appendix 28: Effect of vertical integration on service frequency in a point-to-point network

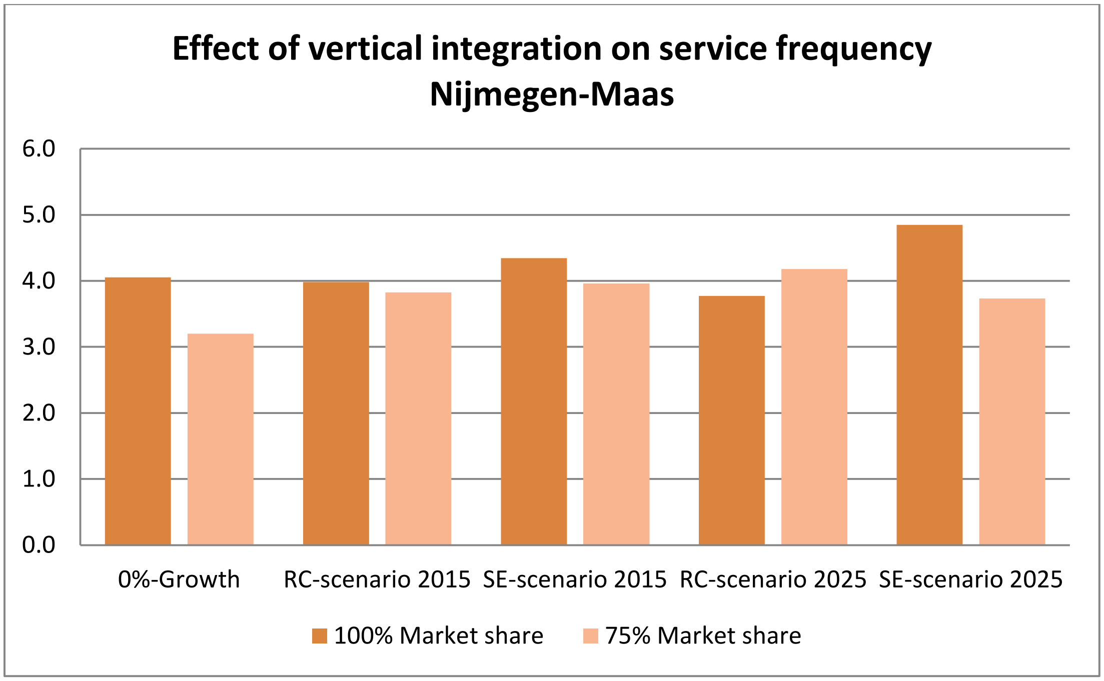
Noord-Nederland



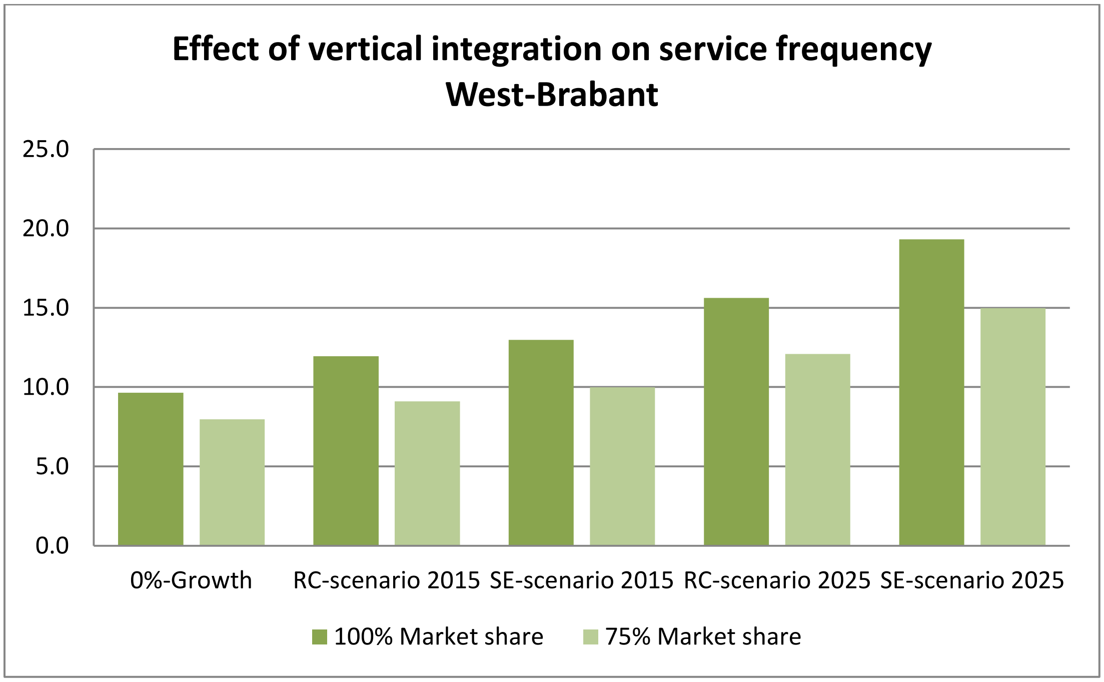
Groot-Amsterdam



Nijmegen-Maas



West-Brabant



Appendix 29: Effect of vertical integration on transport costs per sub category

Supra-regional terminals

Inland Terminal	Sailing area	Volume (TEU)	0%-Growth	RC 2015	SE 2015	RC 2025	SE 2025
CCT + MCT Moerdijk	West-Brabant	150.000	-5%	14%	0%	3%	-2%
OCT Oosterhout	West-Brabant	130.000	0%	-5%	7%	-11%	0%
BT Born	Nijmegen-Maas	125.000	8%	3%	2%	-5%	-3%
DMT Moerdijk	West-Brabant	120.000	10%	-29%	-15%	0%	4%
CT Den Bosch	West-Brabant	120.000	-3%	0%	9%	-4%	1%
WIT Wanssum	Nijmegen-Maas	95.000	-7%	8%	7%	-3%	2%
CTVrede Amsterdam	Groot-Amsterdam	95.000	0%	0%	-15%	-14%	4%
CT Nijmegen	Nijmegen-Maas	85.000	6%	-1%	-14%	12%	5%
MCT Bergen op Zoom	West-Brabant	70.000	6%	7%	5%	10%	5%
CTU Utrecht	Groot-Amsterdam	67.550	19%	-2%	-5%	17%	2%
	Total volume:	**1.057.550**	**3%**	**0%**	**-2%**	**0%**	**2%**

Local terminals

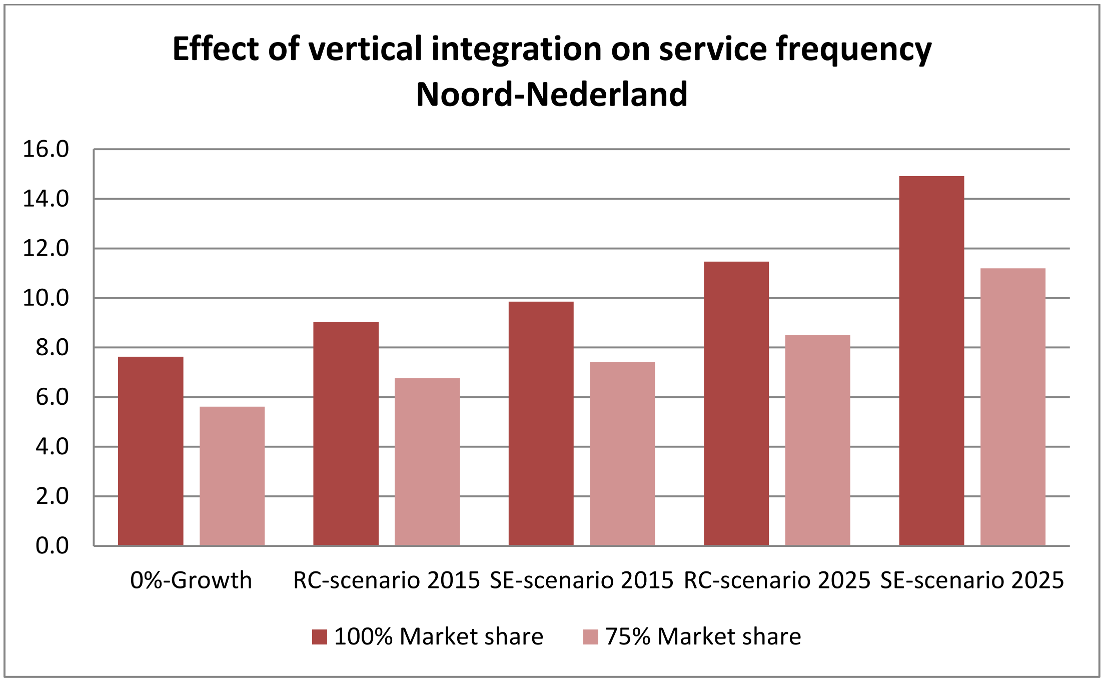
Inland Terminal	Sailing area	Volume (TEU)	0%-Growth	RC 2015	SE 2015	RC 2025	SE 2025
Wijnne & Barends Delfzijl	Noord-Nederland	2.500	4%	3%	1%	8%	-2%
CSY IJmuiden	Groot-Amsterdam	8.500	19%	-5%	-6%	-6%	-3%
CT Cuijk	Nijmegen-Maas	10.000	17%	-5%	-4%	2%	6%
CT Heerenveen	Noord-Nederland	12.000	31%	21%	21%	24%	23%
MEO Velsen-Noord	Groot-Amsterdam	15.000	16%	22%	25%	25%	22%
MCS Leeuwarden	Noord-Nederland	15.000	20%	23%	22%	19%	0%
CTS Stein	Nijmegen-Maas	20.000	-3%	-1%	-1%	17%	3%
ROC Kampen	Noord-Nederland	20.000	-7%	29%	-2%	-6%	1%
	Total volume:	**103.000**	**10%**	**8%**	**5%**	**11%**	**5%**

Regional terminals

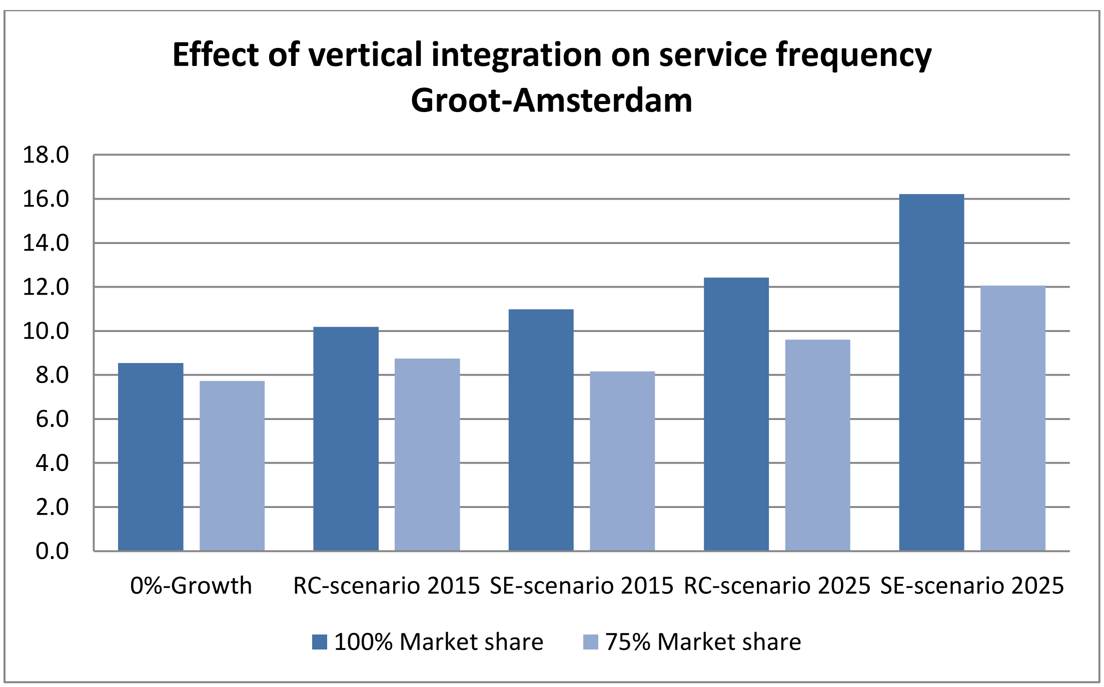
Inland Terminal	Sailing area	Volume (TEU)	0%-Growth	RC 2015	SE 2015	RC 2025	SE 2025
CTB Beverwijk	Groot-Amsterdam	57.000	16%	16%	2%	1%	5%
BTT Tilburg	West-Brabant	55.000	5%	1%	2%	0%	0%
ROC Waalwijk	West-Brabant	50.000	4%	8%	-3%	-6%	1%
IT Veghel	West-Brabant	50.000	-2%	2%	-3%	0%	0%
OOC Oss	Nijmegen-Maas	50.000	0%	14%	15%	11%	5%
LCG Gorinchem	Nijmegen-Maas	50.000	11%	14%	-5%	-5%	15%
CTVrede Zaandam	Groot-Amsterdam	45.000	-5%	-6%	0%	0%	5%
TCT Venlo	Nijmegen-Maas	43.000	6%	-7%	-7%	10%	6%
BTT Vossenberg	West-Brabant	40.000	-5%	1%	0%	4%	-7%
USA Amsterdam	Groot-Amsterdam	40.000	-7%	-6%	1%	-3%	15%
CTU Tiel	Nijmegen-Maas	40.000	-5%	1%	1%	16%	2%
MCS Meppel	Noord-Nederland	37.000	22%	4%	-3%	16%	1%
BSC Groningen	Noord-Nederland	30.000	0%	1%	0%	5%	35%
SCS Amsterdam	Groot-Amsterdam	30.000	-7%	22%	27%	21%	-6%
CTU Kampen	Noord-Nederland	25.000	-2%	-7%	-7%	1%	16%
MCS Westerbroek	Noord-Nederland	24.000	-3%	-3%	22%	1%	-7%
HOV Harlingen	Noord-Nederland	22.000	26%	-3%	-3%	0%	5%
	Total volume:	**688.000**	**3%**	**2%**	**2%**	**5%**	**5%**

Appendix 30: Effect of vertical integration on service frequency in a line network

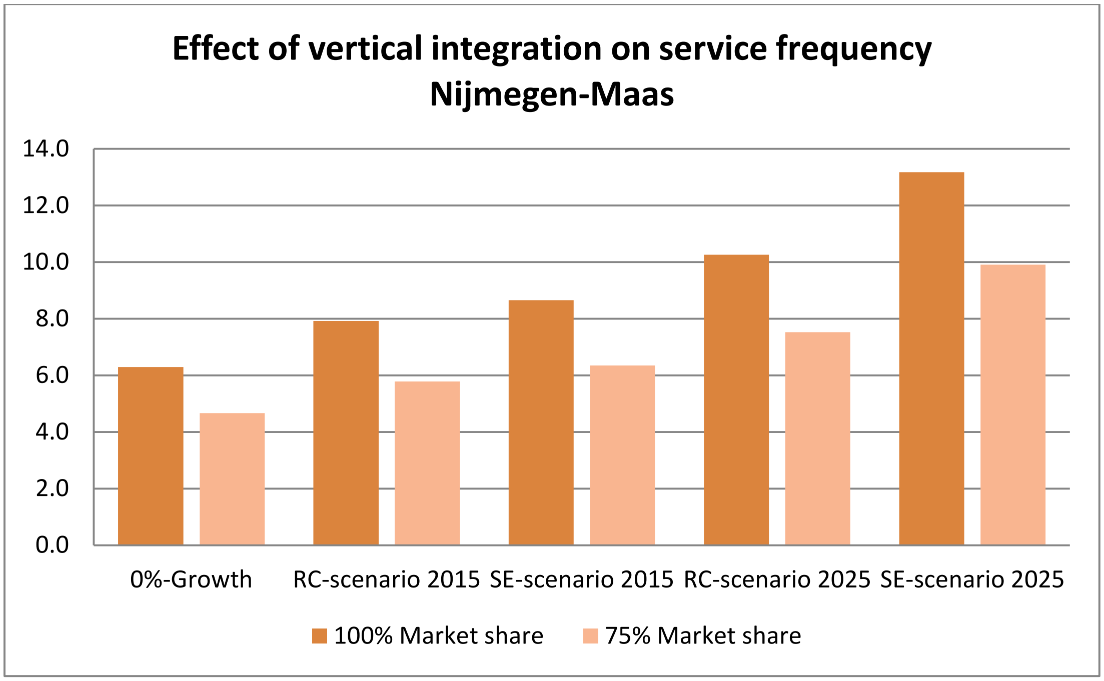
<u>Noord-Nederland</u>



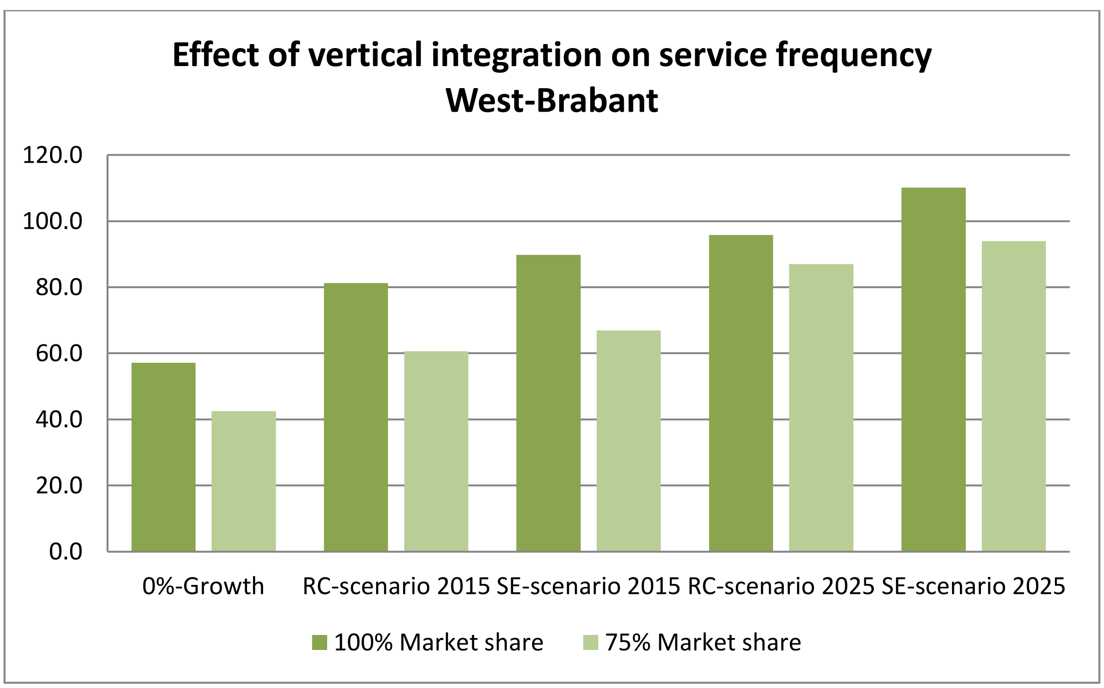
<u>Groot-Amsterdam</u>



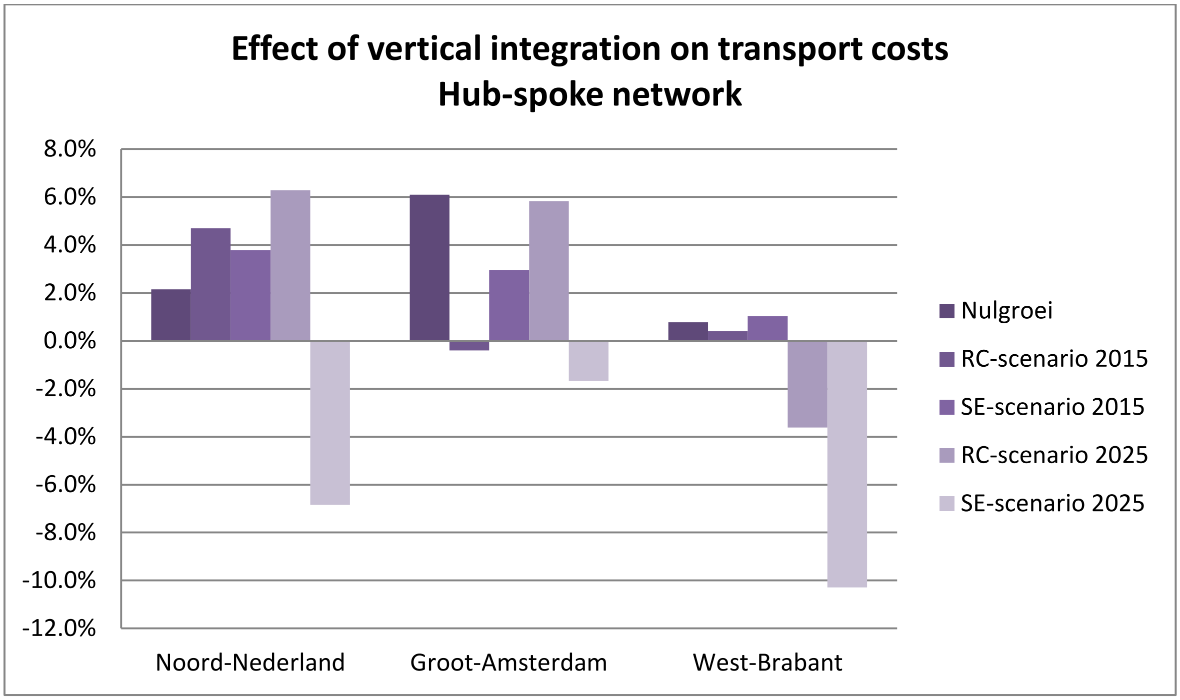
Nijmegen-Maas

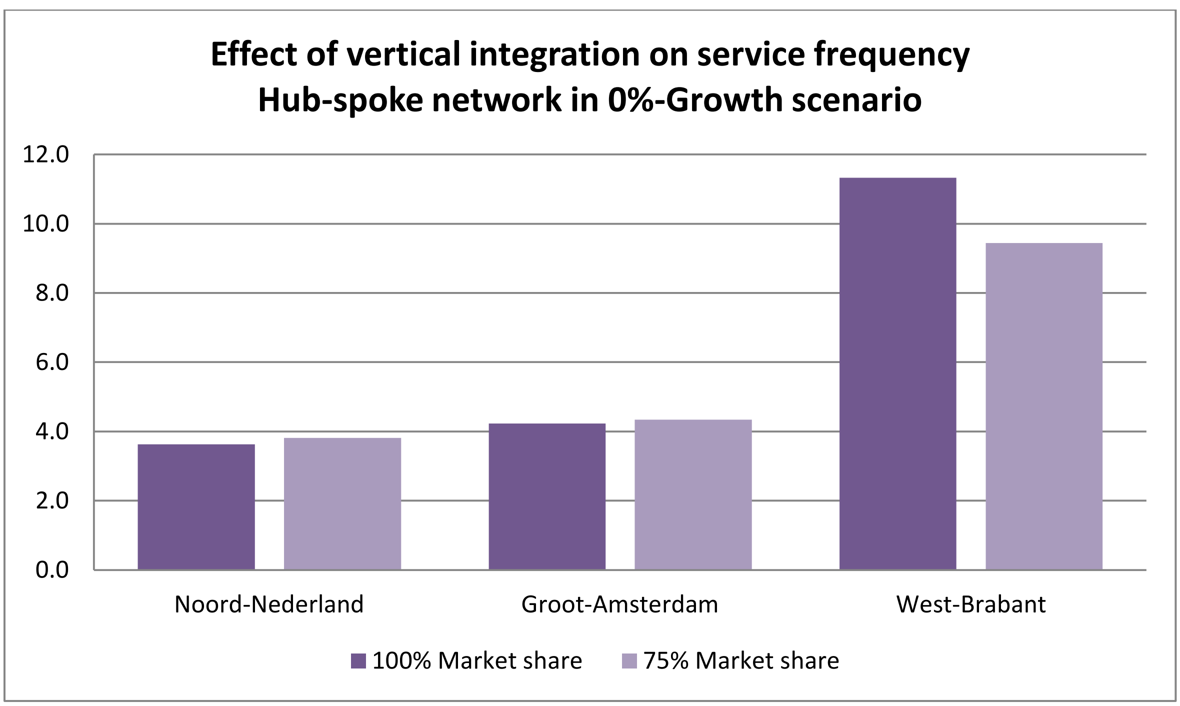


West-Brabant

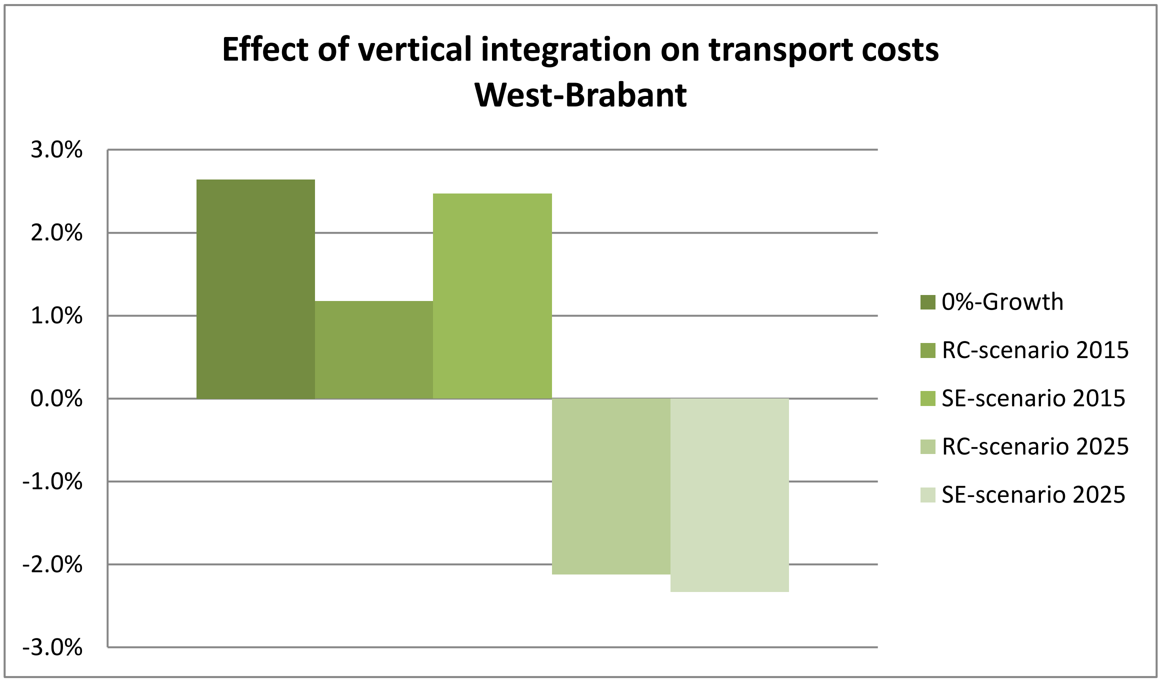


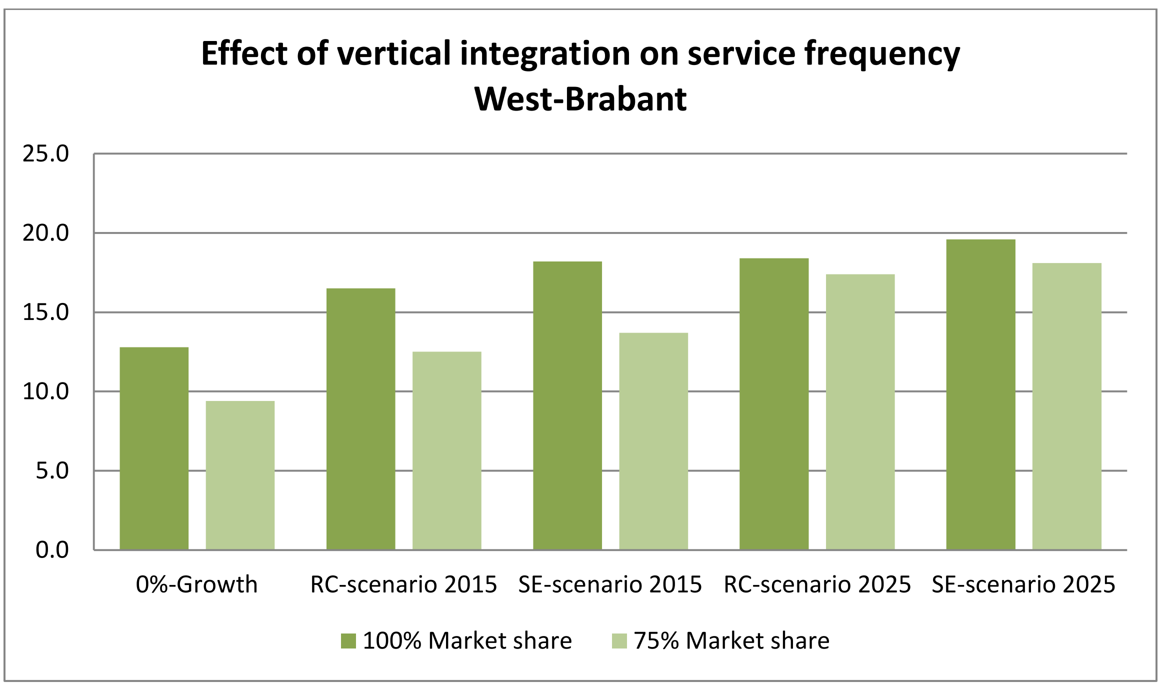
Appendix 31: Effect of vertical integration on efficiency of a hub-spoke network





Appendix 32: Effect of vertical integration on efficiency of a trunk-feeder network





Appendix 33: Uitwerking van de interviews

Interview 1:

Naam:	Ard-Jan Cieremans
Company:	Ab Ovo
Functie:	Senior Consultant
Plaats:	Capelle aan den Ijssel
Datum:	25 november 2013

Toekomstige ontwikkeling van het achterlandnetwerk

De verwachting is dat er in de toekomst meer containerstromen gebundeld gaan worden. Afgelopen week is aangekondigd in het nieuws dat er weer drie nieuwe inland terminals bijkomen: Lelystad, Haaften en de heropening van de terminal in Veendam. Door de uitbreiding van het terminalnetwerk in Nederland zal het onmogelijk worden om rechtstreeks naar de haven van Rotterdam te blijven varen tegen een aantrekkelijk tarief, zelfs als de containervolumes gaan stijgen. Een andere belangrijke ontwikkeling is de opwaardering van de Zuid-Willemsvaart in vaargebied West-Brabant. Dit maakt het mogelijk om met grotere schepen te gaan varen. Om de schepen vol te krijgen, zal er meer gecombineerd gaan worden.

Bemoeienis van diepzee partijen in het achterland

Het hangt heel erg van af van de moedermaatschappij van een diepzee partij of ze wel of niet gaan investeren in het achterland. Wanneer er voldoende volume in het achterland is, zullen diepzee partijen zich met name focusen op de overname van bestaande terminals. De verwachting is echter dat diepzee partijen in de komende jaren nog niet voldoende volume zullen hebben om eigen terminals te ontwikkelen. Daarom zullen diepzee partijen eerst eigen vaardiensten gaan opzetten in samenwerking met bestaande inland terminal operators (allianties). De toenemende bemoeienis van diepzee partijen in het achterland zal naar verwachting geen gevaar vormen voor de bestaande inland terminals. Uiteindelijk heeft een diepzee partij een inland terminal operator toch nodig voor het laden en lossen van de schepen. De verwachting is dat de toenemende bemoeienis weinig tot geen effect zal hebben voor de gehele binnenvaartsector in Nederland. De vraag naar transport zal eerder bepalend zijn voor de concurrentiepositie van de containerbinnenvaart sector (bepalend voor aantal schepen dat in haven van Rotterdam aanmeerd). Binnenvaart is ten allen tijden concurrerend ten opzichte van andere modaliteiten op gebied van prijs. Verladers hechten daarnaast een grote waarde aan betrouwbaarheid.

Onderscheidend vermogen van inland terminal operators

In de toekomst is de situatie van nu niet meer houdbaar. Op dit moment verzorgt een inland terminal operator zowel de exploitatie van de vaardiensten als de overslag van de containers van het binnenvaartschip naar de truck. De verwachting is dat beide diensten uiteindelijk van elkaar losgekoppeld zullen worden. Dit betekent dat inland terminal operators geen vaste dienst naar Rotterdam meer zullen aanbieden, waardoor het varen een dynamischer karakter zal krijgen (afhankelijk van de vraag). Inland terminals kunnen zich onderscheiden van diepzee partijen doordat ze een kortere lijn met verladers hebben en zodoende beter kunnen inspelen op de logistieke behoeften van verladers.

Daarnaast kunnen inland terminals zich onderscheiden door extra services aan te bieden (warehousing, planning en doaune-afhandeling). Door een totaal pakket aan diensten aan te bieden, kunnen inland terminal operators steeds meer de rol van expediteurs in het achterland overgaan nemen.

Samenwerking tussen inland terminal operators

Een manier om een succesvolle samenwerking tussen inland terminal operators te realiseren is door een cooperatie op te richten. Uit praktijk blijkt dat los samenwerken niet werkt, omdat er altijd wel een partij is die zich niet aan de afspraken kan houden (met name het toezeggen van volumes is lastig). Een andere belangrijke voorwaarde is een stabiele verdeling tussen kosten en opbrengsten voor de partijen. Er zijn op dit moment twee factoren die samenwerking in de containerbinnenvaart sector belemmeren. Een daarvan is het gebrek aan onderling vertrouwen. Doordat inland terminals in met name de vaargebieden West-Brabant en Nijmegen-Maas relatief dichtbij elkaar liggen, verschuiven de ladingpakketen van verladers over en weer. Er is over het algemeen meer kans op een succesvolle samenwerking tussen vaargebieden en regio's waar nauwelijks concurrentie is (bijv. de samenwerking tussen HOV Harlingen en ROC Kampen). Daarnaast is informatiedeling en transparantie in de keten erg belangrijk. Dit is lastig om te realiseren, vanwege de hoge investering die er mee gemoeid is.

Nieuwe terminal initiatieven in Nederland

Een belangrijke voorwaarde voor een inland terminal operator om een vaardienst naar de haven van Rotterdam te kunnen opzetten is dat een bepaalde frequentie kan worden aangeboden. Een verdere uitbreiding van het terminalnetwerk in Nederland is op dit moment niet haalbaar, omdat de vraag naar containerbinnenvaart te laag is. Wanneer er meer inland terminals bij komen, zal dit leiden tot een verdere versnippering van de goederenstromen in het achterland waardoor het aantal stops in de haven van Rotterdam zal toenemen. Zodra de vraag naar containerbinnenvaart gaat stijgen, zullen nieuwe terminal initiativen gunstig zijn voor de verdere ontwikkeling van de sector. De ontwikkeling van nieuwe inland terminals werkt concurrenend. Bovendien heeft een verlader meer opties om uit te kiezen.

Ontwikkelingen in de containerbinnenvaart sector

Een belangrijke vraag is of de overslagvolumes die voorspeld zijn door het Rotterdamse Havenbedrijf ook wel daadwerkelijk gehaald zullen worden. Zeeschepen worden steeds groter. Doordat er veel concurrentie is tussen havens in Noord-West Europa is het nog maar net de vraag of deze schepen ook wel echt Rotterdam zullen aandoen. De haven van Antwerpen ligt immers vlakbij. Zeeschepen krijgen voorrang op binnenvaarstschepen, omdat een stuwadoor een boete krijgt van een rederij als een een diepzee schip te laat wordt afgehandeld. Stuwadoors hebben geen contractuele relatie met barge operators en dus moet een binnenvaartschip wachten op afhandeling. Doordat er steeds grotere schepen in de haven van Rotterdam zullen aanmeren, zal de huidige afhandelingsproblematiek wellicht verergeren. Hierdoor kan de omlooptijd van de binnenvaartschepen in gevaar komen, waardoor het binnenvaart product minder aantrekkelijk wordt ten opzichte van andere modaliteiten.

Interview 2:

Naam: Ben van Rooy
Company: Brabant Intermodal
Functie: Consultant Business Development
Plaats: Oosterhout
Datum: 28 november 2013

Toekomstige ontwikkeling van het achterlandnetwerk

Door de opening van de Maasvlakte II zullen er twee nieuwe containerterminals bijkomen in de haven van Rotterdam. Hoe het achterlandnetwerk zich verder zal ontwikkelen, hangt heel erg af van de vraag of de toename in de terminalcapaciteit ook zal leiden tot een groei van het volume in het achterland. Groei in het achterland is alleen mogelijk als er nieuwe bedrijven gebruik gaan maken van de containerbinnenvaart of als bestaande klanten gaan groeien. Door de opening van de nieuwe containerterminals zal het volume in de haven van Rotterdam zich gaan verspreiden. Als gevolg hiervan zal het aantal calls per omloop toenemen. Dit houdt in dat een schip 8 à 10 uur langer bezig zal zijn om alle containers te distribueren in de haven van Rotterdam. Omdat de geplande omlooptijd van een schip niet meer wordt gehaald, zal een inland terminal operator extra scheepscapaciteit moeten gaan inzetten wat geld kost. Hierdoor zal de bundeling van containerstromen aantrekkelijker worden. Aan de andere kant kan de overcapaciteit in de haven van Rotterdam er voor zorgen dat stuwadoors meer aandacht gaan besteden aan het laden en lossen van binnenvaartschepen waardoor de betrouwbaarheid zal toenemen en bundeling helemaal niet nodig is. De verwachting is dat in de toekomst een combinatie van verschillende netwerken zal ontstaan (combinatie van bijv. line netwerk en hub-&-spoke netwerk). Afhankelijk van de vraag zal er per dag een andere vaarplanning worden gemaakt. Het is dan wel noodzakelijk dat er geen commercieel tarief wordt gerekend op de hub terminal, maar dat de container wordt overslagen tegen marginale kosten. De ervaring van Brabant Intermodal met hub-&-spoke en trunk-feeder modellen is niet goed, omdat er onnodig extra kosten aan de keten worden toegevoegd.

Bemoeienis van diepzee partijen in het achterland

De toenemende bemoeienis van diepzee partijen in het achterland is een potentieel gevaar voor de huidige inland terminal operators, maar de praktijk is dat verladers niet snel switchen naar een andere vervoerder. Een inland terminal heeft een bepaald afzetgebied. Een nabijgelegen terminal kan hier vaak niet tegen op concurreren, omdat het voor- en natransport van een container per truck duur is. Als er lokaal voldoende volume is dan zal de toenemende invloed van diepzee partijen geen probleem vormen voor de bestaande terminals. De verwachting is dat stuwadoors met name deelnemingen zullen nemen in bestaande terminals, omdat ze geen eigen klantenbasis hebben. Op dit moment biedt EGS een bepaalde aflevergarantie aan verladers. Ze geven hun eigen schepen voorrang in de haven van Rotterdam en lopen hierdoor nauwelijks vertraging op. Normaal gesproken kan een inland terminal operator hier niet tegen op concurreren, omdat een bepaalde marge in het vaarschema moet worden opgenomen om met de vertraging in de haven van Rotterdam te kunnen omgaan. Door de opening van Maasvlakte II zal het volume zich verder verspreiden. Een deel van de omzet van ECT zal wegvallen. De grote vraag is dan of EGS dan nog wel een aantrekkelijk barge product kan aanbieden. Om hun schepen te vullen, zullen ze uiteindelijk ook volume bij andere terminals moeten gaan halen.

Onderscheidend vermogen van inland terminal operators

Een manier om verladers te binden is door een goede relatie op te bouwen. Diepzee partijen kunnen de lokale klant niet benaderen, omdat ze hier de contacten niet voor hebben. Een inland terminal kan gezien worden als een soort lokaal voorraadpunt voor een verlader. Elke klant heeft een aantal dagen vrije opslag en kan op afroep een container laten uitleveren. Dit kun je alleen aanbieden als je kennis hebt van de lokale spelers. Daarnaast kan een inland terminal operator zich onderscheiden van diepzee partijen door flexibel te zijn. Een groot probleem waarmee inland terminal operators te kampen hebben, is de onbetrouwbaarheid van de afhandeling van de schepen in Rotterdam. Stuwadoors zien niet het belang van een goede achterlandverbinding. Het laden en lossen van binnenvaartschepen is een buffer voor stuwadoors om hun personeel aan de gang te houden zodra er geen zeeschepen zijn. Er zijn veel vertragingen in de haven van Rotterdam, waardoor de barge planning continue aangepast moet worden. Doordat er veel vertragingen zijn, kun je als inland terminal op dit moment geen garanties aan verladers bieden. Er wordt een grote buffer ingebouwd, zodat een betrouwbaar product kan worden aangeboden. Als de problemen in de haven van Rotterdam zullen worden opgelost dan zal dit een positief effect hebben om de omlooptijd in de haven waardoor er uiteindelijk meer verladers voor de containerbinnenvaart zullen kiezen. De toenemende invloed van diepzee partijen in het achterland zal zeker effect hebben op de afhandelingscondities in de haven van Rotterdam, omdat bepaalde binnenvaartschepen voorrang zullen krijgen. Het is afwachten hoe dit zich precies gaat ontwikkelen.

Samenwerking tussen inland terminal operators

Het realiseren van samenwerking tussen inland terminal operators vereist een cultuuromslag. Over het algemeen staan inland terminal operators negatief tegenover samenwerking. Samenwerking is zodoende alleen te bereiken door te lobby'en en de voordelen van samenwerking te blijven benadrukken. Dit is een lang proces waarin continue geinvesteerd moet worden. Ook is het belangrijk om een neutrale partij te betrekken bij het proces die het perspectief van alle partijen belicht. Een belangrijke voorwaarde voor een succesvolle samenwerking is bovenal een centrale barge planning. Het is belangrijk dat de planning continue inzicht heeft in de verschillende manieren waarop een container getransporteerd kan worden (ondersteund door ICT). Dit kan alleen bereikt worden door de planning van de terminals te centraliseren. Tot slot is het belangrijk om een onderlinge structuur te maken voor de verrekening van de kosten en baten van de samenwerking.

Nieuwe terminal initiatieven in Nederland

De ontwikkeling van nieuwe inland terminals in Nederland kan gunstig zijn, zeker als een terminal een compleet nieuwe markt aanboord. Wanneer er een nieuwe terminal wordt ontwikkeld in een regio waar op dit moment al terminals zitten dan is dit juist weer ongunstig voor de containerbinnenvaart sector. Het is lastig om te voorspellen wat precies het effect van een verdere uitbreiding van het terminal netwerk zal zijn voor de afhandeling van de binnenvaartschepen in de haven van Rotterdam. Meer binnenvaartschepen kunnen er voor zorgen dat de problematiek verergerd. Het kan er echter ook voor zorgen dat stuwadoors meer aandacht gaan besteden aan de afhandeling van de binnenvaartschepen.

Ontwikkelingen in de containerbinnenvaart sector

- Ontwikkeling van de 24-uurs economie

Interview 3:

Naam: Hugo de Valk
Company: Ab Ovo
Functie: Senior Consultant
Plaats: Amsterdam
Datum: 29 november 2013

Toekomstige ontwikkeling van het achterlandnetwerk

De verwachting is dat er in de toekomst verschillende soorten netwerken naast elkaar zullen ontstaan (vb. punt-punt netwerk en line netwerk). Dit zie je nu al steeds meer gebeuren bij grote spelers als BCTN en Contargo. Op dit moment worden containerstromen met name gebundeld vanwege “armoede”. Dit betekent dat er te weinig volume is om een frequente wekelijkse dienst naar de haven van Rotterdam op te zetten. In deze gevallen is het aantal stops in de haven van Rotterdam nog steeds aanzienlijk. Als de containervolumes gaan toenemen dan zal er gebundeld worden uit “rijkdom”. Er zal bijvoorbeeld een schip rechtstreeks vanuit het achterland naar de Maasvlakte gaan en een schip naar de empty depots in de stad. De containerstromen zullen dusdanig groot worden dat het in de toekomst zelfs mogelijk moet zijn om een schip dedicated naar een containerterminal te laten varen. Naar verwachting zal het aantal stadhavens in de toekomst verminderen door de aantrekkingskracht van de Maasvlakte II. Het volume zal zich verplaatsen waardoor er meer clustering van het volume op de Maasvlakte komt.

Bemoeienis van diepzee partijen in het achterland

De verwachting is dat diepzee partijen niet zelf hun eigen vaardiensten zullen gaan opzetten, omdat de volumes erg volatile zijn. Diepzee partijen zullen de diensten voornamelijk inkopen bij bestaande operators en gebruik maken van bestaande concepten; of ze zullen zelf concepten bedenken maar deze laten uitvoeren door derden (vb. Inland CY product van Maerks). Belangrijk om te melden is dat er op dit moment ook een tegengestelde beweging in de sector gaande is. Zo heeft APM Terminals recentelijk zijn inland terminal in Hamburg verkocht. De verwachting is dat met name diepzee rederijen zich zullen gaan mengen in het achterland, omdat voor hen het achterland onderscheidend kan zijn. Wel is het belangrijk om te melden dat een eigen achterlandstrategie hooguit weggelegd is voor de top 5 diepzee rederijen in de wereld. Door de opening van Maasvlakte II gaat diepzee terminal operator ECT klanten verliezen zoals CMA. Het volume wat ze nu hebben, zal zich verspreiden over de haven van Rotterdam waardoor het EGS product in gevaar komt (minder frequent en kleinere schepen). Rotterdam World Gateway en APM Terminals zullen een meer faciliterende rol op zich nemen (niet regiserend). Naar verwachting zal de toenemende bemoeienis van diepzee partijen in het achterland geen gevaar vormen voor de bestaande inland terminals in Nederland. In Nederland zie je steeds meer netwerken van terminals ontstaan, bijv.: BCTN en HCL (Heerenveen, Harlingen, Groningen, etc.). Deze netwerken vormen een goed tegenwicht tegen de toenemende bemoeienis van diepzee partijen in het achterland. De verwachting is dat de bemoeienis geen grote verandering teweeg zal brengen voor het gehele containerbinnenvaart systeem.

Onderscheidend vermogen van inland terminal operators
Een mogelijkheid voor inland terminal operators in Nederland om met de toenemende bemoeienis in het achterland om te gaan is door een samenwerkingsverband aan te gaan met diepzee partijen. Door toenadering tot elkaar te zoeken, kunnen nieuwe logistieke concepten worden ontwikkeld en geimplementeerd. Dit kan weer kan leiden tot een concurrentievoordeel voor zowel beide partijen.

Samenwerking tussen inland terminal operators
Om een succesvolle samenwerking tussen inland terminal operators tot stand te laten komen, is het belangrijk dat er transparantie is. Daarnaast is het erg belangrijk dat er duidelijke afspraken worden gemaakt en dat de afspraken continue worden gemonitord. Tot slot moet er voor alle partijen een win-win situatie zijn. Samenwerking komt nu vaak niet tot stand, omdat partijen niet buiten de dagelijkse praktijk kijken. Ze zitten vastgeroest in de dagelijkse operatie waardoor ze niet innovatief zijn. Om samenwerking tot stand te laten komen, is een neturale partij nodig die de mediator rol op zich neemt (geen overheidspartij). De neutrale partij kan het voortouw nemen en de inland terminal operators bij elkaar brengen. Omdat er in alle casussen verschillende belangen spelen, is maatwerk noodzakelijk.

Nieuwe terminal initiatieven in Nederland
Een verdere uitbreiding van het terminalnetwerk in Nederland kan gunstig zijn, maar ook weer niet. Verladers wisselen niet snel van vervoerder, tenzij er een aanzienlijk prijsvoordeel bereikt kan worden door te switchen. Dit is vaak alleen het geval als er bespaard kan worden op voor- en natransport. Een verdere uitbreiding van het netwerk met de huidige containervolumes is nadelig voor zowel bestaande als nieuwe terminals. Bijvoorbeeld de ontwikkeling van de nieuwe terminal Cuijk is ongustig voor de containerbinnenvaart sector, omdat de terminal in Nijmegen op korte afstand van Cuijk gevestigd is.

Ontwikkelingen in de containerbinnenvaart sector
- Ketensamenwerking met als doel een verdere optimalisatie van het achterlandnetwerk
- Toenemende focus op duurzaamheid bij verladers

Interview 4:

Naam: Ivo van Beijeren
Company: Pro-Log
Functie: Coordinator Operations
Plaats: Zwijndrecht
Datum: 3 december 2013

Toekomstige ontwikkeling van het achterlandnetwerk

Op dit moment heeft een rederij weinig onderscheidend vermogen. De aangeboden zeediensten zijn allemaal hetzelfde. Rederijen kunnen enkel concurreren op prijs en het aantal vrije opslagdagen. In de toekomst zullen rederijen zich gaan proberen te onderscheiden in het achterland. De verwachting is dat de bemoeienis van rederijen zal gaan toenemen zodra de containervolumes gaan stijgen na de opening van de Maasvlakte II. Rederijen zullen met name geintresseerd zijn in trajecten die wat verder van de haven van Rotterdam gelegen zijn (vb. Duisburg en Amsterdam). Op korte afstanden zal men gewoon punt-punt blijven varen zoals nu het geval is op o.a. het traject Bergen op Zoom – Rotterdam (< 100 km).

Bemoeienis van diepzee partijen in het achterland

De verwachting is dat diepzee partijen zullen beginnen met het opzetten van eigen vaardiensten, omdat hier minder volume voor nodig is dan voor het ontwikkelen van een eigen terminal. Op termijn zullen diepzee partijen wellicht ook deelnemingen gaan nemen in terminals. Op korte termijn zullen diepzee partijen zich met name focusen op het opzetten van vaardiensten met behulp van strategisch gekozen partners. Dit kan nadelig zijn voor bestaande inland terminals. Bijv. Groot-Amsterdam is een klein gebied waar veel terminals gevestigd zijn. Zodra een diepzee partij een vaardienst opzet naar dit gebied en het volume laat overslaan op slechts één terminal dan zal de rest van de terminals moeten sluiten. Door de toenemende macht van diepzee partijen in het achterland zullen de tarieven in de containerbinnenvaart sector nog verder onder druk komen te staan. Als het volume van rederijen wegvalt, zullen een aantal bestaande barge operators hier niet meer tegen op kunnen concurreren vanwege de onderbezetting van de schepen. Dit zal een ongunstig effect hebben op de containerbinnenvaart sector. Wanneer er inland terminals wegvallen uit het achterlandnetwerk dan zal de gemiddelde afstand tussen de terminals en verladers weer groter worden. Door het grote aandeel van het voor- en natransport in de totale kosten van de containerbinnenvaart zal zodoende het aantal truckbewegingen weer toe nemen.

Onderscheidend vermogen van inland terminal operators

Helaas is het niet voor alle inland terminal operators mogelijk om zichzelf te beschermen tegen de invloed van rederijen. Een grote verlader met veel macht kan een inland terminal beschermen tegen de toenemende invloed van rederijen in het achterland. Een aantal inland terminals zullen bij genoeg volume een rechtstreekse dienst kunnen opzetten naar container terminals in de haven van Rotterdam en zodoende een concurrentievoordeel behalen. Een andere optie voor een inland terminal operator is om exclusief voor een rederij te gaan werken. Inland terminal operators zullen zich daarnaast met name moeten focussen op een verbetering van de dienstverlening en flexibiliteit. De verwachting is dat de schepen van rederijen een voorkeurspositie zullen krijgen in de haven van Rotterdam, omdat ze een betalende klant zijn voor stuwadoors. Rederijen zullen met name de concurrentie aangaan op prijs. De vraag is echter of rederijen genoeg volume kunnen genereren om een volledig schip te vullen.

Samenwerking tussen inland terminal operators

Het tot stand laten komen van een succesvolle samenwerking tussen inland terminal operators is lastig, maar het kan wel. Een belangrijke voorwaarde is vertrouwen. De relatie tussen de partijen moet ijzersterk zijn. Daarnaast moet men loyaal zijn tegenover elkaar en er moeten goede afspraken worden gemaakt over de capaciteit van de schepen. Onlangs was er een staking bij APM Terminals. Het is belangrijk om calamiteiten contractueel vast te leggen om conflicten in dit soort gevallen te voorkomen. Samenwerking in Nederland is lastig te realiseren, omdat er veel concurrentie is tussen de inland terminals. Er spelen dus vaak lokale belangen mee. Pro-Log is een neutrale barge operator die een vaardienst onderhoudt tussen Barge Service Center Groningen, Container Terminal Heerenveen en de haven van Rotterdam. De samenwerking tussen deze partijen verloopt moeizaam, zelfs met een neutrale barge operator ertussen. Samenwerking is een lange termijn investering. De meeste partijen zijn echter niet bereid om kosten te nemen en hebben uiteenlopende belangen wat samenwerking lastig maakt.

Nieuwe terminal initiatieven in Nederland

Een verdere uitbreiding van het terminal netwerk in Nederland is enerzijds goed. De totale vraag naar containerbinnenvaart zal toenemen, omdat een verlader meer opties heeft. Het leidt anderzijds ook tot een verdere versnippering van goederenstromen in het achterland. Een binnenvaartschip zal als gevolg hiervan meer containerterminals in de haven van Roterdam moeten aandoen, waardoor de vaardienst onbetrouwbaarder wordt. Dit kan verstorend werken voor het huidige binnenvaartsysteem.

Ontwikkelingen in de containerbinnenvaart sector

Een belangrijke vraag die nu speelt is of barge operators de omlooptijd van hun vaardiensten nog wel kunnen halen zodra de Maasvlakte II wordt geopend. Op dit moment liggen de containerterminals in de haven van Rotterdam allemaal dichtbij elkaar. Door de opening van de nieuwe terminals zal er meer versnippering zijn. Daarnaast is de verwachting dat het aantal empty depots in de toekomst zal afnemen (in de stad). Op dit moment zijn de depots ’s nachts en in het weekend gesloten. Een andere belangrijke ontwikkeling is dat steeds meer diepzee rederijen met nieuwe producten op de markt komen.

Interview 5:

Naam: Frits Bisschop
Company: Connekt
Functie: Program Manager
Plaats: Delft
Datum: 4 december 2013

Toekomstige ontwikkeling van het achterlandnetwerk

De transportsector is erg concurrentiegevoelig. Vervoerders ervaren een continue druk om de efficiëntie van hun diensten te verhogen. In de meeste transportsectoren worden stromen al gebundeld. De containerbinnenvaart sector heeft een forse achterstand ten opzichte van andere sectoren. Uiteindelijk zal er ook in de container binnenvaartsector meer gebundeld gaan worden. Dit zal of afgedwongen worden door verladers (binnenvaart te duur) of op initiatief van partijen in de sector ontstaan.

Bemoeienis van diepzee partijen in het achterland

Op dit moment is het aandeel carrier haulage erg laag. Een aantal diepzee partijen heeft er strategisch belang om dit aandeel te verhogen en zullen dan ook zeker een strategie opzetten (bijvoorbeeld Maersk). Dit zal niet gebeuren door middel van voorwaartste integratie, vanwege de grootschalige investeringen die ermee gemoeid zijn. Diepzee partijen zullen contracten afsluiten met derden voor de uitvoering van hun diensten. De bemoeienis van diepzee partijen in het achterland zal uiteindelijk leiden tot een herorientatie van het achterlandnetwerk. Diepzee partijen zullen een aantal inland terminals uitkiezen waarmee ze zaken zullen doen. Hierdoor zullen een aantal inland terminals gaan groeien, terwijl anderen zullen moeten sluiten. Deze keuze hangt af van een aantal factoren zoals de openingstijden van een inland terminal. De bemoeienis van diepzee partijen in het achterland zal een impuls geven aan de gehele containerbinnenvaart sector in Nederland. Diepzee partijen zijn continue gericht op het verminderen van het aantal truckbewegingen, omdat wegtransport duur en milieuontvriendelijk is. De containerbinnenvaart in Nederland is beter ontwikkeld dan het railvervoer en dus zal deze ontwikkeling ten gunste komen van de containerbinnenvaart sector.

Onderscheidend vermogen van inland terminal operators

Voor inland terminal operators is het moeilijk om zichzelf te profileren in de markt. De randvoorwaarden zijn gegeven: waterdiepgang, ligging van sluizen, etc. Een inland terminal operator kan dus weinig invloed uitoefenen op de markt. In het verleden zijn inland terminal operators daarom begonnen met het opzetten van een eigen vaardienst. In de toekomst zal er geen bestaansrecht meer zijn voor kleine inland terminals in Nederland. Inland terminals die in staat zullen zijn om een rechtstreekse vaardienst op te zetten naar grote containerterminals in de haven van Rotterdam zullen een concurrentievoordeel gaan behalen. De onvoorspelbaarheid in Rotterdam beinvloedt de efficiëntie van de vaardiensten. Door een rechtstreekse vaardienst op te zetten, worden de inland terminal operators voor een groot deel onafhankelijk van de afhandelingsproblematiek in de haven van Rotterdam. Op dit moment is er nog onvoldoende schaalgrote (volume) om rechtstreekse vaardiensten mogelijk te maken. Het gevolg van deze ontwikkeling zal zijn dat bepaalde inland terminals in Nederland dominanter zullen worden en meer volume zullen genereren dan anderen.

Samenwerking tussen inland terminal operators

Op dit moment zijn er te veel partijen in de keten waardoor samenwerking belemmerd wordt. Desondanks neemt de bereidheid tot samenwerking wel steeds meer toe. De partijen zijn erg op hun eigen operatie gericht door de prijsdruk in de markt. Daarnaast zitten veel inland terminals in elkaars vaarwater. Een belangrijke voorwaarde om samenwerking tot stand te brengen is dat de baten van de samenwerking door alle partijen gezien moeten worden. Dit kan worden gerealiseerd door partijen bij elkaar te brengen en een stimulans te bieden. Een andere belangrijke voorwaarde is vertrouwen. Ook moeten partijen er strategisch belang bij hebben om samen te werken. Fusies en overnames zullen zeker helpen om het achterlandnetwerk verder te optimaliseren. Wanneer er slechts vijf terminal organisaties zouden zijn in Nederland dan wordt het aan de ene kant organisatorisch moeilijker om samenwerking te realiseren, omdat een inland terminal onderdeel is van een groep. Aan de andere kant is samenwerking niet meer nodig, omdat er vanuit de partijen zelf netwerken zullen ontstaan.

Nieuwe terminal initiatieven in Nederland

Het is belangrijk dat het terminalnetwerk in Nederland zich niet verder uitbreidt, vanwege verladerswensen. Dit gebeurt in praktijk wel vaak. De ontwikkeling van een nieuwe inland terminal is ongunstig, tenzij een verlader een lange termijn commitment aan de containerbinnenvaart geeft en een zeker overslagvolume kan garanderen. Dit kunnen eigenlijk alleen de echte grote verladers in Nederland. Middelgrote verladers verplaatsen makkelijk hun locatie en maken in praktijk niet echt een keuze voor de containerbinnenvaart. Op dit moment zitten alle grote verladers in Nederland al bij een inland terminal zoals Heineken, Bavaria en FrieslandCampina. Om deze reden is een verdere uitbreiding van het terminalnetwerk in Nederland ongunstig voor de containerbinnenvaart sector.

Ontwikkelingen in de containerbinnenvaart sector

- Professionaliseringslag: actoren kijken steeds strategischer naar hun business case
- Concentratietendensen: bepaalde partijen in de markt worden steeds groter
- Toenemende nadruk op transparantie in de keten
- Toenemende bereidheid tot samenwerking
- Toenemende focus op duurzaamheid en modal shift veranderingen vanuit de maatschappij

Interview 6:

Naam: Wilko van Wijk en Bart Post
Company: Kuehne + Nagel
Functie: Manager Sea Freight Import en Manager Intermodal
Plaats: Rotterdam
Datum: 5 december 2013

Toekomstige ontwikkeling van het achterlandnetwerk

Lokaal zie je al steeds meer samenwerking ontstaan. De verwachting is dat er in de toekomst meer containerstromen gebundeld gaan worden, omdat dit efficienter is. Daarnaast komen er meer containerterminals in de haven van Rotterdam bij door de opening van de Maasvlakte II waardoor het volume zich verder zal verspreiden. Schaalgrote zal een belangrijke onderscheidende factor worden voor inland terminals. Grote inland terminals zullen in staat zijn om een rechtstreekse vaardienst aan te bieden naar container terminals in de haven van Rotterdam. De verwachting is dat inland terminals op belangrijke verbindingspunten consolidatiepunten zullen worden in het achterlandnetwerk. De vraag is wel of deze terminals een toenemend aantal handelingen aankunnen qua capaciteit. De verwachting is dat de afhandelingsproblematiek in de haven van Rotterdam zal verminderen door de opening van Maasvlakte II, omdat er meer terminalcapaciteit beschikbaar is. Stuwadoors geven nu de prioriteit aan het laden en lossen van zeeschepen. Daarnaast wordt een groot deel van de vertraging bij de containerterminals veroorzaakt door de inzet van personeel. Barge operators zijn geen serieuze speler voor stuwadoors. Op dit moment is niet bekend waar een container precies heen gaat nadat het gelost is van een zeeschip en met welke modaliteit het vervoerd zal worden naar het achterland. De vraag is hoe stuwadoors in de toekomst zullen omgaan met de aan- en afvoer van containers.

Bemoeienis van diepzee partijen in het achterland

Diepzee rederijen willen controle over hun equipment hebben. Op dit moment weten ze niet waar een container heengaat en wanneer die precies terugkomt. Om meer controle te kunnen uitoefenen, willen ze spelers als Kuehne + Nagel buiten spel zetten. In de toekomst zullen ze zich dan ook zeker meer gaan bemoeien met het achterland. Dit zullen rederijen voornamelijk doen door de samenwerking met inland terminal operators op te zoeken (hoge investeringen in de zeevaart). Ook stuwadoors zullen zich steeds meer gaan mengen in het achterland. De verwachting is dat ze dit zullen doen door te investeren in bestaande terminals. Eventueel zullen stuwadoors op termijn omgevallen inland terminals overnemen. Er is veel concurrentie in de haven van Rotterdam door de opening van de Maasvlakte II, waardoor het goedkoper zal zijn om de activiteiten te verplaatsen naar inland terminals. Naar verwachting zal de bemoeienis van diepzee partijen in het achterland geen gevaar vormen voor het bestaansrecht van inland terminals. Uiteindelijk is een inland terminal operator toch nodig om de schepen te laden en lossen. Een diepzee partij zal een strategische keuze maken voor 5 à 6 partijen waarmee een samenwerkingverband zal worden aangegaan. Naar verwachting zullen er hierdoor wel een aantal inland terminals in Nederland om gaan vallen. De verwachting is dat dit met name kleine terminals zullen zijn, omdat die te weinig capaciteit hebben om aan de wensen van diepzee partijen te voldoen.

Onderscheidend vermogen van inland terminal operators
Kleine inland terminals zullen in de toekomst geen recht van bestaan meer hebben. Inland terminals hebben weinig onderscheidend vermogen. Als we bijv. kijken naar inland terminals in West-Brabant dan zijn de prijzen die ze aanbieden nagenoeg overal hetzelfde. Kuehne + Nagel baseert de keuze voor een inland terminal met name op basis van de volgende factoren: prijs, aantal afvaarten, afstand tot verlader en service. Ook wordt er gekeken of een lege container kan worden achtergelaten op de inland terminal.

Samenwerking tussen inland terminal operators
De containerbinnenvaart sector in Nederland is in beweging. Er zijn veel projecten waar marktpartijen bij elkaar worden gebracht. Samenwerking is tot op zekere hoogte mogelijk. Uiteindelijk zullen alle partijen voor zichzelf kiezen. De verwachting is dat de bundeling van containerstromen uiteindelijk uit zichzelf tot stand zal komen. De kleine inland terminals zullen verdwijnen uit het netwerk. Hierdoor krijgen de grote inland terminals meer volume te verwerken. Dit volume zullen ze gaan bundelen om zodoende een rechtstreekse dienst naar container terminals in de haven van Rotterdam te kunnen aanbieden. Overnames en fusies zullen zeker helpen om het achterlandnetwerk verder te optimaliseren.

Nieuwe terminal initiatieven in Nederland
Op dit moment zijn er meer dan genoeg inland terminals in Nederland. Een verdere uitbreiding van het terminal netwerk in Nederland zal leiden tot een verdere versnippering van de goederenstromen in het achterland. Dit zal leiden tot een grotere inefficiëntie in de haven van Rotterdam en een prijsstijging.

Ontwikkelingen in de containerbinnenvaart sector
Een belangrijke ontwikkeling in de containerbinnenvaart sector die een grote impact heeft op Kuehne + Nagel is de ontwikkeling van nieuwe achterlandproducten bij diepzee partijen. Een voorbeeld is Maersk. Maersk heeft onlangs het product Inland CY op de markt gebracht. Dit product is een gevaar voor Kuehne + Nagel. Maersk hanteert vaste prijzen voor het transport van een container naar een inland terminal en garandeert dat een container binnen een vast tijdsbestek op een inland terminal aanwezig is. Daarnaast kunnen verladers hun lege containers achterlaten bij een inland terminal waardoor ze alleen een single trip hoeven te betalen. Hier kan Kuehne + Nagel niet tegenop concurreren.

Interview 7:

Naam: Klaasjan Kolle
Company: Container Terminal Beverwijk
Functie: Director
Plaats: Beverwijk
Datum: 10 december 2013

Toekomstige ontwikkeling van het achterlandnetwerk

In Groot-Amsterdam zijn de kosten om een container per binnenvaart te laten vervoeren gelijk aan de kosten voor trucking. Doordat de kosten hiervan gelijk zijn, is het prijstechnisch niet mogelijk om de container tussentijds nog een keer over te slaan. Een groot nadeel van bundelen is de documentenstroom. Op de documenten staan vaak belangrijke klantgegevens. Door bundeling zijn deze gegevens voor iedereen toegankelijk. Bovendien is het voor reefercontainers lastig om bundeling tot stand te laten komen. Nu worden deze containers één dag voor de closing getransporeerd naar de haven van Rotterdam. Er is eigenlijk geen tijd om deze containers tussentijds nog een keer over te slaan. Daarnaast moet de hub terminal goed beveiligd zijn, omdat in sommige containers hoogwaardige producten worden vervoerd (productkarakteristieken). Er zijn in het verleden al diverse inititieven geweest om containerstromen te bundelen. Zo heb je o.a. Barge Center Waalhaven, Pernis Combi Terminal en Groenenboom Containertransferium Ridderkerk die ontwikkeld zijn om kleine partijen te verzamelen en verder te distribueren in de haven van Rotterdam, maar niemand maakt gebruik van deze diensten. Op dit moment heeft Container Terminal Beverwijk eigenlijk niemand nodig om de diensten efficient te kunnen aanbieden aan verladers. Wat wel een grote vraag is of de omloopsnelheid van de vaardiensten nog wel haalbaar is als de Maasvlakte II straks geopend is. Door de opening van de nieuwe containerterminals zal het volume versnipperen. Nu wordt 80% van het volume bij ECT gedropt.

Bemoeienis van diepzee partijen in het achterland

De bemoeienis van diepzee partijen in het achterland zal steeds meer toenemen. Dit zullen ze doen door hun eigen vaardiensten op te zetten (naar verwachting zullen niet alle rederijen dit gaan doen). De verwachting is dat diepzee partijen gebruik zullen gaan maken van de bestaande inland terminals in Nederland om hun schepen te laden en lossen. De grote vraag hierbij is alleen welke inland terminals ze gaan kiezen om mee samen te werken. De verwachting is dat diepzee partijen zich met name zullen concentreren op regio's waar veel afzet is en op de ladingpakketten van grote verladers zoals FrieslandCampina, Heineken en Sony. Container Terminal Beverwijk heeft op dit moment weinig last van de invloed van diepzee partijen in het achterland. De inland terminal doet zaken met verschilllende kleine verladers die vaak wisselen tussen rederijen. De verwachting is dat de toenemende bemoeienis van diepzee partijen nauwelijks tot geen effect zal hebben op de gehele binnenvaartsector in Nederland.

Onderscheidend vermogen van inland terminal operators

De bemoeienis van diepzee partijen in het achterland is niet tegen te houden voor een inland terminal operator. Doordat een diepzee partij zijn netwerk vanuit de haven van Rotterdam organiseert, is het mogelijk om een concurrentievoordeel te behalen t.o.v. inland terminal operators. Rederijen zijn een betalende klant voor stuwadoors en zullen een voorkeursbehandeling krijgen in de haven. Rederijen zullen het daarom zeker gaan winnen op prijs, maar ze zullen het niet winnen op service. Rederijen zijn logge en hierarchische organisaties. Ze zitten niet dicht op de klant waardoor ze niet goed kunnen inspelen op de logistieke behoeften van verladers. Een manier voor een inland terminal operator om zich te blijven onderscheiden in de markt is dus door een hoge service te bieden en flexibel te zijn. Daarnaast is een belangrijke ontwikkeling dat de expediteur steeds vaker wordt overgeslagen (bijv. bij Cornelis Vrolijk uit IJmuiden). Deze ontwikkeling biedt ook weer nieuwe kansen voor inland terminal operators.

Samenwerking tussen inland terminal operators

Er is een aanzienlijke kans dat Container Terminal Beverwijk op den duur ook zal samen gaan werken met een andere terminal. In Groot-Amsterdam zijn er op dit moment erg veel terminals gevestigd. De ladingpakketen schuiven over en weer, terwijl er geen nieuwe lading wordt gegenereerd. Nieuwe internationale bedrijven richten zich met name op Brabant en vestigen zich niet in regio Amsterdam. De belangrijkste reden waarom Container Terminal Beverwijk op dit moment nog niet samenwerkt met andere terminals is omdat ze een bepaald serviceniveau willen garanderen. Stel er wordt samengewerkt en een schip vertrekt te laat uit de haven van Rotterdam dan zal altijd de vraag zijn welke terminal het eerst wordt geholpen. Door samen te werken is er erg veel onzekerheid en heb je niet meer in eigen hand dat de containers op tijd geleverd worden. Daarnaast is er veel angst om klanten kwijt te raken.

Nieuwe terminal initiatieven in Nederland

Op dit moment zijn er meer dan genoeg inland terminals in Nederland. Momenteel is er nog geen inland terminal in de kop van Noord-Holland, maar hier is ook nauwelijks lading te vinden. Bovendien wordt deze regio deels bediend door HOV Harlingen.

Ontwikkelingen in de containerbinnenvaart sector

Een belangrijke ontwikkeling in de maritieme sector die ook doorwerkt op de containerbinnenvaart sector is dat zeeschepen steeds groter worden waardoor er minder aanlopen zijn in de haven van Rotterdam. Een diepzee schip heeft altijd de voorkeur boven een binnenvaart schip. Door deze ontwikkeling zijn er meer pieken en dalen ontstaan in de operatie van stuwadoors. De ene keer wordt je heel snel geholpen omdat de kade niet bezet is, terwijl je op andere momenten heel lang moet wachten.

Interview 8:

Naam: Walter Kusters

Company: Ab Ovo

Functie: Senior Manager

Plaats: Capelle aan den Ijssel

Datum: 11 december 2013

Toekomstige ontwikkeling van het achterlandnetwerk

Naar verwachting zullen er in de toekomst meer containerstromen gebundeld gaan worden, omdat dit een positief effect zal hebben op het serviceniveau en de effecitviteit van de vaardiensten. Ook kun je flexibeler omgaan met vertragingen in het netwerk. Veel samenwerkingsverbanden zijn in het verleden ontstaan vanuit "armoede". Samenwerking komt vaak op gang in tijden van stagnatie en weinig groei. De grote vraag is of deze partijen nog steeds met elkaar blijven samenwerken als de volumes gaan aantrekken. Zodra de volumes gaan toenemen, zal het voor grote inland terminals in Nederland mogelijk zijn om een rechtstreekse vaardienst naar containerterminals in Rotterdam op te zetten. Hierdoor kan het aantal stops in de haven van Rotterdam worden beperkt. Hoe groter de groei van het volume, hoe meer differentiatie er zal plaatsvinden. In Nederland zal er ook een soort consolidatie van inland terminals komen. De verwachting is dat er in de toekomst slechts 5 à 6 grote partijen zullen zijn om zaken mee te doen. Hierdoor zal er vanzelf al een soort samenwerking tussen inland terminals tot stand komen. Tot slot is de vraag hoe de afhandelingsproblematiek in de haven van Rotterdam in de toekomst zal worden aangepakt. Op dit moment heeft een stuwadoor alleen een contractuele relatie met een rederij. Het is belangrijk dat de terminal handling costs (THC) worden opgebroken in een zee- en landzijde, zodat er een directere relatie tussen een barge operator en stuwadoor zal ontstaan.

Bemoeienis van diepzee partijen in het achterland

Diepzee partijen zullen vooral diensten inkopen en zelf beperkt investeren in assets. Er is op dit moment al veel overcapaciteit in de markt. Het toevoegen van assets in de markt zal dus erg nadelig zijn: return on investment is laag. Bij grote groei zullen diepzee partijen wel gaan investeren. De verwachting is dat gerichte inversteringen in het achterland alleen zijn weggelegd voor de top 3 rederijen in de wereld. In de beginfase zullen diepzee partijen dus met name grootschalig inkopen en scherpe TEU-prijzen proberen af te dwingen. Op een gegeven moment zal er een omslagpunt zijn en zullen ze ook zelf schepen gaan inkopen en vaardiensten gaan opzetten. De toenemende bemoeienis is geen bedreiging voor inland terminals in Nederland. De verhoudingen zullen alleen veranderen. Nu is een inland terminal operator samen met een expediteur verantwoordelijk voor het port-to-door-transport. Door de toename in het aandeel carrier haulage zal een inland terminal meer klanten krijgen en gedwongen worden om terug te gaan naar zijn core business (terminal handling). Het varen zal steeds vader worden overgelaten aan andere partijen. Door de toenemende bemoeienis van diepzee partijen in het achterland zal er ketenbreed naar de efficiency van het binnenvaartsysteem worden gekeken. De inefficienties zullen uit de keten worden gehaald zoals het vervoer van lege containers. Er zal steeds meer focus komen op het matchen van import- en exportstromen. De tarieven zullen aangepast worden: het betalen voor een roundtrip zal tot het verleden behoren (alleen single trip). Dit zal leiden tot een grotere concurrentieslag waardoor het aandeel binnenvaart in de modal split zal toenemen.

Onderscheidend vermogen van inland terminal operators

De verwachting is dat inland terminal operators door de toenemende invloed van diepzee partijen minder volume zullen hebben om te varen, terwijl het overslagvolume misschien wel hetzelfde blijft. Inland terminal operators moeten proberen om hun vaardienst op een dusdanige manier op te zetten dat het aantal stops in de haven van Rotterdam afneemt. Hierdoor kan een betrouwbaar product worden aangeboden en zal de behoefte van diepzee partijen om zich te mengen in het achterland minder zijn. Diepzee partijen zullen zich namelijk alleen mengen als ze het idee hebben dat er winst te behalen valt door een achterlandstrategie op te zetten. Kleine inland terminals moeten in hup en hop concepten gaan denken om een hoge efficientie te kunnen bereiken (slim varen). Wat een opmerkelijke constatering is: Tilburg en Veghel hebben op dit moment een sterke concurrentiepositie, omdat ze rechtstreeks naar een containerterminals in Rotterdam varen. De kosten van de vaardienst zijn alleen relatief duur, omdat ze vanwege de waterwegrestricties slechts met kleine schepen kunnen varen.

Samenwerking tussen inland terminal operators

De huidige verdienmodellen van de inland terminal operators in Nederland houden samenwerking tegen. Op dit moment verzorgt een inland terminal operator vaak zowel het varen als de overslag van een container van het schip naar de truck. Het varen is nu exclusief verbonden aan een inland terminal, waardoor het opzetten van een netwerkstructuur lastig is. Iedereen behandelt zijn eigen containers eerst en is bang voor een zogenaamd domino-effect. Het varen zou losgekoppeld moeten worden van de terminal activiteiten. Dit kan alleen bereikt worden door een neutrale barge operator tussen de diverse inland terminal operators te zetten die aangesproken kan worden op servicelevels. Nu kijkt iedereen vooral naar de andere partij. Daarnaast is de inefficientie niet groot genoeg anders had samenwerking vanzelf wel tot stand gekomen. Een belangrijke voorwaarde om samenwerking tot stand te laten komen is dat er een win-win situatie moeten worden gecreeërd. Daarnaast moeten inland terminal operators over een zekere complexiteitsdrempel heen stappen om tot samenwerking te komen. Ook transparantie is belangrijk. Dit zal echter wel gaan toenemen door de opkomst van het internet.

Nieuwe terminal initiatieven in Nederland

In de basis is de ontwikkeling van een nieuwe inland terminal gunstig voor het achterlandnetwerk. Een verlader heeft meer opstappunten wat de toegankelijkheid van containerbinnenvaart verhoogd. Vanwege het hoge aandeel van het voor- en natransport in de kosten, is de nabijheid van een inland terminal gunstig voor een lokale verlader. Het gevaar is echter dat een inland terminal operator een eigen vaardienst gaat opzetten naar Rotterdam. Hierdoor zullen er meer schepen komen die allemaal halfvol zijn en op elkaar liggen te wachten in de haven van Rotterdam. Wanneer een nieuwe terminal gaat samenwerken en gebruikt maar van bestaande vaardiensten dan zal dit gunstig zijn voor de gehele containerbinnenvaart sector in Nederland. De markt is echter nog relatief jong, er wordt een enorme groie verwacht en er is veel opportunisme. Hierdoor zijn partijen minder geneigd om samen te werken.

Ontwikkelingen in de containerbinnenvaart sector

Het Havenbedrijf van Rotterdam heeft een bepaalde groei verwacht. De verwachting is dat de huidige volumes over 10 jaar 2 à 3 keer zo hoog zullen zijn. Iedere partij probeert daarop in te spelen. Door de beperkte groei die er tot nu toe is, is er overcapaciteit in de markt (Rotterdam, inland terminals en binnenvaartschepen). Op dit moment zie je dat alle actoren moeite hebben om hun vaste kosten dekken. Er zijn twee manieren om hier mee om te gaan. Ze kunnen of de capaciteit vasthouden vanwege de verwachte groei of proberen de vaste lasten te verlagen. Vanwege de vergaande samenwerking in de zeevaart (P3 en G6), zal er nog meer druk op het achterland komen te staan vanuit de rederijen. Het achterland is immers de enige plek waar een rederij nog een eigen identiteit heeft.

Interview 9:

Naam: Bertwin Zonneveld
Company: BCTN
Functie: Chief Commercial Officer
Locatie: Capelle aan den Ijssel
Datum: 8 januari 2014

Toekomstige ontwikkeling van het achterlandnetwerk

Op dit moment combineert BCTN veel stromen tussen Container Terminal Nijmegen en Wanssum Intermodal Terminal. Bundeling scheelt aantoonbaar in kosten en de frequentie kan omhoog, dus hoe meer bundeling hoe beter. De verwachting is dan ook dat er in de toekomst meer containerstromen gebundeld gaan worden. De ontwikkeling van een hub terminal in Nijmegen is een eerste stap in de richting. Line bundling zal echter naar alle waarschijnlijkheid meer toekomst hebben dan een hub-&-spoke concept. Ten eerste is het makkelijker op te zetten dan een hub-&-spoke concept. Daarnaast is een groot nadeel van een hub-&-spoke concept dat een extra handling nodig is. Het verschil tussen intermodaal transport en wegtransport in Nederland is echter niet zo groot dat een extra handling kan worden gedragen. Het ontwikkelen van een hub-&-spoke concept op korte afstand van de haven van Rotterdam zal daarom lastig zijn. Railtransport is in Nederland een ongeschikt product. Rail transport is alleen aantrekkelijk als een rechtstreekse verbinding kan worden opgezet (vb. verbinding ECT-Venlo). Wanneer er meerdere punten aangedaan moeten worden dan is het kostentechnisch niet meer haalbaar. Door de opening van de Maasvlakte II zal het containervolume zich verder verspreiden over meerdere terminals in de haven van Rotterdam. Hierdoor zal het treinproduct in Nederland te duur worden wat weer ten gunste zal komen van de containerbinnenvaart. Daarnaast is de vraag of er in de toekomst nog bestaansrecht zal zijn voor kleine inland terminals in Nederland. Als de containervolumes gaan toenemen zoals voorspeld dan zal er voor alle bestaande inland terminals bestaansrecht zijn. Voor het exploiteren van een inland terminal is namelijk slechts zo'n 20.000 TEU per jaar nodig.

Bemoeienis van diepzee partijen in het achterland

De verwachting is dat stuwadoors zich niet in het achterland zullen mengen. Rotterdam World Gateway en APM Terminals hoor je er niet over en zelfs ECT komt er van terug. De belangrijkse motivatie voor stuwadoors is om er achter te komen met welke modaliteit een container naar het achterland wordt vervoerd. Als ze dit weten dan kunnen ze het aantal handelingen op de containerterminal beperken. In tegenstelling tot stuwadoors zie je dat rederijen zich steeds meer gaan bemoeien met het achterland. Rederijen zijn steeds meer gaan samenwerken in de zeevaart (P3 en G6). Om zichzelf in de toekomst te kunnen onderscheiden, zullen ze dus wel naar het achterland moeten kijken. De verwachting is dat rederijen niet zelf diensten zullen opzetten, maar dat ze subcontractors zullen gebruiken om hun dienstenpakket uit te breiden. In Nederland hebben rederijen maar een aandeel van 20-25% in het achterland. De containerstromen zijn simpelweg te klein om zelf diensten te kunnen opzetten. Mochten ze wel zelf vaardiensten opzetten dan zullen ze zich alleen concentreren op strategische punten in Nederland (wellicht op middellange termijn). Rederijen hebben een andere motivatie dan stuwadoors, namelijk de controle over de equipment. Ze zullen zich focusen op het matchen van import- en exportstromen. Door deze stromen te matchen, kunnen ze single trips aanbieden en zichzelf onderscheiden van andere partijen. Als gevolg hiervan zullen de schepen van bestaande terminals minder efficient varen. BCTN heeft berekent dat deze ontwikkeling totaal 1/3 van de omzet kan kosten. Veel terminals in Nederland zijn opgezet door wegtransporteurs. Deze bedrijven trucken ca. 30% van alle containers naar Rotterdam. Terminals als Tilburg en Veghel hebben een andere kostenstructuur dan BCTN waardoor ze naar verwachting beter om kunnen gaan met deze ontwikkeling.

Onderscheidend vermogen van inland terminal operators
Om invloed te kunnen uitoefen in het achterland is kennis van de markt nodig. Deze kennis zit bij inland terminal operators en niet bij alle andere actoren in de keten. Zoals rederijen het nu aanpakken, zal de toenemende bemoeienis weinig invloed hebben op inland terminal operators. De meeste grote verladers kiezen nu allemaal voor merchant haulage. Het aandeel carrier haulage is simpelweg te laag. Mocht dit in de toekomst gaan veranderen dan is het heel simpel: inland terminal operators moeten gewoon een extra fee rekenen voor elk schip van derden dat langs komt. Op deze manier kunnen inland terminals er voor zorgen dat ze ook in de toekomst bestaansrecht zullen blijven houden.

Samenwerking tussen inland terminal operators
Overnames en fusies hebben een grotere kans van slagen. Dit wil echter niet zeggen dat samenwerking tussen inland terminal operators in Nederland niet zou kunnen. Op dit moment zijn er twee factoren die samenwerking tussen inland terminal operators belemmeren. De eerste belemmering is de openingstijden van een inland terminal. Voor kleine terminals is het kostentechnisch niet mogelijk om 24/7 open te zijn, omdat je meerdere ploegen nodig hebt. Bij een aantal andere terminals is een 24-uurs operatie niet mogelijk, vanwege de vergunning. BCTN zou bijvoorbeeld goed kunnen samenwerken met Born, omdat deze speler geen concurrent is en hun schepen langs Wanssum varen. Born willen echter alleen samenwerken als Wanssum 24/7 open is, maar dit is niet mogelijk vanwege de vergunning. Een andere belemmering is dat veel terminals gemanaged worden door personen die tevens de eigenaar zijn van de bedrijven. Er is veel wantrouwen onderling wat samenwerking belemmert. Een belangrijke voorwaarde voor een succesvolle samenwerking is dus dat er een goede vertrouwensbasis is. Samenwerking zal met name goed werken bij partijen die ongeveer even groot zijn, omdat de samenwerking voor beide partijen voordeel moet hebben. Waarom zou je als grote partij samenwerken met een kleine partij? De samenwerking zal voornamelijk voordelen hebben voor een kleine partij, tenzij een deel van de opbrengsten ten gunste komt van de grote partij (creeëren van een win-win-situatie).

Nieuwe terminal initiatieven in Nederland
Nederland is op dit moment redelijk vol qua terminals. Er zullen nog wel wat inland terminals bijgebouwd worden, maar de verwachting is dat de wilgroei wel voorbij is. Alleen in Midden-Nederland is nog ruimte voor een aantal nieuwe inland terminals. Een verdere uitbreiding van het terminalnetwerk in Nederland is dus ongunstig voor de containerbinnenvaart sector in Nederland. Wanneer er uitgegaan wordt van het huidige volume dan is iedere nieuwe terminal in Nederland er een te veel, omdat de nieuwe terminals lading zullen wegpakken bij bestaande terminals (Bijv.: Container Terminal Cuijk).

Belangrijkste ontwikkelingen in de containerbinnenvaart sector
- Ontwikkeling van een hub terminal in Nijmegen
- Toenemende bemoeienis van diepzee partijen in het achterland

Interview 10:

Naam: Richard Klaassen
Company: Markiezaat Container Terminal
Functie: Account Manager
Locatie: Bergen op Zoom
Datum: 14 januari 2014

Toekomstige ontwikkeling van het achterlandnetwerk

Een eis van de Maasvlakte II is dat er in de toekomst meer containers via de binnenvaart naar het achterland worden vervoerd. De verwachting is dat het aantal inland terminals in Nederland verder zal toenemen. Elke stad wil namelijk zijn eigen terminal. Ook is een eis dat er meer containers vervoerd worden over het spoor. De spoorverbinding in Nederland is echter dermate slecht dat de visie van het Havenbedrijf Rotterdam inmiddels al is bijgesteld. Wel zie je dat er steeds meer productie in Oost-Europa plaatsvindt. De verwachting is dat de productie zich langzamerhand zal verplaatsen van China naar o.a. Polen en Roemenie. Tilburg is zodoende erg strategisch gelegen met zijn treinverbinding. Naar verwachting is er in Nederland geen ruimte om hub-&-spoke concepten op te zetten, omdat er een extra handling moet plaatsvinden. Om dit te kunnen realiseren, moet de totale logistieke keten er bij betrokken worden. De marge zit bij rederijen en verladers, maar niet bij de logistieke dienstverleners. Elke inland terminal operator in Nederland die op dit moment genoeg marge heeft om de kosten van een extra handling te kunnen drukken, doet het niet goed. Er zal naar verwachting in de toekomst wel meer gebundeld gaan worden. Binnen de regio Brabant zie je dit al gebeuren. Markiezaat Container Terminal probeert zich te onderscheiden door zoveel mogelijk lege containers uit het achterland zelf te halen en is van mening dat hier de meeste potentie uit te halen is. In de toekomst zal er wellicht een schip gaan varen tussen inland terminals in Brabant die lege containers ophaalt en weer distribueert zonder dat in de tussentijd de haven van Rotterdam wordt aangedaan. De echte optimalisatie van het netwerk zal echter moeten komen vanuit de haven van Rotterdam zelf. De opening van de Maasvlakte II zal resulteren in een verdere versnippering van containerstromen waardoor een binnenvaartschip meer tijd kwijt zal zijn met rondvaren. In dit geval zal bundeling interessanter worden. Een andere oplossing is om een rechtstreekse verbinding naar grote containerterminals in Rotterdam aan te bieden. Echter de praktijk is dat het beter is om lading over zoveel mogelijk schepen te verspreiden. Als er een zeeschip aankomt dan is een stuwadoor meestal nog wel bereid om kleine calls te behandelen, omdat dit nog net past in de planning. Schepen met grote call sizes zullen in zulke gevallen moeten wachten.

Bemoeienis van diepzee partijen in het achterland

De verwachting is dat rederijen zich in de toekomst meer gaan bemoeien in het achterland. Rederijen willen meer controle hebben over hun eigen containerstromen. Het achterland biedt een mogelijkheid om extra omzet te genereren. De toenemende bemoeienis van diepzee partijen in het achterland vormt geen bedreiging voor Markiezaat Container Terminal zelf. De basis van de terminal is namelijk anders dan bij andere terminals in Nederland, vanwege het "rondetafelconcept". Om deze reden is het mogelijk om diepzee partijen af te houden. Voor terminals als Tilburg is het wel een bedreiging, omdat deze terminal veel carrier haulage doet en er veel doorgebruik van containers is. Deze terminals lopen het gevaar de controle over de stromen te verliezen. Of het aandeel carrier haulage in de toekomst daadwerkelijk gaat toenemen, hangt af van de verladers. Als rederijen het voor elkaar krijgen om commercieel een goed product neer te zetten dan zal het aandeel zeker gaan stijgen. Een gedeelte van de stromen zal echter altijd merchant haulage blijven, omdat rederijen geen value added services kunnen bieden. De toenemende bemoeienis van diepzee partijen in het achterland is nadelig voor de gehele containerbinnenvaart sector, omdat je een verschuiving gaat krijgen die niet ten gunstig is voor de efficientie van de totale logistieke keten. Iedere partij moet zich focussen op zijn core business.

Onderscheidend vermogen van inland terminal operators

Het is lastig voor inland terminal operators in Nederland om zich te wapenen tegen de toenemende bemoeienis van diepzee partijen in het achterland. De uiteindelijke keuze ligt bij de verlader. Verladers beslissen of ze wel of geen interesse hebben in de diensten van diepzee partijen. Wat wel een bedreiging is, is dat diepzee partijen meer winst hebben om het "achterlandgevecht" aan te gaan dan inland terminal operators. Aan de andere kant is het EGS ook nog niet gelukt om invloed uit te oefenen op het achterland. Er sluit niemand bij aan, behalve de terminals van ECT zelf. De schepen van ECT worden beter afgehandeld in Rotterdam wat in principe oneerlijke concurrentie is. Ook doen ze niet mee aan Nextlogic. Het netwerk van ECT is niet dekkend. Uiteindelijk zal de situatie niet meer houdbaar zijn voor ECT en kunnen ze niet meer concurreren op prijs. Een groot nadeel van diepzee partijen is dat ze de lokale klant niet kennen. Hierdoor kunnen ze niet goed inspringen op de logistieke behoeften van een verlader en toegevoegde waarde bieden. Bij een rederij is een verlader een nummertje en dat willen ze niet graag. Daarom zal een rederij nooit volledig grip op het achterland krijgen. De bemoeienis van diepzee partijen in het achterland gaat naar verwachting pas echt vervelend worden als strategisch gelegen terminals hun deuren openen voor diepzee partijen (bijv. Oosterhout). Inland terminals kunnen zich onderscheiden van anderen op basis van de volgende punten: strategische ligging van de terminal, openingstijden van de terminal, flexibiliteit, transparantie en betrouwbaarheid.

Samenwerking tussen inland terminal operators

Markiezaat Container Terminal werkt op dit moment al veel samen met andere inland terminals in Nederland zoals Harlingen, Hengelo, Brabant Intermodal en Vlissingen. Belangrijke factoren voor een succesvolle samenwerking zijn vertrouwen, transparantie en openheid van zaken (laten zien wat je doet). Daarnaast is het belangrijk om extra handelingen door te rekenen op basis van kostprijs, omdat samenwerking anders niet haalbaar is. Ook de ligging (ten opzichte van bruggen en sluizen) en de openingstijden van een inland terminal zijn erg belangrijk. Tot slot is het belangrijk om te melden dat een verdere samenwerking tussen inland terminal operators wordt belemmerd door havengelden. In Bergen op Zoom moet er 500 euro betaald worden om een groot schip binnen te laten komen.

Nieuwe terminal initiatieven in Nederland

Een verdere uitbreiding van het terminalnetwerk zal gunstig zijn voor de containerbinnenvaart sector in Nederland. Het is echter wel belangrijk dat het niet zal leiden tot een versnippering van containerstromen. Op dit moment is er nog geen versnippering, omdat er nog altijd bestaande terminals zijn die nieuwe inland terminals blijven ontwikkelen zoals Oosterhout, Tilburg en Almelo. De bestaande terminals roepen het hardst dat er versnippering is, maar het zijn de terminals zelf die zorgen voor een versnippering door nieuwe terminals te blijven ontwikkelen. In Noord-Nederland is er wel versnippering. Zo zijn er bijvoorbeeld twee terminals in Kampen. Het kan niet anders dat er daarvan een gaat omvallen.

Ontwikkelingen in de containerbinnenvaart sector

Een belangrijke vraag die speelt in de containerbinnenvaart sector is hoe er in de toekomst om zal worden gaan met de afhandeling van binnenvaartschepen in de haven van Rotterdam. De afhandelingsproblemen zijn een serieuze bedreiging voor de concurrentiepositie van de haven van Rotterdam. De afhandelingsproblematiek heeft een enorme invloed op de kostprijs van de vaardiensten. Er zal een inititief moeten komen die dit probleem verder op gaat pakken.