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The impact of ultra large container vessels on short haul feeder connections

Case study: Short haul feeder shuttle Port of Rotterdam – Port of Amsterdam

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Acknowledgements

Economic growth, market liberalisation, globalisation and international trade have been the driving forces for the strong development of containerised freight transport in the world. There's no doubt about the increasing containerisation of cargo flows in the world and the importance of the contribution of the container to the global trading economy.(Stopford, 2009)

The continuing growth of international trade resulted for container shipping in increased competition and a strategy of rationalization, consolidation and a continuous search for economics of scale. This has fueled the development of shipping innovation.

In 2000, I was a delegate at a congress about shipping innovation in Rotterdam. One of the presentations was titled *"Malacca-Max: The Ultimate Container Carrier".(Wijnolst , 1999).* Of all the geographical innovation triggers for container ship design, the Malacca Strait is the most relevant with its 21 meter draught. On the basis of the 21 meter draught restriction, the "Malaccamax" ship design was born on the drawing table in 1999. Wijnolst elaborated by then, that by 2010, containerships with a capacity of 18,000 TEU (standard container described as twenty foot equivalent unit) would be operational on the Asia-Europe trade. Ten years ago, this concept received some skeptics from the –traditionally- conservative audience of the maritime industry. Many conference delegates regarded by then this scale as not feasible. Nevertheless, in 2006, Maersk already launched the design of the vessel Emma Maersk with a capacity of 14.000 TEU and in 2010 and 2011, Maersk ordered in total 20 ultra large container vessels of 18.000 TEU.

Innovations at seaside, as for example the mentioned Malacca max, require for an answer at the landside, in particular on hinterland transport innovations.

The impressive designs of ultra large container vessels does appeal to people's imagination. It's therefore understandable that this new generation of vessels and its consequences for container terminal design received a lot of attention from the media in the maritime industry and academic institutes.

The impact of the scale increase at the seaside on the scale of the interface between container terminal and hinterland transport networks, seemed to be the more neglected side. Apparently, it was this lack of information which triggered me, to write a thesis about a potential solution for up scaling this interface by the transport mode of short haul feedering.

From a personal perspective, I reckon that all efforts put in this thesis will pay-off for enriching my expertise on container logistics and will be useful for my future career.

Finalising my thesis feels like mooring a vessel: you can not do it entirely by yourself. The personal task of writing a thesis would not have been possible without the help of my "*Koperen Ploeg*")* . First of all, I would like to express my gratitude to my supervisor Peter de Langen. His pragmatic, business like academic approach of writing a thesis was exactly the style I needed.

Furthermore many thanks to all the interviewed experts of the maritime industry. Acknowledgements to the board of the Port of Amsterdam, in particular Dertje Meijer and Koen Overtoom, for their inspiration and for offering me the opportunity to fulfil a master study in maritime economics. Special thanks to all my Port of Amsterdam colleagues from the nautical, financial, strategic and commercial division, for their understanding, support and patience. In particular, I would like to thank Youri Hildebrand, Marleen van de Kerkhof and Jan Egbertsen for their constructive opinions and advice. Also Tamara Visser, thanks for the great assistance in the editing part. Sincere appreciations to my colleagues from the Port of Rotterdam for their input and interesting discussions, in particular I would like to mention Patrick Vroegop.

Last but not least, my home front; my parents who have been encouraging me in my personal development for more than 43 years! ; and of course not to forget my wife Yvonne and daughter Lotte Weisje: in their own emphatic way, they've made me fulfil this mission; in good times they inspired me and in bad times they helped me to take the next hurdle.

)* ~mooring company in Port of Amsterdam

Abstract

The continuing growth of global trade, resulted for container shipping in increased competition and a strategy of rationalization, consolidation and a development to optimize the economics of scale at the deep sea side. The outcome is an increasing deployment of ultra large container vessels. Ultimately, a successful operation of these big vessels will be determined by the way, the land side operation can meet the required scale of the deep sea side. The potential bottleneck for container shipping will therefore be the interface between the container terminal in the mega hub port and its hinterland transport network. In order to contribute to the aimed elimination of the described bottleneck, the mode of short haul feedering has been studied in a quantitative and qualitative way via literature review, interviews and a case study. The case study focused on the interface between mega hub container terminals in the Port of Rotterdam and the hinterland transport network with intermediate hub terminals in the Port of Amsterdam. Analyzing the economical, logistical, sustainable and governance elements of short haul feedering, it can be concluded that cooperation in container shipping at the seaside, need to be followed by increasing cooperation, alliances and vertical integration in container logistics on the land side by shipping lines, terminal operators and shippers. This makes sense, as already for the main trades, container shipping is already increasingly perceived as a homogeneous good, paving the way to cooperation and collaboration among all actors involved in the supply chain. The approach of the supply chain on the level of total cost of ownership will result in rationalization and consolidation at the land side operations. The reached economies of scale for hinterland transport will contribute to meet the governments and citizens aim of decreasing congestion, pollution and environmental costs. The mode of short haul feedering has the potential to contribute to the realization of sustainable, reliable and cost effective corridors, supporting the efficiency and creating more capacity for the interface between the container terminal in the mega hub and its hinterland transport networks. Improving the required scale at the landside in order to match the sea side developments would ultimately lead to a competitive and resource efficient transport system of container shipping.

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List of Abbreviations

AEO: Authorized Economic Operator

TEU: Twenty foot equivalent unit. Measurement of a standard container of 20 foot in length.

FEU: Forty foot equivalent unit. Measurement of a standard container of 40 foot in length.

GT: Gross tonnage

DWT: Deadweight

ULCV: Ultra Large container vessel

EU: European Union

MV 1: Maasvlakte 1

MV 2: Maasvlakte 2

LNG: Liquid Natural Gas

ESI: Environmental Shipping Index

Chapter 1- Introduction

1.1 Background

Maritime logistics is an important part of the engine responsible for the current global trade and economic development. As shown in table 1.0, the container throughput in global ports grew in a decade from 233,5 Million TEU in the year 2000, towards 536 Million TEU in 2010(Dynamar, 2011).

Table 1.0 Global container throughput in TEU

Worldwide Port Handled TEU			
	Ø Growth	2010	2000
Throughput	8.7%	536,000,000	233,500,000
Millionaire ports (incl.)	4.8%	96	60

Europe-Far East	Highest	Year	Lowest	Year
10-year grw Throughput	16%	2003	-9%	2009
10-year growth Ports	9%	2004	0%	2009

Source: Dynamar, 2011

The competitive environment has been the driving force behind the used transport systems resulting into more efficient and reliable service levels. The benefits of improved systems are for the users and eventually also for the sake of the final consumers.(Baird, 2002) However, in the end, the majority of the environmental costs, congestion costs and other burdens are for the account of the whole society. This society and its individual tax-payers are increasingly becoming averse to pay the bill of all externalized environmental costs. In the last decade, this tendency has led to more recognition for the negative impact of the environmental consequences of maritime transport on urban areas.(Haralambides, 2010)

In North West Europe as one of the most densely populated areas in the world, dealing with the mentioned increasing economic activities, is recognized as a challenge. Finding a balance between economic development -with increasing derived demand for transport and quality of life, with the right spatial and environmental level, has become a hot topic on the political agenda. The competitive environment pushes the maritime logistic sector towards achieving efficiencies of scale and concentration of logistic trade flows. This global tendency is leading towards an increasing demand for sustainable logistics concepts.

In a conservative sector as the maritime industry, it requires a rethinking of traditional patterns. This study is exploring the need for a new routing in container shipping, which inspires the industry with shipping innovations and shows that sustainable solutions stimulate the economy instead of restrict its opportunities.

An example of such a process of reconsidering, can be found in this study, which is focusing on the chances of an extended gate concept (ref. chapter 4), feedered by a short haul feeder shuttle. The research will be illustrated in depth by means of a case study on the main players in the Dutch Port network; the Port of Rotterdam as the biggest European transshipment port and European market leader in container logistics and the Port of Amsterdam as the fourth biggest port in Europe. In order to optimize the industrial logistics complex in the Netherlands, cooperation and collaboration between the key players in the Dutch port network is essential (Houweling, 2010). One part of the strategy of the Port of Amsterdam is to acquire a stable future position in container logistics by consolidating critical mass in container volumes. This can among others be obtained via providing an extended gate function to the Port of Rotterdam. The challenge for the Port of Rotterdam, is facilitating the growing container flows in a sustainable, economical and competitive way. The extended gate as innovative hinterland logistics concept has already been of added value for both port strategies. The mode of the short haul feeder shuttle will be studied as option to further optimize the extended gate concept and to meet with the increasing capacity requirements introduced by the deployment of ultra large container vessels.

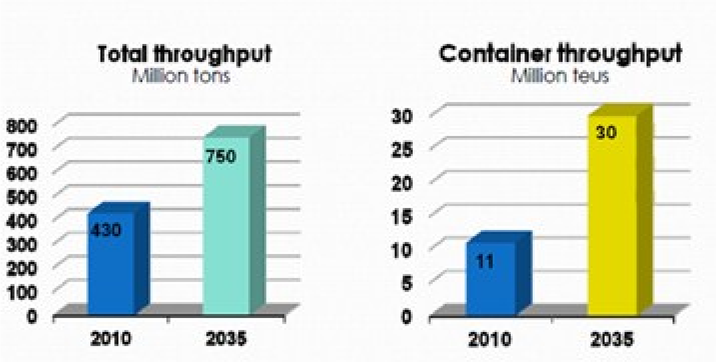
1.2 Problem Statement

Growing container volumes, economies of scale and environmental factors are changing the classical approach in maritime economics(Stopford,2009). In 2011, out of the top 20 container carriers, 13 shipping lines have already announced their orders for new ultra large container vessels (Dynamar, 2011). It can therefore be concluded that, the maritime industry realizes that ultra large container vessels (ULCV) with a size bigger than 10.000 TEU, will become more common. The deployment of ULCV might lead to a trend that changes traditional port patterns into mega hub-ports and feeder ports. Baird(2002) described that such a trend is leading to substantial operating and capital cost advantages for the hub and spoke model with transshipment. According to Baird(2002), the model of a low cost container transfer hub for ULCV justifies the increase of transshipment between major multi-port gateway regions.

Haralambides(2011) stated that the economics of scale in container logistics at the seaside development will face diseconomies of scale at the hinterland side. This creates a bottleneck for achieving an efficient process of sustainable container logistics). It's therefore expected that – ultimately- the economics of scale for container logistics will be determined by the ability of the hinterland transport systems to match the scale introduced by the deep sea side, in particular on the interface between container terminal and hinterland transport networks(Haralambides, 2011).

This study follows the assumption that increasing global container flows will positively impact the position and the container throughput in the Port of Rotterdam. For background information on this assumption, table 5.3, in chapter 5 of this study, provides the forecasts of container volumes in the period of 2010 to 2040 for the Port of Rotterdam, based on a scenario with high growth in global trade and high economic growth in Europe.

Table 1.1 Total throughput Port of Rotterdam



Source: Port of Rotterdam, 2011

With reference to table 1.1, illustrating the prognosis of container volumes for 2035 in the Port of Rotterdam, one of the main challenges for container shipping will be to find an economical and sustainable logistics solution to facilitate the increasing container flows in the future.

The Port of Rotterdam, as European market leader in container throughput, stated that an answer on the question of how to secure future accessibility for containerized cargo, needs to be found in an expansion of infrastructure and the development of innovative transport concepts. In order to optimize port and hinterland logistics, all intermodal and multi modal options and systems need to be reviewed by the maritime industry(Port of Rotterdam, 2011).

From various potential solutions, this study choose to focus on a potential solution for optimization, being the innovative hinterland transport concept of short haul feedering. Other opportunities for research can be found in section 7.4. From exploratory research in the market, it became clear that the general impression about short haul feeder operating from a mega-hub to a feeder port at short distance is not competitive with the mode of barge shipping. To research this claim, the feasibility of a short haul feeder shuttle as transport mode in between the Port of Rotterdam and the Port of Amsterdam will be the topic of a case study. The choice of this particular case study can be explained with some background information. In 2009, the rationalization and consolidation in container shipping, did ultimately result in the loss of direct calls of container liner services of the main Asia - Europe trade, ultimately transforming Amsterdam into an intermediate hub for mega hub Port of Rotterdam. The extended gate in Amsterdam is feedered by a barge shuttle. In the case study the feasibility of a short haul feeder shuttle as alternative mode for feedering the extended gate, is demonstrated by calculations for the specific case of Amsterdam.

1.3 Objective

The purpose of this study is to analyse how short haul feedering can contribute to increase the capacity and efficiency of the interface from the container terminal to the port hinterland networks. Up scaling the capacity of the interface system will be needed in order to avoid a future mismatch in scale caused by the growing numbers of deployed ultra large container vessels.

Therefore this thesis addressed the following main research question:

> How can short haul feedering, as a result of the increasing deployment of ultra large container vessels, add value to the interface between container terminals and hinterland transport networks ?

The complementary role of the Port of Amsterdam as logistic hub for the northern part of the Netherlands and possible other destinations, can be realized by organizing frequent services in between mega hub Port of Rotterdam and the intermediate hub Port of Amsterdam. These services can be operated by barge, but might possibly be operated by a short haul feeder shuttle as well. The Port of Amsterdam regards connections by feeder shuttle as a potentially more attractive option for extending its position as deep sea container port. The aim for the Port of Rotterdam is to secure its status and competitiveness as mega hub, by anticipating on increasing container flows and by removing potential bottlenecks. Deviating container volumes towards extended gates will contribute to sustainable and economical hinterland logistics. The operational and commercial feasibility of the short haul feeder shuttle will be studied and compared to the barge alternative.

In the following chapter, the quantitative and qualitative stages of the research set up are described which are needed to provide an answer on the research questions derived from the problem analysis.

Chapter 2- Research design

2.1 Introduction

The type of research can be described as sequential mixed methods research; being a combination of quantitative and qualitative research. This methodology has been used at different stages of inquiry. It involved philosophical assumptions combined with findings from interviews. In this way, it was possible to highlight all sides of the research problem. The applied research set-up helped to create a better understanding of the topic and its environment than can be done by means of either qualitative or quantitative research.

2.2 Problem definition

This study has the following main research question:

How can short haul feedering, as a result of the increasing deployment of ultra large container vessels, add value to the interface between container terminals and hinterland transport networks ?

The growing numbers of deployed ultra large container vessels is leading towards a future mismatch in container shipping between the sea leg and the land side. Up scaling the capacity of the interface system between the container terminal and the hinterland port networks will be needed in order to avoid an upcoming mismatch in scale. The purpose of this study is to analyse how short haul feedering can contribute to increasing the capacity and efficiency of the interface between container terminals and port hinterland networks.

This results in the following four research questions;

1. What is the impact of increasing deployment of ultra large container vessels on container logistics in a port?

2. What is the economic viability of a short haul feeder shuttle supporting an extended gate as alternative for a barge shuttle?

3. What are the critical success indicators in the logistics chain for the solution of short haul feedering?

4. What can be the contribution of short haul feedering on sustainable hinterland logistics for the Northern part of the Netherlands?

2.3 Methodology

Exploratory research
The start of the research was with qualitative research via two exploratory, unstructured, face-to-face interviews with purposefully selected individuals. These interviews helped to create a better understanding of the problem and the research question. The outcome of the qualitative exploratory interviews is used to further filter the required data and to strengthen the focus of the research. The outcome of this phase of the research has been used to structure the qualitative interviews. The selection of the participants was based on their dominant position in the market. The author recorded the information from the interviews by making hand written notes.

Quantitative research
Quantitative research has been used for examining the relationship among variables, like for example forecast of container volumes and container terminal capacity. Details on the quantitative research and data analysis can be found in the appendix.

Qualitative research
Qualitative research is a methodology, which has been used to explore the research problem. The whole process of research involved: emerging questions and procedures, collecting typical data of the participant's setting, data analysis by inductively working from particulars to general themes and finally the interpretation of the meaning of the specific data. The author preferred an inductive style of research with a focus on individual meaning and the importance of rendering the complexity of a situation. The aim for the qualitative research was to understand the context of the participants through visiting this context and gathering the required information personally. The process of qualitative research was meant to directly collect data & meaning as first-hand information from experts in the maritime industry.

The interviews contained open ended questions, in this way all respondents could fully share both their personal opinions and company's point of view. The author has been able to objectively understand and interpret the outcome of the semi-structured interviews. The interpretation is shaped by the author's experiences and background in container logistics as well as his international network in the maritime industry.

The overview of the qualitative research can be found in the appendix.

Case-study
This research has been illustrated in depth with the case of the Port of Amsterdam. This case is chosen as Amsterdam provides a good example of a major seaport that effectively functions as a satellite port with an extended gate function for mega hub Port of Rotterdam.

As an employee of the Port of Amsterdam, the author had access to and knowledge of all relevant data regarding the thesis topic.

The case-study Port of Amsterdam, generated -to some extent- preliminary pilot findings for this research, as Amsterdam lost direct calls from container liners due to the in section 1.3 described trends as consolidation and the search by the liners for economics of scale during the recession in 2009. These trends weakened the position of the Port of Amsterdam as container port and strengthened the position of mega hub Port of Rotterdam.

Nature and form of results
The applied research of this study is destined for the maritime industry in the Hamburg –Le Havre range, in particular for The Netherlands, The Port of Rotterdam and the Port of Amsterdam.

2.4 Relevance

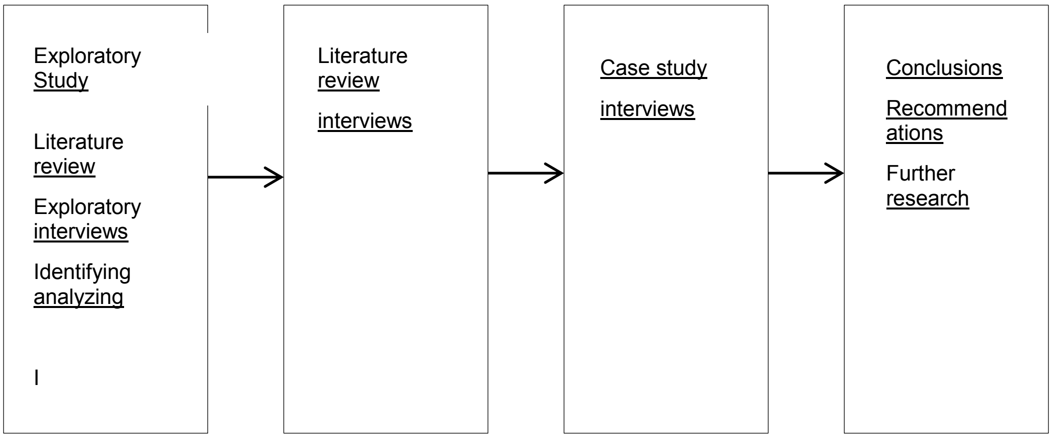
Practical relevance
This study contains innovative solutions for reform that hopefully contribute to a mental shift leading to a change in traditional patterns in container shipping .The author's aim is to provide a valuable contribution to an effective decision making process for all players involved with container shipping in the Netherlands. The author's goal is to ask for the attention of all the players in container shipping, that all available capacity and innovative combinations of sustainable modes of hinterland transport will be needed in order to process the increasing future flows of containers destined for the hinterland. A mismatch between the scale of ultra large container vessels and the scale of the landside operations will result in bottlenecks for container shipping and diseconomies of scale for the container liners.

Scientific relevance
When reviewing publications, reports, articles and scientific sources on the topic of ultra large container vessels and its impact on container shipping, one can conclude that the current focus of the industry is on the sea side developments. So far, the impact of the ULCV on the landside developments has resulted in only limited publications. Therefore, the topic of this research does contribute to literature as, so far, changing feeder patterns and hinterland logistics due to increase of mother vessel size has not received a lot of attention yet.

2.5 Scope

The focus of this study is examining the mode of short haul feedering as one of the potential solution for increasing the capacity and efficiency of the interface between container terminals and hinterland transport networks. The economic viability and competitiveness of a short haul feeder shuttle as alternative feeder mode for the barge shuttle has been researched. For all aspects related to barge transport as feedering mode for an extended gate concept, the study of Konings is highly recommended. (Konings, 2010) The impact of the calls by ULCV on terminal operations will not be researched extensively in this thesis. This topic has been widely covered in various publications and academic articles as for example by Saanen. (Saanen, 2011) Furthermore, the transport from the extended gate to its final destination in the hinterland will not be covered in this study.

2.6 Research Framework



Chapter 3- Literature review

This chapter will provide insight in the trends and developments of container shipping, increasing vessel dimensions, container liners, container terminal operators and network design.

3.1 Introduction

This study follows the assumption from Wijnolst(2009), that shipping innovation at seaside will lead to an increasing number of deployed ULCV. This trend will change feeder patterns towards a system of hub-feedering via a few mega hubs and the development of dense feeder networks (Wijnolst, 2009).

The assumption of Haralambides(2010) that the bottlenecks of container shipping will be found at the landside, has been one of the main triggers for executing this study. For details on the terminal part of the landside, this study refers to Saanen(2011). For details on the competence of intermodal barge transport as the potential solution for increasing hinterland transport volumes at the landside, this study refers to Konings(2010). The impact of hub and spoke models on the environment is elaborated in the study of Rodrigue and Slack (2005). Finally, the EU Whitepaper, as published in 2011, provides the impact from governance with details on the leading policies on hinterland transport and the aim of the European union to secure future sustainability & mobility in cargo transport.

Table 3.0 Global container trade at regional level
Port volumes (x 1.000 TEU) including empty moves and transshipment

Port volumes in ‘000 teu including empty moves and transhipment

	1980	1990	2000	2006	2007	2008	2009	2010*	
North America	9,531	16,662	30,869	46,971	47,893	45,955	39,834	43,460	8.2%
West Europe	11,753	22,557	51,650	81,136	90,831	91,879	79,420	84,992	16.1%
North Europe	*8,647*	*16,001*	*31,707*	*49,613*	*55,725*	*56,518*	*47,443*	*51,026*	*9.7%*
South Europe	*3,106*	*6,556*	*19,943*	*31,523*	*35,106*	*35,361*	*31,977*	*33,966*	*6.4%*
Far East	7,587	22,951	71,666	153,269	180,911	194,565	178,350	200,968	38.1%
South East Asia	1,871	9,679	34,400	59,838	67,578	71,304	65,679	73,065	13.9%
Mid East	1,943	3,583	11,065	24,545	27,475	31,670	31,080	34,384	6.5%
Latin America	2,359	5,079	17,920	31,462	35,160	37,032	32,998	36,479	6.9%
Carib/C America	*1,816*	*3,312*	*9,944*	*16,115*	*18,232*	*19,282*	*17,480*	*19,184*	*3.6%*
S America	*543*	*1,767*	*7,976*	*15,347*	*16,928*	*17,750*	*15,518*	*17,294*	*3.3%*
Oceania	1,611	2,334	5,027	7,900	8,658	9,296	8,842	9,535	1.8%
South Asia	249	1,780	5,481	11,487	13,554	14,790	14,070	15,959	3.0%
Africa	1,471	2,721	7,429	15,719	17,711	20,784	20,703	22,383	4.2%
Eastern Europe	374	628	1,121	5,467	7,208	8,010	5,114	6,144	1.2%
World	**38,748**	**87,974**	**236,649**	**442,795**	**496,981**	**525,285**	**476,088**	**527,369**	

Source: Drewry, 2011

3.2 The strategic response of container shipping

Table 3.0 and 3.1 shows the supremacy, in terms of throughput per continent, of the Asia Europe trade lane. As the majority of trade flows are linked to the Asian continent, particularly on these trades bigger vessels are deployed in order to accommodate the sizable containerized cargo flows. Dynamar (2011) has categorized each of the continents by trade. The strategic response of container shipping to acquire the necessary efficiencies of scale is by calling hubs in each region with ULCV on each geographic trade lane. This can be explained by the facts, that an Asia Europe service covers in this hub concept the categorized continents of the Far East, Australasia, South East Asia, Indian sub continent, Mediterranean, Middle East and Europe.

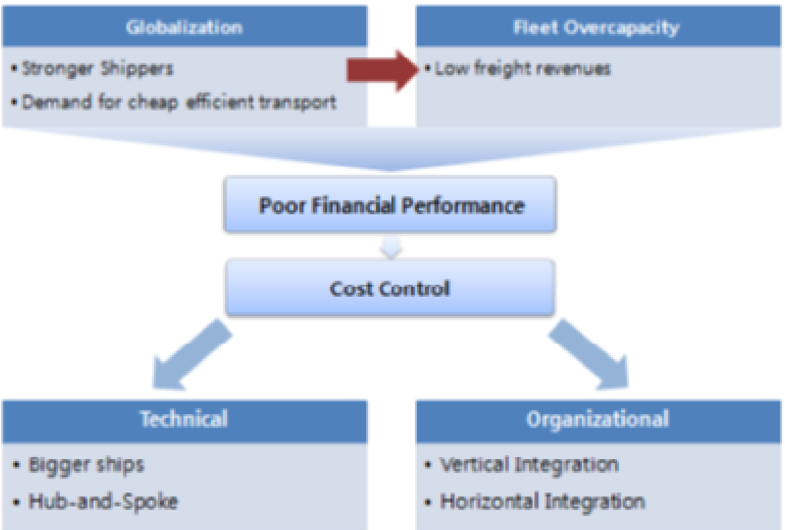
Table 3.1 Throughput in TEU per continent

Trade area	2010	2001
Africa	2	1
America	13	11
Australasia	2	2
Europe	9	7
Far East	36	24
Indian Sub Continent	6	2
Latin America	8	2
Mediterranean	14	7
Middle East	6	4
Ports	**96**	**60**
Throughput TEU *1,000	**433,775**	**166,200**

Source: Dynamar, 2011

Globalization and lower freight rates per transported unit, as illustrated in figure 3.2, introduce a new dynamic in the market of container shipping. The introduction of ultra large container vessels as technical tool for cost saving achievements in the Asia Europe trade leads towards increased use of a hub-and-spoke concept with changing feeder patterns. The risk of not being able to fill up those vessels can be a potential show stopper. In order to deal with the shadow-side of bigger vessels, organizational changes as alliances are needed to secure a high utilization degree. (Midoro, 2010)

Figure 3.2 Liner shipping-Issues and Strategic Responses



Source: Midoro, Haralambides, 1999

3.3 Developments container vessel

Container vessels can be categorized by type of vessel in feeder, feedermax, handy, sub-panamax, panama, post panamax and super post panamax. The feeder, feedermax and handy are for the greater part deployed in short sea trades, north-south trade lanes, feeder services and in ports with nautical restrictions. The larger scale vessels as sub-panamax, panamax and post-panamax are steaming mainly on long-haul intercontinental trade lanes.(Wijnolst,2009)

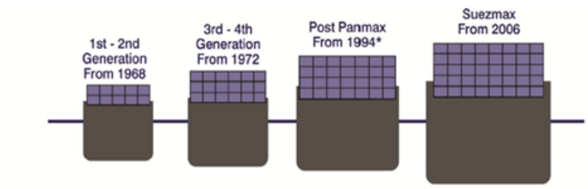
Three main global determinants are essential for the vessel sizes on the longer term; the enlargement of the lock complex in the Panama canal, the deepening of the Suez Canal and the increasing size of container vessels.

Widening and enlargement of Panamax Canal
The current vessel dimensions of 32,26 meter wide, will become 49 meter when the new Panama locks are in place. The maximum vessel dimensions for the new locks in the Panama Canal are determined at a length of 366 meter, a width of 49 meter and a draft of 15.2 meter. This is about comparable with the size of a 13.000 TEU container vessel. The impact of the new Panama canal locks on vessel design, will

be that for the optimal flexible deployment of vessels, the size of vessels will be up scaled to a maximum width of 49 meter. (Dynamar, 2011)

Suez Canal
After the realization of the deepening of the Suez Canal from 66 ft. (20,12 meter) to 72 ft. (21.95 meter), container vessels with a higher draft, can permit a more wide design. It's therefore expected that vessel design destined for the Asia Europe trade will develop towards 60 meter width. With reference to table 3.4, the biggest container vessels passing the Suez Canal in 2011 are already 57 meter wide. (Dynamar, 2011)

Table 3.2 Development of container vessel size



	1st - 2nd Generation From 1968	3rd - 4th Generation From 1972	Post Panmax From 1994*	Suezmax From 2006
TEU	1,000 - 2,000	3,000 - 4,700	4,700 - 9,000	~12,000 - 14,500
DRAFT	10 - 11.5m	12.5m	13.5 - 14.5m	15.5m
WIDTH	28m	32m	39.43m	57m

Source: Drewry,2010

3.4 Ultra large container vessel

A combined demand for storage capacity and mobility for increasing containerized global cargo flows, results in a search for innovations and an occurring end of the so-called s-curve *(see: definitions in appendix 1)*, a performance indicator graphically showing -by means of the shape of the character "S"-, the relationship between effort and performance of the container ship design.(Wijnolst, 2009)

Container vessel dimensions increased spectacular recently. As shown in table 3.3; the average ship size of the top 25 container liners increased from 2.110 TEU in 2000 to 3.650 TEU in 2010 and within a decade, the biggest vessel with a dimension of 7500 TEU has more than doubled, towards the impressive size of the newly ordered 18.000 TEU vessel designs by Maersk Line.

Table 3.3 Capacity container vessels

Ships - Average TEU size - Total TEU capacity - in liner services	Ø Growth	2010	2000
Total Fleet			
Ships	3.0%	5,957	4,450
Average ship size	6.8%	2,490	1,290
Capacity	9.9%	14,809,000	5,750,000
Top 25			
Ships	5.7%	3,504	2,005
Average ships size	5.6%	3,650	2,110
Capacity	11.7%	12,806,000	4,227,000

Total capacity growth	Highest	Year	Lowest	Year
10-year growth	15%	2006	5%	2009

Source: Dynamar, 2011

Deployment ULCV

The deployment of the new generation ULCV is mainly dedicated for the corridor of the Asia-Europe trade. The dominance of big vessel types and its competitive slot costs, will cause difficulties for a successful operation with smaller size vessels on this trade. This trend of deploying bigger vessels can be explained by the carrier's aim for cost savings, efficiencies of scale and energy efficiency(Wijnolst,2009). The last mentioned cost element of fuel cost as trigger for using ULCV is illustrated in table 3.4. This table shows the impact of economies of scale when operating bigger vessels on fuel cost per TEU-slot at the same speed of 18 knots. In order to stay competitive as a container liner, in a market with decreasing trends in revenues from freight rates, the operational costs per slot for a ULCV on the Asia-Europe trade are U$ 250,- lower than the costs on a 6.500 TEU vessel. (Dynamar, 2011)

Table 3.4 Economics of scale

Vessel Size TEU	12,500	8,000	5,000	2,500	1,000
Speed/knots	18	18	18	18	18
Fuel Costs/TEU USD	4.46	6.01	6.58	9.11	15.18

(Note: Fuel costs/TEU USD per day)

Source: Dynamar, 2011

Order book ULCV

Referring to table 3.5, with the order book details of ULCV, it becomes clear that about 50 % of all deliveries of ULCV in 2011 are in the category >13.000 TEU. This type with dimensions: Length over all 350 meter, width 48,2 meter and draft 15,5 meter, is triggered by the Panama canal developments as described in section 3.3. This trend will consequently lead to changing liner service patterns, as ports with a width restriction of less than 49 meter will get isolated for direct calls by main trade lane services using optimal width size vessels. (Dynamar, 2011)
(Note: case study chapter 6: the width restriction in Amsterdam is 45 meter)

Table 3.5 ULCV- Container ships over 10.000 TEU

Delivery	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total ULCS	Ships Share	TEU Share
>10,000	-	2	11	7	2	3	10	-	4	**39**	16%	13%
>11,000	-	-	3	3	4	6	-	-	-	**16**	7%	6%
>12,000	-	-	-	-	-	6	1	14	3	**24**	10%	10%
>13,000	-	-	1	3	15	24	39	27	4	**113**	47%	48%
>14,000	-	-	-	2	9	9	6	-	-	**26**	11%	12%
>15,000	2	5	1	-	-	-	-	-	-	**8**	3%	4%
>16,000	-	-	-	-	-	-	3	-	-	**3**	1%	2%
>18,000	-	-	-	-	-	-	-	10	-	**10**	4%	6%
Ships	2	7	16	15	30	48	59	51	11	**239**	100%	100%
Total TEU	31,100	97,900	176,400	175,900	394,300	614,500	761,600	710,800	130,100	**3,092,600**	100%	100%

Source: Dynamar, 2011

Increasing width container vessel

From all 685 vessels at order in the panamax-category, in total 481 vessels (71%) have a width larger than 32,26 meter. This strongly indicates that the current fleet as shown in table 3.7 will shift towards increasing width and deadweight. In view with the low freight rates and full order book, it's expected that ,after delivery of all vessels mentioned in the order book of table 3.5, for a number of years only few vessels will be ordered. Regarding an average technical depreciation time of 25 years for a container vessel, one can conclude that within 12 years time (year 2023), the majority of all panamax vessels will have a width of 49 meter(Dynamar, 2011).

Vessels shifting trades
The continuing growth of container vessel dimensions results in a shift of bigger vessels to medium size and small trades. To illustrate this shift: the 8.000 – 9.000 TEU vessels that were previously servicing the far east trades, are now sailing on the South Atlantic trade.

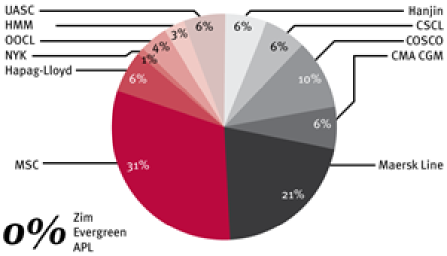
Table 3.6 ULCV operators

By overall cap.	By ULCS Cap.	Carrier	Ships	Average TEU	Total TEU
6	10	APL	10	10,400	104,500
10	9	China Shipping	8	14,100	112,600
3	3	CMA CGM	30	12,400	385,900
5	4	Coscon	20	12,200	291,900
4	14	Evergreen	2	10,100	20,100
9	6	Hanjin	16	12,300	148,200
7	7	Hapag-Lloyd	10	13,100	131,000
18	12	Hyundai	5	13,100	65,500
1	2	Maersk Line	38	14,400	534,600
2	1	MSC	54	13,300	746,200
13	13	NYK	4	13,100	52,400
12	11	OOCL	6	13,100	78,600
20	8	UASC	9	13,300	119,700
17	5	ZIM	15	11,600	173,300
-	-	Non operating owners	16	12,800	128,200
Grand total ULCS			243	12,900	3,092,600

Source: Dynamar, 2011

Conclusions ULCV
With reference to table 3.5, 3.6 and 3.7, it's obvious that the majority of global carriers are upsizing their container fleet by ordering ULCV. According to Dynamar, (2011) only 7 shipping lines have not yet decided to place orders for ULCV . Most of the top 20 container carriers are member of an alliance or are cooperating with other shipping lines via slot-charter agreements. It's expected, that two years from now, most of the carriers calling the Port of Rotterdam on the trunk route between Asia-Europe, will deploy ships larger than 13.000 TEU(Dynamar, 2011).

table 3.7 Market share ULCV by operators



Source: Sea Intel Maritime, 2011

Slot utilization
The consequence of the deployment of ULCV on slot utilization is the challenge for shipping lines to fill up the number of slots. For this reason ULCV needs, apart from transshipment volumes, also a captive area which is generating sufficient container volumes. When slot-occupancy on the ULCV is too low, vessel operators will then face diseconomies of scale, instead of the aimed cost advantages. This threat is the main reason why some container liners of the global top 20, like Evergreen, did not join the up scaling of their fleet. The tendency of consolidation and rationalization is here to stay and is leading towards a market development in main trades, like Asia-Europe, in which the perception of container shipping is changing. It is increasingly regarded by the shippers as a homogeneous good, like a commodity.
(Haralambides, 2010).

3.5 Feeder

Feeder transshipment & empties
With reference to the data as described in table 3.8, it’s obvious that there’s hardly any change in the total transshipment share until 2020. Nevertheless, increasing container volumes carried by ULCV, consequently leads to increasing absolute transshipment volumes. According to Drewry(2011), the share of empty transshipment in percentages as a result of imbalanced trade will remain about 20%. Increasing container volumes will consequently lead to the repositioning of higher volumes of empty equipment.

The prognosis in table 3.8 by Drewry(2011), regarding the transshipment share of 28 % in 2020, can be regarded as questionable when assuming that the share of transshipment logically should increase when using a hub and spoke concept(Wijnolst,2009) The forecast 2020 for the share of container transshipment in the Port of Rotterdam is 34%. This can partly be explained by the increase of feeder traffic from Rotterdam to the southern ports in the United Kingdom, as a result of ULCV bypassing these ports(Port of Rotterdam, 2011).

Table 3.8 transhipment share

	2000	2010	2020
Transhipment share	25%	28%	28%?
Empties share	~20%	~20%	~20%
Typical EBITDA margins (terminals)	20-40%	20-40%	20-40%

Source: Drewry, 2011

Common feeder liners
A common feeder liner, can be defined as a feeder operator carrying container traffic flows to and from mother vessels, operated by various container liners. The common feeder operator is not exclusively operating for a mainline container carrier. (Dynamar,2011) Examples of common feeder operators are the shipping lines Unifeeder and Team Lines.

Dedicated feeder liners

A dedicated feeder liner is exclusively operating for the mother vessels of a individual container liner. Vroegop(2008) described in his survey among container liners the feasibility range for mainline carriers, to switch from common feeder operation towards dedicated feeder operation and the determinants of the slot costs for various service levels. The conclusions of this survey were that for starting a dedicated feeder service an operator needs a minimum of 3 strings and a critical base volume of 800 TEU per week. This should then also be in combination with a consistent service level. If this is not the case, common feeder operation is recommended. Vroegop(2008) further describes that in container shipping, the factors utilization degree and imbalance are the key determinants for the slot costs of a feeder operator. Regarding the service level, it's obvious that the concept of a dedicated feeder operation, if possible in combination with dedicated container terminal, guarantees more flexibility to the mainline. Controlling the chain and marketing sensitivities about key accounts are other reasons container liners, deploying dedicated feeder liners. An example has been the reluctance of the individual partners of the container liner alliance “Grand Alliance” to share slots with their partners on individual feeder networks in Europe until 2009.(Port of Amsterdam,2011)

Impact of ULCV on feeder operators

An increasing number of deployed ULCV, will consequently lead to bigger transshipment volumes and feeder services operating with bigger vessels. Maersk ordered their first series of 18.000 TEU for U$190 million per container vessel (Lloyds List, 2011). The consequently higher charter rates of bigger ships, makes the financial factor of the captive capital locked into the asset of the vessel (Stopford,2009), now also an augmenting issue for the feeder operator. In order to achieve a fast turn-around time of the feeder vessel, a reduction of waiting-time and efficient vessel handling will become more important for the feeder operator as well. This may lead to more tensions towards the terminal operator in the ports between the competing -but liaised- demands for terminal services by the, generally prioritized main vessel operator and the feeder vessel operator. (Lloyds List, 2011).

As mentioned by Baird(2002), transshipment can offer substantial operating and capital cost savings for the main liner. For this reason, the status of feeder liners as working horses for the main liners has improved. This resulted in better service at the terminal and a faster turn around time of the feeder vessel. (Lloyds List, 2011).

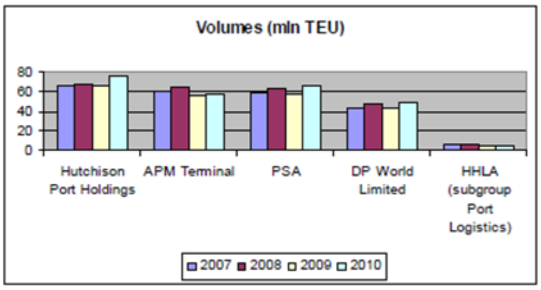
The classical trade-off between multi-porting and hub and spoke leads to evaluating the transshipment costs of the feeders. According to an analysis of the feeder company Team Lines, it's important for a successful feeder service network to strive for minimizing the sailing distance for feeder vessels from their regional hub to the feeder destination.(NT, July 2011)

3.6 Container terminal operators

Function container terminal
Saanen (2011), describes a container terminal as a material handling system, linking the container flows in the intercontinental transportation chain. The buffer function of a container terminal acts as intermediary between sea and land transport. Apart from secondary services as inspection, screening, maintenance, repair and consolidation of cargo, the prime function of a container terminal is to handle deep sea vessels in a fast manner(Saanen, 2011).

Globalization of multi-user terminals
Since the ‘80-‘s, there’s been a tendency of port privatization indirectly leading to the birth of global container terminal operators, acting as multi user terminals. The globalization trend among terminal operators followed the global character of container shipping lines. From 2000 to 2010 the trend of consolidation continued, leading to a growing global market share of container terminals by the top 4 terminal operators Hutchison Port Holding, APM Terminals, PSA and DP World (Drewry, 2011). As shown in figure 3.2, the operators Hutchison Port Holdings, APM terminals and PSA , each handled container volumes of over 60 Million twenty foot containers.

Figure 3.2 volumes global terminal operators



Source: BNP Paribas, 2011

Fast turn around time
As mentioned by Haralambides(2010) and as decribed in section 3.1, the success-story of containerization depends for the greater part on the achieved handling efficiency at the terminal, that is shortening the vessel time at berth and realizes a fast turn around time of the container vessel. Maersk already anticipated on this by announcing required service levels of a turn around time of maximum 24 hours for its so-called “e-class vessels” of 18.000 TEU. This means that the time needed for current call sizes of 2000 TEU will be about the same for the future call sizes of 6.000 TEU, provoking the terminals to anticipate by investing in new systems and adapting the terminal lay-out(Lloyds List, 2011).

Dedicated terminals
Container liners carrying large volumes are capable of running their own terminals. Their aim is to integrate and control their operations and acquire a bigger pie of the whole supply chain. By owning the terminal, the liner operator can obtain a higher

service level in the port and a better exchange of information between liner and terminal operator. For example: an exchange of information between the liner division and the terminal division can optimize the performance of a network of dedicated terminals by matching the stowage plan of the vessels with the preferred discharge operation in the consecutive ports (Saanen, 2011).

Table 3.9 provides good insight in the composition of the global container operators and their dominance.

Table 3.9 Global Container Terminal Operators Throughput 2009

Ranking	Operator		Million TEU	% Share	Global Carriers	Global Stevedores	Global Hybrids
1	HPH	Hong Kong	64.2	13.6%		x	
2	APMT	Denmark	56.9	12.0%			x
3	PSA	Singapore	55.3	11.7%		x	
4	DPW	Dubai	45.2	9.5%		x	
5	Cosco	China	32.5	6.9%			x
6	MSC	Switzerland	16.4	3.5%	x		
7	Eurogate	Germany	11.7	2.5%		x	
8	Evergreen	Taiwan	8.6	1.8%	x		
9	SSA Marine	USA	7.7	1.6%		x	
10	CMA-CGM	France	7	1.5%			x
11	Hanjin	South Korea	6	1.3%	x		
12	NYK Line	Japan	5.2	1.1%			x
13	HHLA	Germany	5	1.1%		x	
14	Dragados	Spain	4.9	1.0%		x	
15	APL	Singapore	4.6	1.0%			x
16	K Line	Japan	4.3	0.9%	x		
17	OOCL	Hong Kong	4.2	0.9%	x		
18	Yang Ming	Taiwan	4.1	0.9%	x		
19	ICTSI	Philippines	3.6	0.8%		x	
20	MOL	Japan	2.7	0.6%	x		
21	Grup TCB	Spain	2.6	0.5%		x	
22	Hyundai	South Korea	1.4	0.3%	x		
Global operators total			354.0	74.80%			

Source: Drewry, 2010

Strategic response container liners

The investment of shipping lines in container terminals can be regarded as a strategic effort in response of the increasing dominance of global terminal operators like Hutchison Port Holding(HPH), PSA and DP World. As individual container liners already have limited market power to influence the freight rates that shippers are willing to pay, the dominance of global terminal operators created another unfavorable negotiation position for container liners regarding terminal handling charges, securing terminal windows and preferred service level. This has been one of the main reason to explain the appetite of container liners like Maersk Line, NYK Line, OOCL and CP ships to invest in their own dedicated container terminal networks. Another obvious reason is the return on investment on strategic long-term assets. (Haralambides, 2002)

Dilemma

A disadvantage for dedicated terminals is, that in case of insufficient container volumes, it can be difficult to attract terminal business from other container liners. This dilemma can be illustrated with the case of NYK Line, the previous 100% shareholder of the Ceres Paragon Terminal in Amsterdam. NYK Line was facing problems to attract other carriers to its terminal as the terminal was not regarded as an non-neutral NYK terminal.

Table 3.10 Development container throughput in Asia

	2000	2010	2020
Container share of general cargo mkt	48%	67%	72%
World port teu throughput	237m	542m	1.1bn?
Asian ports' share of world teu	47%	55%	65%+
Chinese ports' share of world teu	16%	29%	40%+

Source: Drewry, 2010

joint venture terminal operators & container carriers
Conferences, alliances and slot-charter agreements are illustrative characteristics for the level of cooperation in the container liner industry. The derived effects of the mentioned cooperation are: consolidation, rationalization, bigger vessels and falls in freight rates. The container terminal sector experiences effects from privatization, consolidation and globalization. When combining the characteristics of both the global terminal operators and the leading global container liners, there's clearly food for thought for more vertical integration; the terminal operators recognize the opportunity to structurally secure container flows and the liners recognize the comforting opportunity to stabilize the terminal handling charges and to obtain more influence on the performed service level and preferred window availability.(Midoro, 2006). Examples of the described joint ventures in Rotterdam are ECT-Delta terminal and MSC; ECT- Euromax with CKHY-alliance; DP World with New World Alliance and CMA-CGM.

3.7 Impact ULCV on container terminal operations

Increasing trade volumes carried by ULCV will considerably impact the container terminal operations. The increase of the equipment which is going together with the increase of the vessel size is shown in table 3.11.

Table 3.11 trends container shipping

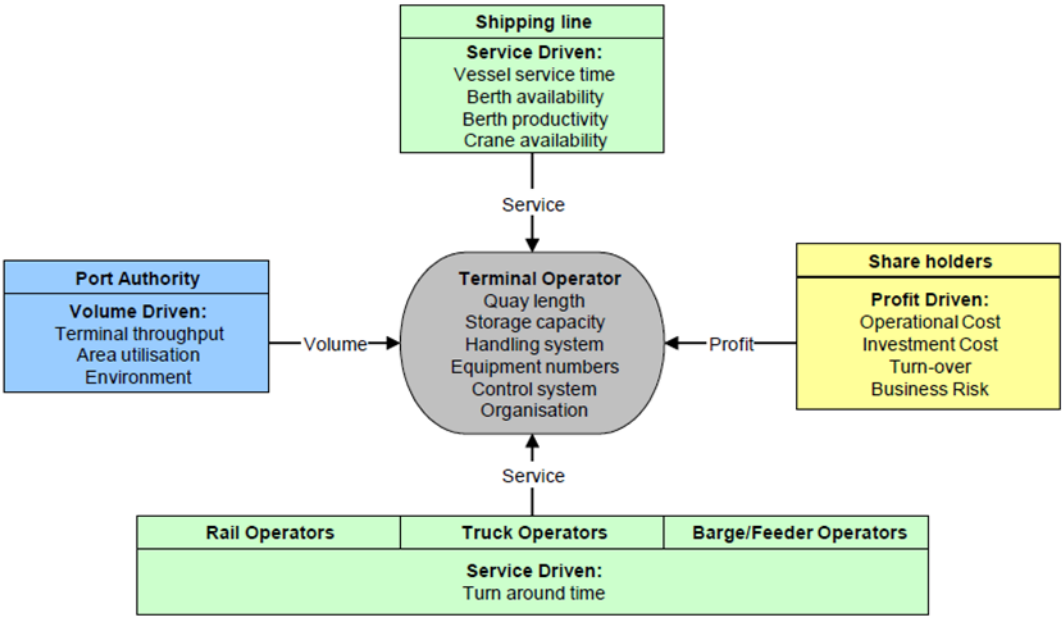
	2000	2010	2020
Largest container ship (teu)	7,060	14,770	20,000+?
Super post-Panamax gantries	20	~900	2,000+?
Market share top 4 terminal operators *	~25%	~48%	?

** total teu basis*

Source: Drewry, 2010

The demand for container terminal operations by the shipping line is highly service driven. As shown in figure 3.3, a vessel service time resulting in a fast turn around time is vital for the vessel operation. Flexibility of the terminal operator regarding berth and crane availability should lead to the desired berth productivity. This indicates, from the perspective of the shipping line, the level of customer responsiveness performed by the terminal operator. The drive to cut down slot costs to achieve the economies of scale at the sea side, is only functioning, as the land-side operation at the terminal is matching(Saanen, 2011).

Figure 3.3 Drivers in container logistics

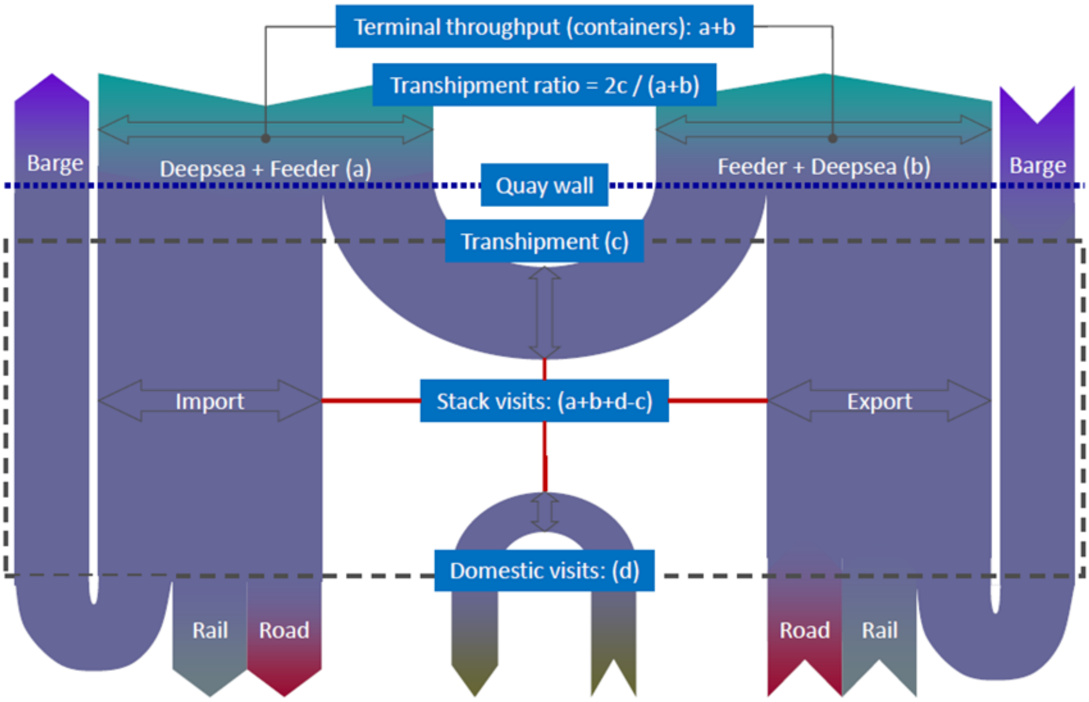


Source: Saanen, 2011

New standards container terminal performance
ULCV require a different approach from the terminal operator. Increasing call-sizes, different demand for berths and quay cranes leads to new capacity standards. Terminal operators are pushed by the shipping lines to anticipate on these new requirements, enhancing accessibility, berthing and vessel service level. Therefore, in order to stay competitive, terminal operators need to expand their capacity by investing in new infrastructure, new technology equipment, automation and innovative solutions. The ultimate goal of the shipping lines is that the terminal is capable of efficiently facilitating their latest generation of container vessels, achieving a matching level of seaside and land side operation(Saanen, 2011).

Transhipment & yard storage capacity
The yard storage capacity of a terminal is determined by the design of the terminal, its stacking systems, dwell time, transshipment ratio, peaking factor and separation factor. It's measured as the number of TEU – calls a yard is able to process. The model from Saanen, as shown in figure 3.4, illustrates the relation between yard storage capacity and transshipment ratio.(Saanen, 2011)

Figure 3.4 Yard storage capacity

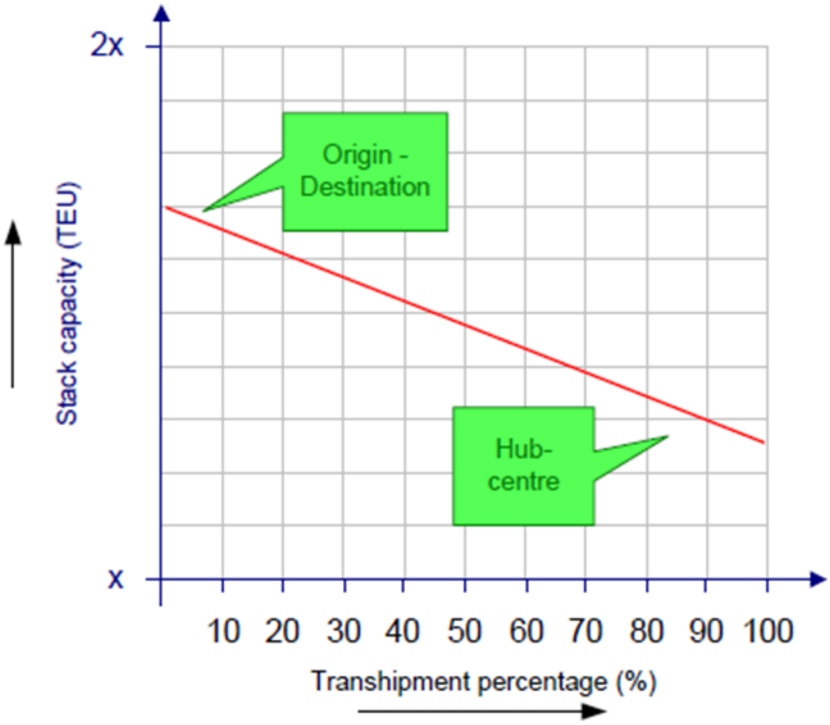


Source: Saanen, 2011

More transshipment requires a lower number of slot capacity at the terminal yard. In figure 3.5, the negative linear relationship (2: 1) is illustrated. The transshipment of 2 TEU can be accommodated on 1 TEU yard storage. Saanen stated that increasing transshipment, positively impacts the yard storage capacity of the terminal. (Saanen, 2011)

Formula: terminal capacity= yard capacity / (1 -/- 0,5 x transshipment ratio)

Figure 3.5 impact transhipment



Source: Saanen, 2011

3.8 Hub and spoke system

The traditionally conservative maritime industry is facing new dynamics which will impact the complete sector. Growing container volumes, economies of scale and environmental factors are changing the classical approach in maritime economics.

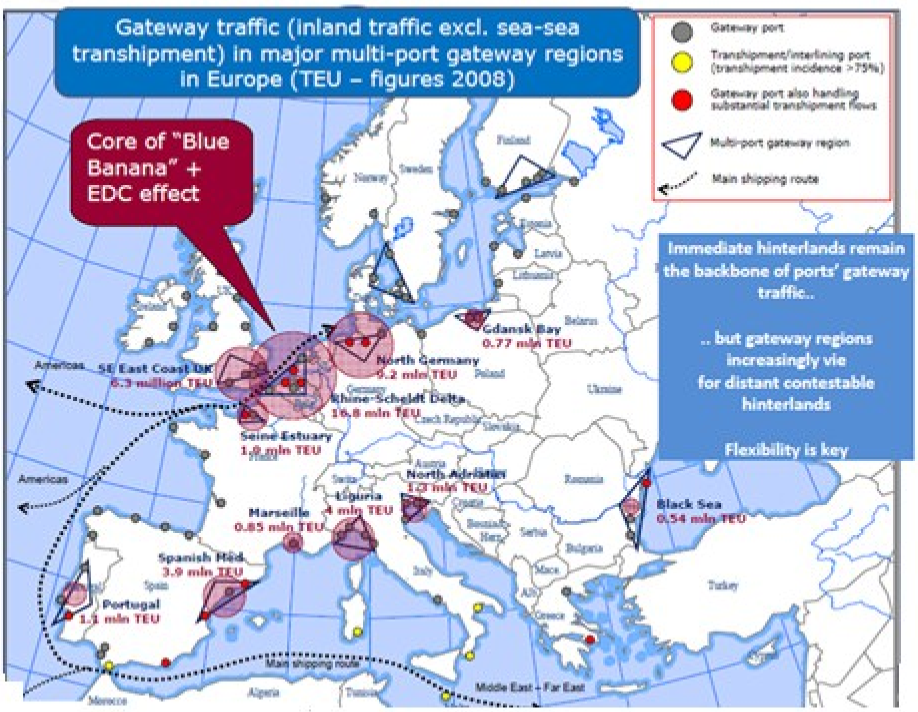
Global grid
The increasing number of calls by ultra large container vessels will result in a change from multi-porting call services to hub-feeder systems. Wijnolst (2009) describes this as a part of the so-called "fourth revolution of container shipping", which is a global restructuring of liner service patterns that will result in the creation of a global grid. On this basis liner shipping becomes an integrated network of east to west and north to south services, providing its customers with an unprecedented level of connectivity. (Wijnolst, 2009)

Cost advantages
The described restructuring also affects the transshipment of containers. Additional feeder costs and terminal handling costs have always made transshipment, a cost increasing element in container logistics.(Baird, 2002) According to a survey on the economics of container transshipment in Northern Europe by Baird, the trend of up scaling vessel sizes leads to substantial operating and capital cost advantages for the hub and spoke model with transshipment. The model of a low cost container transfer hub for ULCV justifies the increase of transshipment.(Baird, 2002).

Spatial & environmental impact
The consequence of the hub-model is a concentration of maritime activities in a constrained port area with impact on the environment of the adjacent region(Rodrigue,2005). Apart from the economics, also the spatial and environmental impact becomes a significant cost increasing element for container logistics. Not all ports can offer enough space to be used for expansion of terminal capacity and are restricted because of nautical reasons or environmental reasons(Houweling, 2010). This sustainable impact will be elaborated in chapter 4. The nautical aspects are described in detail in section 5.5.

Captive area
In general, hub-ports located near the final destination of cargo flows have a higher market share in these markets. Notteboom(2011) regards the throughput potential of the direct hinterland as a critical success factor of a port(see figure 3.6). Shipping lines need to compare the additional costs of a mother vessel sailing closer to the final destination of the cargo, with the impact on the cost of the feeder network. According to Baird (2002), transshipment can offer substantial operating and capital cost advantages. His conclusions were based on an estimated cost comparison in between multi-port service and transshipment for Northern Europe. ULCV can benefit from the economies of scale reached at transshipment container terminals. A hub port which is more centrally located towards its captive area will accomplish decreasing cost of feedering as a result of lower deployment of vessel capacity and bunkering costs(Lloyds List, 2011). Another impact on the hub-port location are the total costs of a port call. Details on these costs can be found in chapter 7.

Figure 3.6 Multi-port gateway traffic



Source: Notteboom,2011

Feeder Patterns
An increasing number of deployed ULCV, will lead to a demand for qualitative feeder networks. As Pederson, MD Team Lines, stated “feeders are the arms and the legs of a hub port, without feeders a hub will not be successful” (Lloyds List, 2011). The traditional underdog position of the feeder operator is gradually changing since the acknowledged importance of the feeder operator’s position in the supply chain.

3.9 Conclusions

The main conclusions of chapter 3 are the following;

- Container liners are taking the lead in shipping innovation by deploying ULCV;
- The drive of container liners to cut down slot costs to achieve the economies of scale at the sea side, will only be functioning, if the scale of terminal operations and hinterland transport systems at the land-side are matching;
- In order to avoid potential bottlenecks for container shipping, a rethinking of corporate strategy regarding cooperation in container shipping at the seaside, will be followed by increasing cooperation, alliances and vertical integration in container logistics on the land side by shipping lines, terminal operators and shippers;
- The introduction of ultra large container vessels as technical tool for cost saving achievements in the Asia Europe trade leads towards increased use of hub-and-spoke concept with increasing transshipment volumes and changing feeder patterns;
- A hub port which is more centrally located towards its captive area will accomplish decreasing cost of feedering as a result of lower deployment of vessel capacity and bunkering costs.

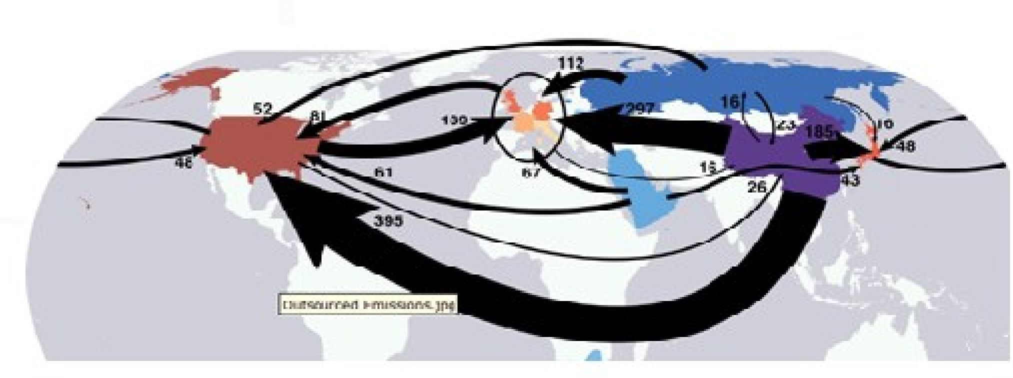
Chapter 4- The impact of ULCV on short haul feeder connections; sustainable, economical and logistical impact

In chapter 4, the sustainable arguments and their relation to the deployment of ULCV are described. Strongly related to the sustainable arguments are the described logistics arguments affected by changing feeder patterns and its logistic consequences. Finally, the overlapping economical argument will be included in this chapter.

4.1 Sustainable behavior in the shipping industry

Banister and Button(1993) calculated that the transportation industry as a whole is causing a major part of the environmental degradation in the world. Since the 1990's, one can observe a clear trend within the transportation industry. As stated in a survey of BSR and as illustrated in figure 4.1, 23 % of the total emissions in the world have been caused by the effects of global trade. The sector gradually started to incorporate environmental friendliness by "painting" their mission statement more "green". (BSR, 2011)

Figure 4.0 Global emissions from international trade



Source: BSR, 2011

negative externalities
A common resource like clean and healthy air is most valuable nowadays. Maritime transport is a serious threat to these valuables for many people living in the vicinity of a port region. The case-study in this report, described the polluted port zone in North West Europe. It can be concluded that regulating "cleaner shipping" is badly needed. The negative externalities in this case can be described as the uncompensated impact of the maritime shipping industry on the well-being of the residents in the polluted ports of Rotterdam and Amsterdam. It happens that these externalities can be solved by private initiatives like; shifting from heavy fuel oil to LNG, installing collectors at exhaust for Sox (scrubbers) or using electricity from the quay-side when docked (cold ironing), instead of energy from the vessel's generator. This can be an effective structural solution, though in practice government interference is often required. Internalizing the negative externality costs is needed so that shipping lines start to adopt these hidden costs to society in their cost structure.

Governments can offer various public solutions to decrease the pollution by the maritime industry. A penalty via intervention through taxes is an option. Regulating is the most drastic measure. After the disaster with the single hull oil-tanker Erika, ports started to allow only port calls of double hull oil tanker-vessels. By doing so, single hull tankers are for the greater part phased out and replaced by new double hull oil tankers.(Wijnolst, 1999)

internalizing external costs
One of the objectives of the EU is to create a transport pricing system, where the external cost as e.g. noise, pollution and congestion can be internalized via a clear price tag for the user of the infrastructure or a service. This price tag can be effected via taxation or regulation.

Internalizing the external cost as regulatory instrument by governments will be used more intensively for the users of the transport system. Increasing public pressure on expenditure of tax payers' money on infrastructure will result in changing systems for funding and pricing(EU, 2011). The EU wants a cost structure of the transport system reflected in the pricing without any distortion (EU, 2011). Pricing and taxation within the EU is heading towards the basic philosophy of the polluter and or user is paying. The cost price should therefor include the total costs of transport. This means including the cost for infrastructure and externalities(EU, 2011). Pricing the use of infrastructure is a methodology for internalizing the externalities in a port region like noise, air pollution and congestion. The road tax for trucks in Germany, the so-called " Maud", and the road tax " Swiss vignette" for the users of the Swiss road system are examples of internalizing costs(EU, 2011).

Internalizing externalities will have its impact on the establishment of a level playing field on transport modes and their substitutes. These new systems will drastically change existing feeder patterns and will consequently acquire the ideal efficiencies of scale, for the operation of corridors(EU, 2011).

Slow steaming
The conditions on environmental regulations imposed by the International Maritime organization in Marpol Annex VI, stimulates the use of bigger vessels steaming at slow speed. The aimed efficiencies will result in lower fuel consumption, a decrease of CO_2 emissions and to acceptable freight rates. The concept is used by shipping lines in times of high fuel costs and insufficient demand. Image wise, both carriers and shippers benefit from slow steaming. The container carrier can adopt a green image while reducing bunker consumption and emissions. Its customer, the shipper, can profile its "green" product with its "green" supply chain towards the environmental conscious consumers.

Fast turn around time of vessels in ports, creates opportunities for slow steaming. It is a trade-off between the additional costs of increased service level with the additional costs of faster steaming, both regarded from an economical and sustainable point of view. The deployment of slow steaming ULCV will lead to a decrease in the number of calls per string. Fewer calls per liner service will consequently impact feeder patterns.

Green Fleet (LNG)
Apart from the green image obtained by measures of reducing bunker costs per slot, the strategy of the European union to decrease the greenhouse gas emissions from ships will also have impact on the development of new technologies and use of other energy sources. The Baltic, the English Canal and the North sea area will face as from 2015 new standards regarding sulphur emissions. Vessels should restrict their sulphur emissions below 0,1 %. Low sulphur bunkers are much more expensive than normal fuels. This may lead to new opportunities for the future use of Liquid natural gas (LNG) bunkers as new energy source for shipping. Currently, major bottlenecks for LNG propulsion for container vessels is the lack of berth infrastructure. The mentioned future regulations on sulphur emissions will have impact on deep sea carriers for mentioned port zones. Also feeder and short sea operators will be impacted, as they are deploying smaller size vessels with emissions levels which are relatively higher. The ideal concept would be to create a feeder network of environmental friendly feeder vessels feedering the ULCV in mega ports.

Green harbor dues
The friendliest public measure is rewarding clean vessels with economic incentives, as the "green harbor dues", to stimulate vessel owners to adopt cleaner vessels. The green harbor dues has been implemented by the Ports of Rotterdam and Amsterdam in 2011. It's based on the Environmental Shipping Index (ESI). This index shows the environmental performance of the ships in terms of air pollutants and Carbon Dioxide (CO2). Ports can use the certificates, issued by the World Port Climate Initiative, to reward cleaner ships & encourage sustainable behavior in the shipping industry.

Initially, the impact on both ports and shipping lines will be limited as the port dues are only roughly 4% of the operational cost of a shipping line. On the long run, the initiative of ESI is to stimulate vessel owners to make extra efforts, to go beyond the current legal standards in reducing air emissions and to get ready for future regulation on emissions.(Port of Amsterdam, 2011)

Green logistics
An increasing impact on the awareness of pollution is the growing demand from consumers for green products and services. This requires also green supply chain solutions. Sustainability across the logistics supply chain is on the agenda of many global key-shippers. Examples of these shippers, as shown in figure 4.2, also linked to the CCWG (Clean Cargo Working Group) are e.g.: The Coca Cola Company, Nike, Li & Fung, IKEA, IBM, Procter & Gamble, Starbucks, Sony, Wal-Mart, Shell, McDonald's.

Figure 4.2 "Green" players in container logistics

Source: CCWG, 2011

As shown in figure 4.0, the arrows representing cargo flows as a result of international trade are causing 23% of the total global emission enclosed in consumer products.(BSR,2011) This is gradually leading to the recognition of the producers of global branded products. Regulation, image and competition are the main topics to take into account by global branded products manufacturers and global consumer behavior.(BSR,2011)

An increasing number of shippers have included environmental behavior in their company's mission statement. Their logistics goal is to improve environmental performance throughout the total supply chain of their product. It's for these reasons, that sustainable elements became part of the selection criteria of these logistics service providers.

In their service level agreement, carriers are obliged to provide reliable information about their environmental performance of their services. Sustainable solutions as slow steaming by the carrier and a reduction of total intermodal emissions can reduce the total transportation emissions of a shipper's product and its carbon footprint.

4.2 EU vision for a competitive & sustainable transport system

The European Union (EU) regards transport as a vital tool to optimize mobility, enabling economic growth and creating employability. The aim of the EU is to efficiently integrate all its regions into the global economy within the feasible range of both environmental and resource constraints. In 2011, the European commission published their “Whitepaper on transport, 2011”, elaborating their vision on the future of the EU transport system and its policy agenda 2020. According to Kallas, EU commissioner for transport, the aim of the EU is to optimize a competitive and resource efficient transport system with a minimum reduction of GHG emissions of 60% (compared to 1990) by 2050 (EU, 2011).

EU Whitepaper 2011

The Whitepaper clearly states the red line in EU policy; decarbonizing is badly needed to safeguard the EU economy and mobility for EU-citizens. Oil dependency in the EU will ultimately lead to increasing rates for oil, impacting inflation, trade balance and competitiveness. The decarbonisation goals in combination with the international agreement to drastically cut down greenhouse gas emissions(GHG), paves the way for initiatives to create a sustainable transport system within the EU (EU, 2011). Cargo should be transported in such a way that the infrastructure is efficiently used. For example by combining intermodal modes from the ports to their final hinterland destination. Optimization of sustainable transport systems should therefor lead to increasing consolidation of cargo flows. For the interest of the shipper, these sustainable trade corridors need to be reliable, economical and preferably match with the shipper’s supply chain management (EU, 2011).

The EU is also pleading for the development of more and efficient gateways to facilitate the European economy. In particular, the development of ports with direct access to inland waterways.

Realizing a more efficient use of information technology in between the players in the supply chain is another goal of the EU.

Innovative transport patterns

The EU whitepaper stimulates the use of all potential and sustainable waterborne transport; Innovative transport patterns of optimal combinations of transport modes , carrying efficiently consolidated large quantities of cargo close to its final destination. The after transport of the individual transport should be carried by clean vehicles.

One goal is to create a structure for the granting of pilot exemption certificates in EU ports. This will lead to considerable cost savings e.g. for a new mode of hinterland transshipment by feeder shuttles.(EU, 2011)

In order to create a single European transport area, “waterborne transport should be used to its full potential” (EU, 2011). A good example is supporting regulations leading to an optimal allocation of resources from the pilots organization. Such a regulation can be the issuing of pilot exemption certificates for European ports to masters frequently visiting a port.

Table 4.0 Advantages of multi modal transport for different stakeholders

	Costs	Traffic flow	The environment
Economic agents			
Shippers	Reducing inland transport prices	Need for reliable transport chains	Showing interest in taking into account sustainable
Shipping lines	Competing with other transport organizers to	Offering reliable transport chains	development
Logistic service providers	attract freight from shippers	Offering reliable transport chains	Anticipating a possible inclusion of environmental
Operators	Same as above if the operator also is a transport organizer	Reliability of the involved operations	costs in transport costs
Public authorities			
Port management	Interport competition	Interport competition	Promoting a sustainable
National, regional and municipal governments	Economic development and jobs	Regional planning	development
Public opinion			
Community groups	Same as above	Low tolerance for environmental externalities	

Source: Frémont and Franc (2010).

4.3 Modal shift

The modal split is the breakdown of cargo moving by the modes truck, barge, rail or short sea. Frémont and Franc (2010) categorized for all involved stakeholders in the supply chain the advantages of multi modal transport. This overview specified on the categories cost, traffic flow and environment is illustrated in table 4.0. Before describing the impact of the modal shift strategy, the mentioned modes will be briefly explained.

Trucking

For many years, trucking as convenient door to door solution, has been the favorite pragmatic choice in transport logistics. Road transport is characterized by -on average- higher emissions per ton/km. This is to a large extent caused by a lower utilization degree of the transport mode of trucking. The utilization is limited by the maximum allowed vehicle weight and the distance the truck drives empty related to the loaded distance. The trucks in the Netherlands have been drastically modernized since 1988. Most new trucks are classified as category Euro5 with cleaner engines (Port of Amsterdam, 2011)

Trucks contribute to the costs of increasing congestion on the roads as a result of capacity constraints in infrastructure. It is therefor a matter of common sense to review traditional logistic concepts and consider the alternatives as provided by the ample transport capacity of rail and inland waterway.

The majority of container flows will be consolidated and transported via efficient concepts of corridors to an inland hub close to the final destination of the cargo. The key-role for the trucking mode in this concept is the before and after transport, making road transport an essential element in the supply chain.

Barge transport

The inland waterway network in the Netherlands has by far the most fine-meshed network in Europe (De Vries, 2000). The geographic position and the quality of inland waterways in North West Europe, makes intermodal transport by barge mode especially suitable for feeder traffic in between Benelux ports and for serving the Ruhr area along the Rhine river corridor(Konings, 2010).

The inland waterway shipping sector sector adapted its product for container logistics to the market requirements during the last decades. This was necessary as the type of barge is restricting the use of certain inland waterways. Bigger barge sizes need inland waterway class V or higher. This is not always and anywhere available due to natural -, geographical- , infrastructural-, environmental-, water draught- and air draught- restrictions. Bigger size barges loose their efficiency because of a lower utilization degree and deviation from optimal routing. The market share of barge transport can shrink up to 28% during dry periods in summer time. In order to limit the impact of climate change a more intensive maintenance of inland waterways should take place. In view of the EU White paper, internalization of these cost should be charged to the users, resulting in competitive disadvantage for inland shipping on certain routes(EU, 2011).

Figure 4.3 inland waterway corridors

Source: Dynamar,2011

Rail transport

The railway network in the Netherlands is, apart from the dedicated cargo track of the so-called “Betuwe route”, a joint network for the use of both passenger and cargo trains. In contrast with the rail situation in the USA, the European rail system traditionally prioritizes passenger traffic. As sustainable transport has become a higher priority topic on the agenda of the EU and national governments, there seems room for improvement, e.g. the development of European cargo corridors. Various political bottlenecks as protectionism, nationalism restrict the progressive development of European cargo transport by rail(Houweling,2011).

In the Netherlands, there are circa 14 rail service operators. DB Schenker Rail Netherlands is a market leader with a market share of 75%. There’s a tendency of vertical integration in the supply chain by rail operators, leading for example to door-to-door propositions.

The management of the Dutch railway network is executed by the company Pro Rail. The exception is the “dedicated rail way track “Betuwe route” from Rotterdam to Germany, which is managed by Key Rail. The shareholders of Keyrail are: Pro Rail (50%), Port of Rotterdam (35%) and the Port of Amsterdam (15%)

.

Characteristics of rail transport as intermodal mode for container logistics are the capacity of maximal 80 – 90 TEU per train. For long haulage, rail is a competitive and more sustainable and reliable alternative for trucking. In terms of capacity, the rail mode has its limitations due to spatial and financial complexities to expand the infrastructure. Congestion at rail-terminals and at rail-infrastructure are potential bottlenecks for modal shift (Houweling, 2011).

Short sea shipping

The European definition of short sea shipping is the transport of cargo between ports located in geographical Europe or between those seaports and their counterparts in neighboring continents(Vroegop, 2008).

Short-sea shipping is characterized by the continental origin of its cargo and is regarded as the sustainable substitute for long haulage trucking or rail *.) The vessel-size is smaller than deployed among the deep-sea carriers. However, also short sea operators gradually upscale their vessel size as a consequence of the changing deep-sea liner service patterns with bigger vessels, a reduction of port calls per string and the aim for cost savings on transshipment cost. The system of short sea shipping is in particular suitable for countries with a stretched coast line (Stopford, 2009).

A lack of detailed intra European cargo data makes it complex to analyze the exact balance of short sea cargo handled by feeders or vice versa. Unifeeder as one of the leading feeder operators in Northern Europe handled in 2010, 1,75 Million TEU lifting's. An increasing number(2010: 23 % of total feeder volume) is intra-European domestic cargo(Lloyds list, July 2011). Wijnolst(1999) described an increasing role of short sea hipping as a result of ULCV deployment.

The modes of transport by rail and by barge are very safe and in general energy efficient when used in an effective manner. Consequently, for the environment these are a less polluting mode of transport(Konings, 2009).

The modal split for container logistics in the Port of Rotterdam was in 2010: 47, 5 % for truck, 39% for barge and 13, 5% for rail. The forecast of the Port of Rotterdam is that they would triple the volume in absolute numbers to and from the hinterland between 2009 and 2035. Therefore, the port needs to anticipate on this growth to avoid environmental degradation and congestion. The goal is to change the modal split percentages to 35% for truck, 45% for barge and 20 for rail by 2035. (Port of Rotterdam, 2010).

In order to achieve this modal shift, the port authority stipulated the composition of the required modal split as mentioned above in the contractual agreements with the concession-holders of the container terminals to be built at Maasvlakte 2(Port of Rotterdam, 2010).

Contractual agreements stipulated in lease contracts of terminal operators are a new phenomenon in container logistics in Europe. It means a change from a free choice of modal split towards a regulated and restricted system. It's a drastic new innovation in the management of intermodal transport with reducing congestion and CO_2 as key-drivers.

**)Footnote: Main difference between feedering & short sea shipping; feeder-cargo is directly related to the mother-vessel and therefore has a deep sea origin. Short sea shipping acting as look-a-like mode has a continental origin.*

The implementation and enforcement of these intermodal contracts will be difficult. Port of Rotterdam seems to balance in between a strict penalty-system with eventual terminating the lease contract with the terminal operator towards a softer juridical “safety-net”.

Initiatives on stimulating sustainable shipping in port regions, issued by regional governments and port authorities will ultimately lead to changing feeder patterns.

4.4 Innovative Intermodal concepts

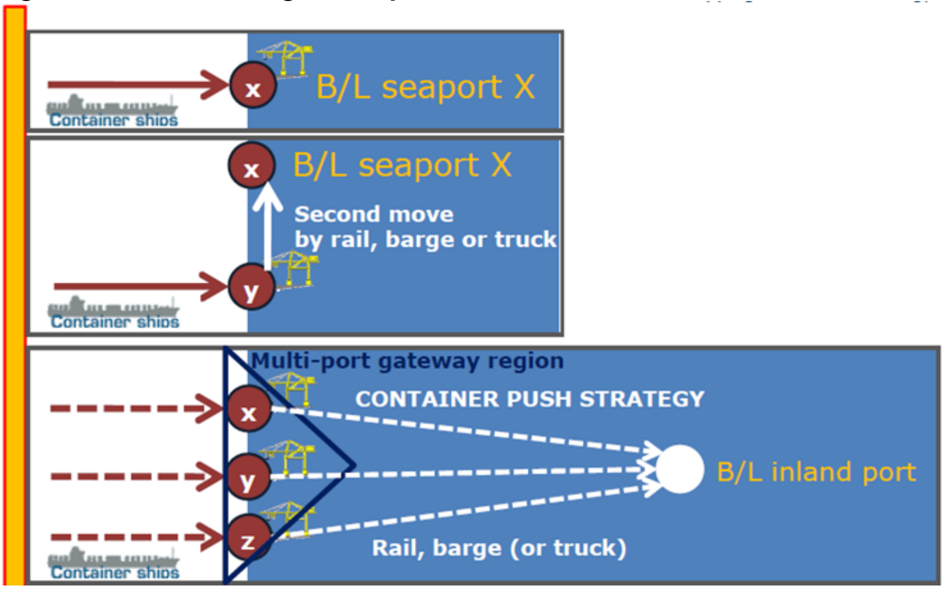
Intermodal transport is more efficient and price competitive in comparison with the traditional door-to-door solution that road haulage is providing. The disadvantage of intermodal transport is the increasing number and costs of additional handlings and costs for pre and after haulage. A decrease of the total transport costs can be achieved by economies of scale, leading towards a lower point in favor of intermodal transport. The sustainable behavior of shippers and carriers will increasingly play a more dominant role in the decision making process. It’s not all about costs. Intermodal concepts aggregating the components of cost efficiency and sustainability can result in successful business cases.

Terminalization
The conventional role of a container terminal as interface between sea and land logistics is changing. In their study, Rodrigue and Notteboom(2009) revealed the changing role for deep sea and inland terminals in the supply chain. They baptized this new extended active role for terminals in the chain as “terminalization”. Rodrigue and Notteboom foresee a continuing process of a changing market with vertical integration and a push towards more intensive use of scarce port-infrastructure and optimizing use of terminal space.The terminal haulage concept foresees a more intensive relation of terminal operators with container liners and intermodal operators(Notteboom(2011) describes the next phase of the terminal haulage, ultimately leading to demand for Bill of Lading- Inland port. This effect is shown in figure 4.4.

This is in line with Haralambides (2011) and Wijnolst (2010) stating that the economies of scale in the supply chain at the seaside development will face diseconomies of scale at the landside, creating a bottleneck for an efficient process of sustainable container logistics.
In accordance with the re-assessment of terminals described by Rodrigue and Notteboom(2011), an optimal use of land in container logistics will therefore be determined at the restructuring and innovations at landside development.

A changing ownership of container terminals will certainly have its impact on “terminalization” and the rethinking of a terminal strategy. Various examples of jointly owned terminals and cooperation between global terminal operators and global container carriers are known e.g. in Rotterdam. (ECT – NYK; ECT – MSC; DPW – CMA-CGM, Hyundai Merchant Marine, MOL, APL).

Figure 4.4 Bill of Lading Inland port



Source: Notteboom, 2011

Extended gate ECT
In Rotterdam, from their City terminal Home and their Maasvlakte terminals Delta and Euromax, the global terminal operator ECT offers their "European Gateway Services" (see figure 5.1) designed for facilitating the flow of containers from the above mentioned deep sea-terminals to extended gates in the hinterland as Moerdijk, Venlo and Amsterdam(ECT, 2011). The extended gate is regarded by the customs in the Netherlands as an extension of the deep sea main gateway. Customs declarations can therefor be executed at the extended inland gate.

Figure 4.5 Extended gate network ECT

Source: ECT, 2010

Intermodal competition
The traditional approach towards intermodal transport has been for a long time that it's difficult to compete with direct trucking. The main reason is that the competitive

advantage of the lower freight rates for rail and inland waterway transport are weakening by the additional costs of both the extra handlings and the so-called first and last mile of road haulage(Konings, 2010).

The first solution needs to be found in increasing the competitive advantage of favorable freight rates by developing concepts of large volume transport modes. The advantage of lower slot costs per transported unit is a substantial factor. Large volume modes depend on consolidation of many smaller cargo flows into “thick” corridors. The second solution is to develop logistic concept in which the start and the finish of the corridors are located as close to ,respectively, the origin and destination of the cargo. In this way, cost savings can be realized on first and final mile road transport. The third solution should provide an answer on the cost element of extra handlings. Innovative solutions in e.g. terminal planning might provide a solution to cut down the costs of additional handlings, being the major cost-factor of intermodal transport. With reference to the previous chapters on logistic and sustainable arguments, the key to optimization is to approach intermodal transport by looking at total cost of ownership(Konings, 2010).

4.5 Conclusions

The main conclusions on sustainable, logistical and economical impacts are the following:

- The transportation industry as a whole is causing a major part of the environmental degradation in the world, though the transport system has become cleaner per transported unit, increasing trade flows continued the severe impact by shipping on the environment;
- Increasing container volumes will lead to the development of ULCV with bigger call sizes, creating opportunities for establishing corridors in between the mega hub port and the feeder ports;
- Pricing and taxation within the EU is heading towards the basic philosophy of the polluter and/or user is paying. Internalizing the external cost as regulatory instrument by governments will be used more intensively for the users of the transport system;
- Increasing public pressure on expenditure of tax payers’ money on infrastructure will result in changing systems for funding and pricing. These new systems will drastically change existing feeder patterns and will consequently acquire the ideal efficiencies of scale, for the operation of corridors. Optimization of sustainable transport systems should therefor lead to increasing consolidation of cargo flows;
- An increasing size of mainline vessels will create more demand for feeder containers needed to fill up the vessel. The transshipment costs need to be absorbed by innovative and efficient operations. Deploying small vessels in the function of feeder shuttles in between two ports can be a solution, as

total port costs per call will diminish. (e.g. exemption pilot obligation, liner service rates, terminal handling costs);

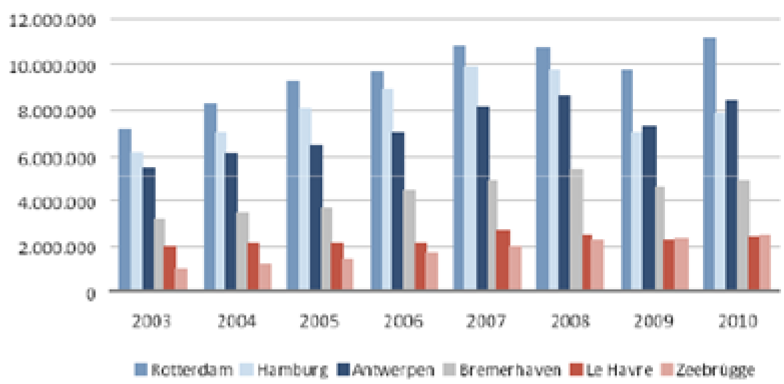
- The main risk in shipping is on one side for the ship owners heavily investing in new vessels and shipping lines, showing long term commitment via chartering or buying new vessels. The other side of bearing the risk of over supply or under supply is for the shippers. An imbalance between demand and supply causes fluctuations in freight rates. These fluctuations determine if the shipping line or the shipper is paying. (Stopford, 2009). As Stopford mentioned: “ the penalty of size is the loss of flexibility”. With this statement he refers to the impact on income, as a result of limited port access and imbalance;

Chapter 5 – Short haul feeder feedering as additional hinterland transport mode; A case study of the concept of short haul feeder shuttle between Amsterdam and Rotterdam

5.1. Container volumes N.W. Europe

As mentioned in chapter 1, global container volumes increase substantially in the future. With reference to table 5.0, in which the competition range of North West Europe is shown with The Port of Rotterdam as European market leader.

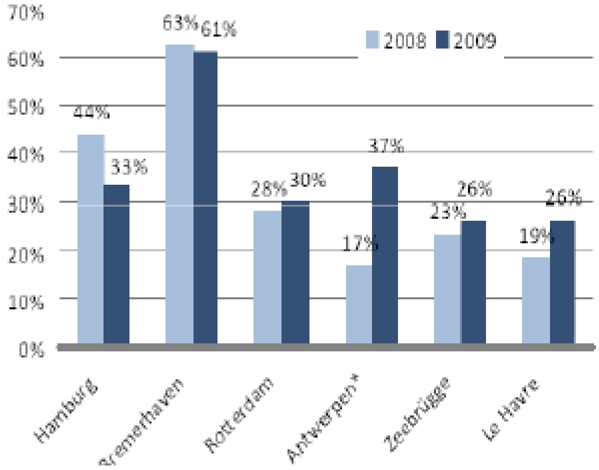
Table 5.0 Container volumes N.W. Europe



Source: Drewry, 2011

Transhipment ratio
As shown in table 5.1, a considerable part of the containerflow consists of transshipment.

Table 5.1 Transhipment ratio



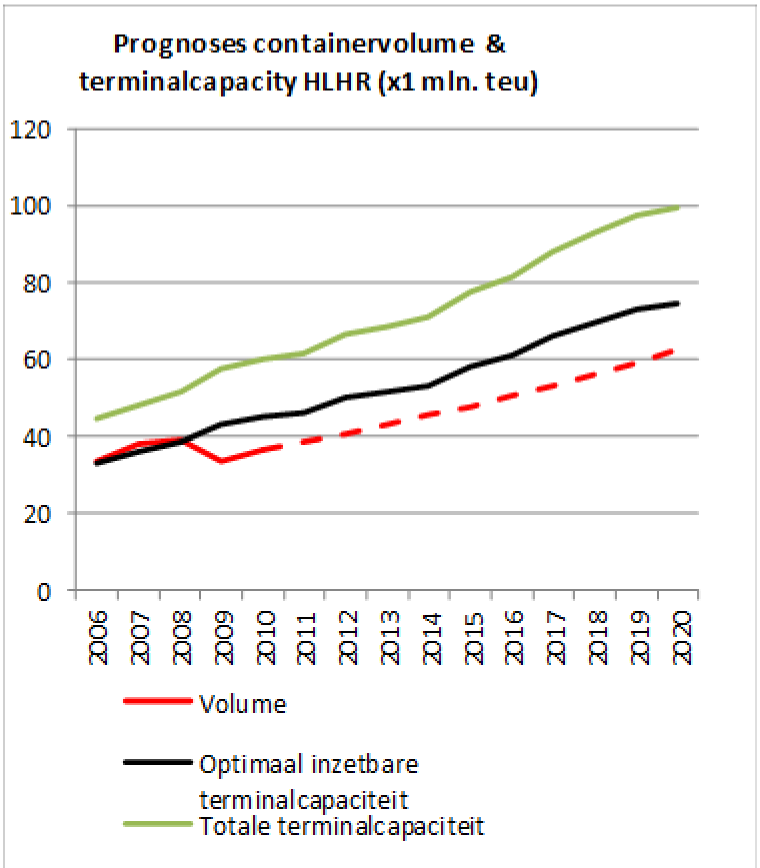
Source: Drewry, 2011

5.2. Container terminal capacity N.W. Europe

Based on the figures as illustrated in table 5.2, it's obvious that demand for container terminal capacity will not exceed the supply of container terminal capacity in the Hamburg-le Havre range. Between 2010 – 2020, 26,5 Million. TEU Container terminal capacity will be available for the market. However , this additional capacity is not matching the expected 4 – 7 % annual increase of container volumes. (Port of Amsterdam, 2011)

It can be concluded that the modality of feeder transshipment between Rotterdam and Amsterdam v.v. will not be fuelled by a lack of terminal space neither in Rotterdam nor in Amsterdam. Moreover, a business case should preferably not be founded on scarcity. The on-going market developments and container logistics innovations will most probably eliminate such temporary elements as capacity shortage.

Table 5.2 Terminal capacity Hamburg Le Havre range



Source: Port of Amsterdam, 2011

Table 5.3 prognosis container volumes

	2008		2020		2030		2040		Growth 2010-2020	Growth 2020-2030	Growth 2030-2040
Total containers (x 1 Mln. TEU)	6,4	100%	12,6	100%	18,5	100%	24,4	100%	97%	47%	32%
Barge	2,3	51%	5,2	40%	8,1	36%	11,0	33%	126%	56%	36%
Train	0,8	13%	2,4	19%	3,7	20%	5,4	22%	200%	54%	46%
Truck	3,3	36%	5,0	41%	6,7	44%	8,1	45%	52%	34%	21%

Source: Port of Rotterdam, 2011

5.3. Port of Rotterdam

The Port of Rotterdam is the largest port in Europe with a market-share of 29,4% in the competition range of Hamburg-Le Havre. (ref. table 5.0) Before Shanghai took over this position in 2004, Rotterdam had been the busiest port in the world since 1962. The World top 10 position of the Port of Rotterdam in container-business shows the international relevance of the main port Rotterdam as gateway into Europe. The competition in the Hamburg Le Havre range is very strong. In order to maintain its top position for Europe on the longer term, the Port of Rotterdam focuses with its corporate strategy on: space for growth, accessibility and sustainability. In 2009, Rotterdam gained market share in the Hamburg Le Havre range. As a result of consolidation in the container logistics industry and the rationalization of container liner services, the downturn in the global economy had more impact on the competitors of the Port of Rotterdam than on Rotterdam it selves. However, the trends of rationalization and consolidation are not only related to deep-sea container services. Also the economies of scale for hinterland services were strengthening the position of Rotterdam as most important gateway into Europe(Port of Rotterdam, 2011).

To maintain the leading position, Rotterdam is investing in improving its accessibility. The focus hereby is on expanding the infrastructure and developing innovative transport concepts. The ultimate aim is to work towards a modal shift from decreasing road transport and to ship more cargo by water and via rail. Rotterdam is conveniently situated at the river delta of the Rhine River and the Maas River. This creates an efficient jump board to ship goods from Rotterdam to the hinterland in Europe and visa versa. Inland shipping is an ideal solution for a cost-effective transport of voluminous cargo-flows and the ample capacity of the rivers can still provide room for accommodating further growth of transshipment. It's for this reason that the Port of Rotterdam created new facilities, like e.g. the "Delta barge feeder terminal"(Port of Rotterdam, 2011).

Port of Rotterdam – does not aim to maximize profit. Market share is more important for the port. Market share and market share growth are more important because in the long term it will yield profits. Long-term profits derived from size and large market share is the goal of corporatized ports. If profit maximization was the objective, the port should be much smaller(Haralambides, 2011).

An increasing number of container terminals in the Port of Rotterdam leads to diseconomies of scale for the hinterland transport. As a result of fragmentized container flows for specific destinations, intermodal operators need to make a milk run in the port area for collecting their containers. The challenge is to organize a sustainable and economical concept of large scale container bundling.

Table 5.4 Modal Split Port of Rotterdam

Rotterdam's modal split (containers only)	2009	2035
Road	48%	35%
Barge	39%	45%
Rail	13%	20%

Source: Port of Rotterdam, 2011

Container terminals Port of Rotterdam MV1 and MV2

Table 5.5 Current major terminals (MV1)

Terminal	Max. capacity (TEU)	80% utilization
APM Terminal Rotterdam	2.700.000	2.160.000
ECT Delta Terminal	6.000.000	4.800.000
ECT EuroMax Terminal	2.300.000	1.840.000
Total current capacity MV1	11.000.000	8.800.000

Source: Dynamar, 2011

Total capacity 2011: 11 Mln. * 80% utilization = 8,8 Million TEU / 1,25 = 7%

Based on this calculation, with the assumption of a terminal utilization of 80% and a total market potential for hub Amsterdam of 1,25 Million TEU, the assumed market share per terminal for containers import/export Northern part of the Netherlands is estimated at 7%.

The share of barge transport is assumed to be 39% based on the Port of Rotterdam statistics. The total market potential in 2011 is as mentioned in table 5.6.

Table 5.6 Total market potential 2011

Terminal	Max. capacity (TEU)	80% utilization	From/To Amsterdam (7%)	By barge (39%)
APM Terminal Rotterdam	2.700.000	2.160.000	151.200	58.968
ECT Delta Terminal	6.000.000	4.800.000	336.000	131.040
ECT EuroMax Terminal	2.300.000	1.840.000	128.800	50.232
Total current capacity MV1	11.000.000	8.800.000	616.000	240.240

Source: Dynamar, 2011

Table 5.7 Planned projects and expansions until 2020 (MV1 & MV2)

Terminal	Max. capacity (TEU)	80% utilization
APM Terminal Rotterdam	400.000	320.000
APM Terminal Rotterdam II	4.500.000	3.600.000
Rotterdam World Gateway	4.000.000	3.200.000
ECT Delta Terminal	770.000	616.000
ECT EuroMax I	700.000	560.000
ECT EuroMax II	1.800.000	1.440.000
ECT EuroMax III	2.600.000	2.080.000
Total additional capacity	14.770.000	11.816.000
Total capacity 2020	25.770.000	20.616.000

Source: Dynamar, 2011 ; Port of Rotterdam, 2011

It is assumed that the total potential share of containers to and from Amsterdam remains equal to 2011 at 7%. The market share of barges is assumed to rise slowly, namely to 41%. The total market potential per new project will be as in table 5.8.

Table 5.8: total market potential 2020

Terminal	Max. capacity (TEU)	80% utilization	From/To Amsterdam (7%)	By barge (41%)
APM Terminal Rotterdam	400.000	320.000	22.400	9.184
APM Terminal Rotterdam II	4.500.000	3.600.000	252.000	103.320
Rotterdam World Gateway	4.000.000	3.200.000	224.000	91.840
ECT Delta Terminal	770.000	616.000	43.120	17.679
ECT EuroMax I	700.000	560.000	39.200	16.072
ECT EuroMax II	1.800.000	1.440.000	100.800	41.328
ECT EuroMax III	2.600.000	2.080.000	145.600	59.696
Total additional capacity	14.770.000	11.816.000	827.120	339.119
Total capacity 2020	25.770.000	20.616.000	1.443.120	591.679

Source: Dynamar, 2011 ; Port of Rotterdam, 2011

Adding up the largest terminals, the market potential approximates 600.000 TEU per year. For the major terminal operators, the market potential is 167.328 (ECT Euromax), 171.472 (APM), 148.719 (ECT Delta) and 91.840 (RWG).

After these calculations, it can be concluded that the ideal vessel size for e.g. 1 MV1 feeder shuttle and 1 MV2 feeder shuttle is as expected the pre-selected 750 TEU vessel. For deploying selected vessel size of 750 TEU at a 80 % vessel utilization (Maximum capacity per year MS Enforcer 750 TEU vessel: 280.800 - 351.000 TEU), combinations of 2 terminals (MV1 shuttle & MV2 shuttle need to be made for a feasible short haul feeder concept.

5.4. Port of Amsterdam

Amsterdam Seaports is an international logistic hub with a strategic position serving the hinterland of North-West Europe via connections by water, rail, road and air.

In 2010, 90,7 million metric tons of cargo (+ 4,5 % growth with 2009) were transshipped via the port region, leading to a ranking as port # 4 on the list of North-West European ports after Rotterdam, Hamburg and Antwerp. All ports along the North Sea Canal (Amsterdam, Zaanstad, Beverwijk and Velsen/IJmuiden) cooperate as Amsterdam Seaports and can be regarded as one industrial port complex area. The throughput in the Port of Amsterdam in 2010 was 72,7 Million. Ton (-/- 1 % with 2009)) The Port region creates an added value of Euro 5, 2 billion and ca. 60.000 jobs to the regional economy. The main part of the cargo transshipped via the Amsterdam Seaports is processed and upgraded in the port area. As an industrial center, the North Sea Canal Area differentiates itself from other port regions, where the focus is more on transit. (Port of Amsterdam, 2010)

Major container terminals Port of Amsterdam
ACT terminal (Hutchison Port Holding);

USA Terminal (Ter Haak Group);

Amsterdam Marine Terminals (Hutchison Port Holding);

CTV Vrede / Steinweg;

Container Strategy Port of Amsterdam
Container logistics is commercially very viable. In discussions with management from Port of Amsterdam, the geographical location, captive area and terminal capacity should create a starting point to develop container logistics in Amsterdam. The Amsterdam ambition is getting 1% of the pie of containers throughput in NW Europe on the long run.(3,5 Million. TEU in 2040)

A modest market share in the container segment in the Hamburg Le Havre range is regarded as essential to further develop the Port of Amsterdam as logistics business industrial complex. It generates a high added value, creates employment, strengthens the business climate and spreads the risk with a better port folio of cargo flows.

The financial crisis had its impact on the container market. Container carriers were forced to rationalize and consolidate. Liner services were combined, slow steaming became the rule and deployment of bigger vessels of their container fleet in order to have the lowest slot-cost per TEU(Dynamar,2011).

Because of these trends, carriers focusing on cost-cutting and consolidation and consequently decreased the number of port calls in the Hamburg le Havre range. Their selection criteria were the potential and level of accessibility of captive hinterland, the quality of hinterland connections and the additional costs per extra port call(Dynamar,2011).

Amsterdam has restrictions on nautical access and the disadvantage of having the biggest European port , Port of Rotterdam, in its vicinity serving the same hinterland. The added value for a direct call in Amsterdam is too small and not regarded as feasible for majority of the carriers active on the main trades like Asia-Europe.

The strategy of the Port of Amsterdam is -in close cooperation with the terminal operators- to bridge the current situation with only small numbers of deep sea container vessels calling Amsterdam by repositioning Amsterdam as inland hub for North Netherlands. This strategy includes building up critical mass as extended gate and transferium by consolidating container volumes for the captive hinterland of Amsterdam in the Northern part of the Netherlands and the German Ruhr Area. Modes of transport used for this concept are rail and barge. The aimed impact of this consolidation, is to make the Port of Amsterdam again more attractive for direct calls of deep sea container liners in the near future.

In the optimization process of container logistics in the Netherlands, the seaside development and terminal development will not create bottlenecks. The challenge is to get the containers in a cost efficient and sustainable way to its final destination in the hinterland(Haralambides,2011). All capacity of hinterland transport will be badly needed to absorb the future container flows. The port of Amsterdam can offer available capacity and act as satellite for Rotterdam without further infrastructural investments. In this way Amsterdam can benefit from the growth in container volumes handled in Rotterdam and anticipate on future changes in modal shift.

Nautical restrictions deep sea Amsterdam

Analyzing the category 7.500 TEU – 10.000 TEU of container vessel dimensions, it can be concluded that ca.11% of the global container fleet fits in the current biggest sea lock “Noordersluis” in Amsterdam. All vessels bigger than 10.000 TEU can not pass the locks complex in Amsterdam as a result of width restrictions.Referring to the order book as shown in table 3.6, in total 24 % of all vessels in the category> 10.000 TEU and 39 % of all vessels in the category >7.500 TEU can not pass the entrance to the North Sea Canal port area. The dimensions of the biggest ULCV (18.000 TEU) can even with a bigger sea lock to be constructed, not call at the Port of Amsterdam, as a result of draft restrictions and nautical maneuverability limitations at the North Sea Canal Area. After completion of a new additional sea lock in 2017, Amsterdam will be technically capable to receive container vessels up to 13.000 TEU with a width 49 meter(Dynamar,2011)

Nautical restrictions inland waterway Amsterdam

As benchmark, the feeder shuttle will be compared with the barge as modality to be used for the extended gate concept for the transshipment of containers destined or originated from the Northern part of the Netherlands. The nautical restrictions of the inland waterways in between the Port of Rotterdam and the Port of Amsterdam are limited for barge combination of 195 meter length over all (LOA) and 22,10 meter width. The maximum size of a barge combination will therefor be 190(LOA) x 17,5 (Width). This will be comparable with a maximum carrying capacity of barge vessels of 500 TEU.

The inland waterway water draft and air draft vary when water levels decreases or increases.

5.5. Hinterland connections

Hinterland costs represent 40 - 70 % of the total cost for door-to-door transport in the supply chain. Developments of the scale and capacity at the sea side, port side and terminal side are growing in a faster pace than the hinterland connections. Economies of scale, congestion and environmental costs are the main drivers ultimately leading towards improving hinterland transport modes and concepts (Notteboom and Winkelmans, 2001). With reference to chapter 4, the EU published their Whitepaper in 2011 with the key message to shift from road to intermodal concepts and to drastically upsize the scale of transported volumes per voyage.

As a result of EU and national regulations, an increasing number of ports are implementing sustainable objectives in their policy regarding modal split.

Diseconomies in the use of infrastructure and terminal capacity, because of peak factors and waiting time, in combination with limited communication in between players in the supply chain are causing bottlenecks in container logistics. Cooperation, consolidation of individual volumes and drastic innovation in container management should largely contribute to a solution to remove these bottlenecks in hinterland transport(De Langen, 2008).

5.7. Conclusions

- An increasing number of container terminals in the Port of Rotterdam leads to diseconomies of scale for the hinterland transport. As a result of fragmentized container flows for specific destinations, intermodal operators need to make a milk run in the port area for collecting their containers. The challenge is to organize a sustainable and economical concept of large scale container bundling;

- In the optimization process of container logistics in the Netherlands, the seaside development and terminal development will not create bottlenecks. The challenge is to get the containers in a cost efficient and sustainable way to its final destination in the hinterland. All capacity of hinterland transport will be badly needed to absorb the future container flows. The port of Amsterdam can offer available capacity and can act as satellite for Rotterdam without additional infrastructural investments. In this way Amsterdam can benefit from the growth in container volumes handled in Rotterdam and is anticipating on future changes in modal shift;

- Analyzing the category 7.500 TEU – 10.000 TEU of container vessel dimensions, it can be concluded that ca.11% of the global container fleet fits in the current biggest sea lock “Noordersluis” in Amsterdam. All vessels bigger than 10.000 TEU can not pass the locks complex in Amsterdam as a result of width restrictions. The dimensions of the biggest ULCV (18.000 TEU) can even with a bigger sea lock to be constructed, not call at the Port of Amsterdam, as a result of draft restrictions and nautical maneuverability limitations at the North Sea Canal Area. After completion of a new additional sea lock in 2017, Amsterdam will be technically capable to receive container vessels up to 13.000 TEU with a width 49 meter;

- The nautical restrictions of the inland waterways in between the Port of Rotterdam and the Port of Amsterdam are limited for barge combination of 195 meter length over all (LOA) and 22,10 meter width. The maximum size of a barge combination will therefor be 190(Length Over All) x 17,5 (Width). The maximum carrying capacity of barge vessels for the corridor Rotterdam – Amsterdam will therefor be maximal 500 TEU.

- Cooperation, improved information exchange, consolidation of individual volumes and drastic innovation in container management should largely contribute to a removal of these bottlenecks in hinterland transport;

- Market share per terminal in Rotterdam Maasvlakte 1 for containers import/export Northern part of the Netherlands is approximately 7%.

- The share of barge transport is assumed to be 39% based on the Port of Rotterdam statistics. The total market potential for the feeder shuttle as alternative for a barge shuttle is therefore in 2011 : 240.240 TEU per year.

- Adding up the largest terminals at MV1 and 2, the market potential approximates 600.000 TEU per year in 2020. For the major terminal operators, the market potential is 167.328 (ECT Euromax), 171.472 (APM), 148.719 (ECT Delta) and 91.840 (RWG);

- It can be concluded that for deploying selected vessel size of 750 TEU, and an 80 % vessel utilization (Maximum capacity per year MS Enforcer 750 TEU vessel: 280.800 - 351.000 TEU), combinations of 2 terminals need to be made for a feasible short haul feeder concept.

Chapter 6 Case study :The feasibility of a short haul feeder shuttle between Rotterdam – Amsterdam vice versa

All intermodal modes of transport are badly needed in order to facilitate the increasing container volumes in a sustainable and efficient manner. The Port of Rotterdam expects the container flow to grow from 11 Million TEU to 14 Million TEU in 2014 and to triple towards 34 Million TEU per year in 2030. (Port of Rotterdam, 2011)

Consolidating containers in regional hubs and transporting these containers in an efficient manner via a corridors with daily connection to and from the mega hub is a concept which is described in the case study on a short haul feeder shuttle between Rotterdam and Amsterdam.

The introduction of the concept of short haul feedering depends in an ideal situation on the economic feasibility. The additional cost for transshipment and terminal handlings should be compensated by the economies of scale caused by the corridors and the lower dwell time at the high cost terminals in Rotterdam.

However, other aspects such as sustainability, capacity, governmental policies and terminal operating costs also play a role

6.1 Potential volume extended gate Amsterdam

The potential of the captive area of the Port of Amsterdam for container logistics has been studied by NEA(2008) and Dufec(2009). These studies both analyzed the transport patterns of containers by the modes rail, barge and truck to and from the Northern part of the Netherlands. This defined area as shown in figure 6.0, regards the Port of Amsterdam as its captive area.

Figure 6.0 potential hinterland area Port of Amsterdam

Source: Port of Amsterdam

■	North-Holland	532.000 TEU
■	Central Netherlands	315.000 TEU
■	North Netherlands	398.000 TEU
	Total	1,25 Million TEU

This study focuses on alternative multimodal shipping modes for barge. As data on the modal split are not available for these destinations, the modal split of the Port of Rotterdam in 2009 (see table 6.4) , has been used for the calculations of barge volumes(Port of Rotterdam, 2011).

Road: 48 %

Barge: 39%

Rail: 13 %

39% barge x total volume of 1,25 Million TEU = 487.500 TEU

Potential volume total market Northern part of the Netherlands per year 487.500 TEU : 468 calls per year = 1042 TEU per call. The potential volume per call is 1042 TEU during 52 weeks per year.

With the assumption of a successful market penetration of 50% of a feeder shuttle, this means a potential call size of 521 TEU for the extended gate.

Potential volume per terminal/alliance

For efficiency reasons, the ideal situation for both barge and feeder shuttling to and from extended gate Amsterdam is by providing direct services, exclusively for a specific mega container terminal. A direct shuttle service creates a more reliable hinterland transport product. Calling with the shuttle at a number of terminals, a so-called milk-run, might cause delays due to waiting hours and should possibly be avoided. The typical trade-off in hinterland transport is between a higher utilization rate of the shuttle and higher voyage costs. A longer transit time impacts the frequency and reliability of the shuttle. For mentioned reasons, it is recommended to exclusively secure an extended gate shuttle service for an individual mega terminal.

The Port of Rotterdam accommodates the following major terminals at the Maasvlakte 1 and as from 2013 also at Maasvlakte 2;

Terminal	**Max. capacity (TEU)**
APM Terminal Rotterdam	2.700.000
ECT Delta Terminal	6.000.000
ECT EuroMax Terminal	2.300.000
Total current capacity MV1:	**11.000.000**

Total capacity 2011: 11 Mln. * 80% utilization = 8,8 Million TEU / 1,25 = 7%

Based on this calculation, with the assumption of a terminal utilization of 80% and a total market potential for hub Amsterdam of 1,25 Million TEU, the assumed market share per terminal for containers import/export Northern part of the Netherlands is estimated at 7%.

Planned new projects and expansions	
APM Terminal Rotterdam	400.000
APM Terminal Rotterdam II	4.500.000
Rotterdam World Gatew ay	4.000.000
ECT Delta Terminal	770.000
ECT EuroMax I	700.000
ECT EuroMax II	1.800.000
ECT EuroMax III	2.600.000
Total additional capacity	**14.770.000**
Total capacity 2020	**25.770.000**

Source: Dynamar, 2011 ; Port of Rotterdam, 2011

6.2. Calculation feasibility feeder shuttle

Selection feeder vessel
For the feasibility study of a short haul feeder shuttle between the Port of Rotterdam and an extended gate in the Port of Amsterdam, a selection of three different sizes of container vessels have been selected and were used for the calculations.(ref.: www.jrshipping.nl). The vessels selected were the following;

MS Elevation; GT 5026 / 538 TEU;

MS Enforcer; GT 7680 / 750 TEU;

MS Elan; GT 11.700   / 1008 TEU;

For the standard calculations, the MS Enforcer, a 750 TEU capacity vessel has been used for three specific reasons;

1. Recommendations on optimal feeder shuttle size from interviewed experts;
2. Potential demand container volumes according to the analysis of section 7.1;
3. Relatively small difference in cost price per TEU when comparing a 538 TEU and a 750 TEU capacity vessel.

Concept feeder shuttle
The container terminals at MV 1 &2 are a starting-point in the feeder-shuttle concept as described in this case-study. In practice it should work as follows;

After mooring the mother vessel at the quayside, the aim of the shipping line, terminal operator and shipper -in general- is to move the containers out of the terminal yard, onwards to its final destination. The deep sea-mother vessel is handled within its window-slot. The terminal operator pre-stack all containers destined for transshipment by the feeder shuttle in the yard area close to the quayside. Whenever the terminal lay-out and systems allows this, pre-stacking should preferably be done in block-stowage. After departure of the mother vessel, the feeder shuttle arrives within its window-slot and collects the conveniently positioned pre-stacked containers. After loading & discharging the feeder shuttle, the vessel leaves for Amsterdam. The steaming-time at sea together with the passage of the locks and North Sea Canal until the mooring at the quayside of a container terminal in the America harbor in the Port of Amsterdam, takes about in total 6,5 hours.

Table 6.0 transit time

Distance: 38 sea miles

Average speed: 16 knots

1.	Rotterdam MV1 – Pilot station Rotterdam	0,5 hrs.
2.	IJmuiden pilot-station(5 sea miles outside locks complex):	
	Total steaming time;	3 hrs.
3.	IJmuiden pilot-station – Locks	1 hrs.
4.	Passage locks IJmuiden:	0,5 hrs.
5.	Passage North Sea canal:	1 hrs.
6.	Mooring	0,5 hrs.
	TOTAL:	**6,5 hrs**.

Source: Port of Amsterdam(2011)

The feeder shuttle is handled by the terminal operator in Amsterdam for inbound and outbound containers. In Amsterdam, the containers are categorized by mode of transport, destination and estimated time of departure. After categorizing, the containers are shifted to the stacks on the terminal yard.

From the inland hub and extended gate Amsterdam, all onwards distribution of the containers takes place by intermodal transport or truc king. This can take place with smaller barges, leading to savings in transit time as the concept leads to more direct hinterland connections. An extended gate close to the final destinations of the cargo implies less feeder vessels and lower bunkering costs. This study focuses on the feedering part in between the mega terminal and the extended gate container terminal. For the phase of transport of the container from the extended gate to its final destination in the hinterland, this study would like to refer to Konings(2010).

In general, the cost elements of port costs, bunkering costs and time charter costs each represent about 1/3 of the total cost of the feeder vessel operation. The element of the time charter costs can not be influenced as this factor is completely market driven. The elements of bunker consumption and the number of deployed feeder vessels can be influenced by strategic choices.

Terminal handling

The cost of cargo handling varies due to differences in the type of cargo, design and shape of the vessel, quality and quantity of equipment, like cranes and vehicles, yard planning and THC(Stopford, 2009). In general, a terminal calculates two moves for every transshipped box. One from the crane into the stack and one from the stack back to the next mode of transport. For the feeder shuttle, the next mode in the Port of Rotterdam is the move at the terminal from the deep-sea container, originating from the main vessel, to the feeder shuttle. In Amsterdam it means the lift from the feeder shuttle to the quay, followed by the move to the stack categorized by intermodal mode and the move to the mode for the distribution to the final destination into the hinterland. Calculation on the costs and differences between barge and feeder are not included in this research due to lack of information.

Performance: 50 moves per hour. **2 cranes** -> 100 moves per hour (twin-spreaders)

Total moves on 750 TEU vessel with 80 % slot-utilization :

1200 (inbound 600 & outbound 600); 1200: 100 = **12 hrs.**

Total time per voyage

Transit time voyage: 6,5 hours

Terminal handling: 12 hours

Total time per voyage: 18,5 hours

Total hours per week = 168

Total voyages per week: 168 / 18,5 = 9 voyages feeder shuttle

Total voyages per year: 468 voyages feeder shuttle

Total calls in Rotterdam: 234

Total calls in Amsterdam: 234

The outcome of the calculations of the total time per voyage leads to the capacity constraints ranges between 80% and 100 % utilization as mentioned below:

Maximum capacity per year MS Elevation 538 TEU vessel: 201.427 - 251.784 TEU

Maximum capacity per year MS Enforcer 750 TEU vessel: 280.800 - 351.000 TEU

Maximum capacity per year MS Elan 1008 TEU vessel: 188.697 - 235.872 TEU

6.3 Total calculation cost short haul feeder shuttle (excl. THC)

Table 6.1 Total calculation cost extended gate feeder shuttle (excl. THC)

	Rotterdam	Amsterdam	Roundtrip	% of total cost		Slotcost single voyage per TEU		
						Utilization	Utilization	Utilization
Harbor Dues						100,00%	80,00%	60,00%
MS Elevation (538 TEU)	€ 3.160,40	€ 1.222,38	€ 4.382,78	28,52%	per TEU	€ 8,15	€ 9,78	€ 11,41
MS Enforcer (750 TEU)	€ 4.660,52	€ 1.699,11	€ 6.359,63	29,59%	per TEU	€ 8,48	€ 10,18	€ 11,87
MS Elan (1008 TEU)	€ 6.776,62	€ 2.265,10	€ 9.041,72	32,18%	per TEU	€ 8,97	€ 10,76	€ 12,56
Charter cost								
MS Elevation (538 TEU)	€ 3.000,00	€ 3.000,00	€ 6.000,00	39,04%	per TEU	€ 11,15	€ 13,38	€ 15,61
MS Enforcer (750 TEU)	€ 4.000,00	€ 4.000,00	€ 8.000,00	37,22%	per TEU	€ 10,67	€ 12,80	€ 14,93
MS Elan (1008 TEU)	€ 6.000,00	€ 6.000,00	€ 12.000,00	42,71%	per TEU	€ 11,90	€ 14,29	€ 16,67
Bunker cost								
MS Elevation (538 TEU)	€ 2.493,30	€ 2.493,30	€ 4.986,60	32,45%	per TEU	€ 9,27	€ 11,12	€ 12,98
MS Enforcer (750 TEU)	€ 3.567,25	€ 3.567,25	€ 7.134,49	33,19%	per TEU	€ 9,51	€ 11,42	€ 13,32
MS Elan (1008 TEU)	€ 3.528,33	€ 3.528,33	€ 7.056,65	25,11%	per TEU	€ 7,00	€ 8,40	€ 9,80
Total cost								
MS Elevation (538 TEU)	€ 8.653,70	€ 6.715,68	€ 15.369,38	100,00%	per TEU	€ 28,57	€ 34,28	€ 39,99
MS Enforcer (750 TEU)	€ 12.227,77	€ 9.266,36	€ 21.494,12	100,00%	per TEU	€ 28,66	€ 34,39	€ 40,12
MS Elan (1008 TEU)	€ 16.304,95	€ 11.793,43	€ 28.098,37	100,00%	per TEU	€ 27,88	€ 33,45	€ 39,03

Source: Port of Rotterdam, Port of Amsterdam

Sensitivity analysis

Table 6.1 shows the cost price for freight per TEU on a single voyage from Port of Rotterdam / Maasvlakte 1 or 2 to the Port of Amsterdam/ America harbor or Westhaven vice versa. The calculation is based on a vessel utilization of 100%. The voyage costs are split in harbor dues, charter cost and bunker cost. The costs of a port call by the feeder shuttle does not include tug boat charges and pilot costs. Regarding the pilot costs; this can be explained as pilot costs are not applicable for the selected vessel types assuming that certified masters manage the high frequency calls. Regarding the tug boat costs; tug boat duty is not applicable for the selected vessel types.

For all other calculated scenarios with combinations of variances of 80 % utilization, 60 % utilization, charter rates 150% and 200%, the voyage cost element is not economically feasible for the feeder shuttle compared with the barge shuttle.

Regarding the harbor dues, the assumption has been made that for a high frequency feeder shuttle, an operator will deploy a container vessel meeting the highest standards in order to obtain the maximum discount for both the green award program as well as the Environmental Shipping Index (ESI).

The black lines in the graph represent the range for the costs per TEU via the alternative barge shuttle. The upper line of Euro 25,- for the barge shuttle is only matching with the single voyage cost of the feeder shuttle for the 1008 TEU vessel "MS Elan" at a 100% utilization. All other scenarios as also illustrated in tables 6.2 – 6.6 show a cost increasing impact on the cost for a single voyage per TEU.

It can be concluded that the feeder shuttle, based on the calculations for the selection of vessel types can not compete with the barge shuttle in terms of cost per TEU for a single voyage Rotterdam- Amsterdam and vice versa.

Table 6.2 Price 100% utilization

Table 6.3 Price 80% utilization

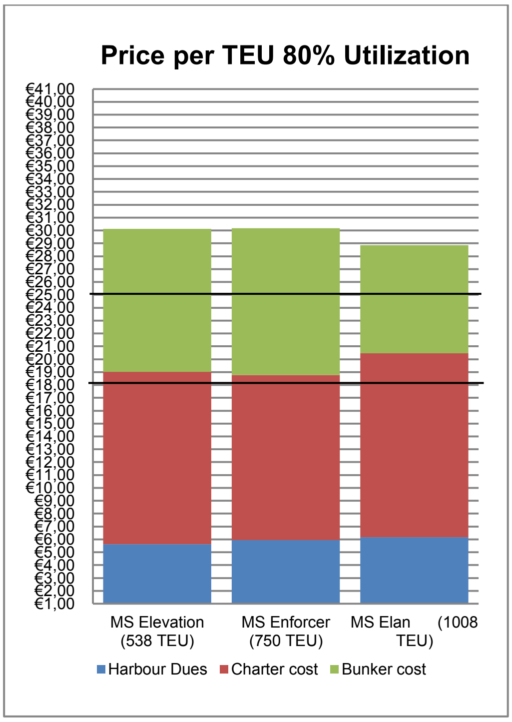


Table 6.4 Price 60% utilization

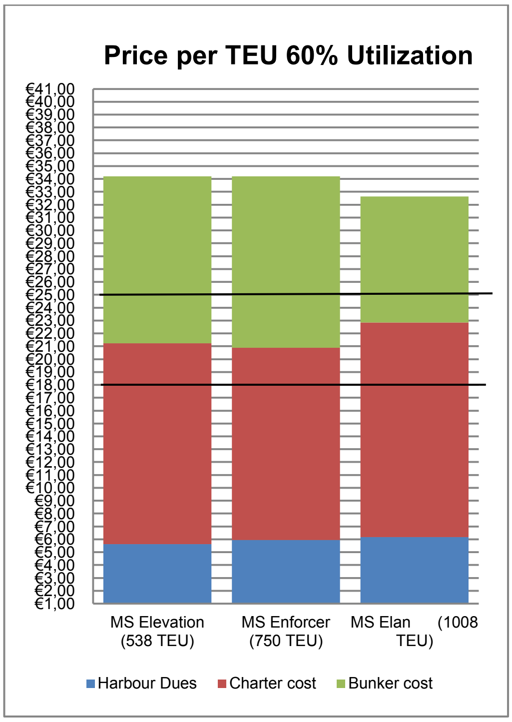
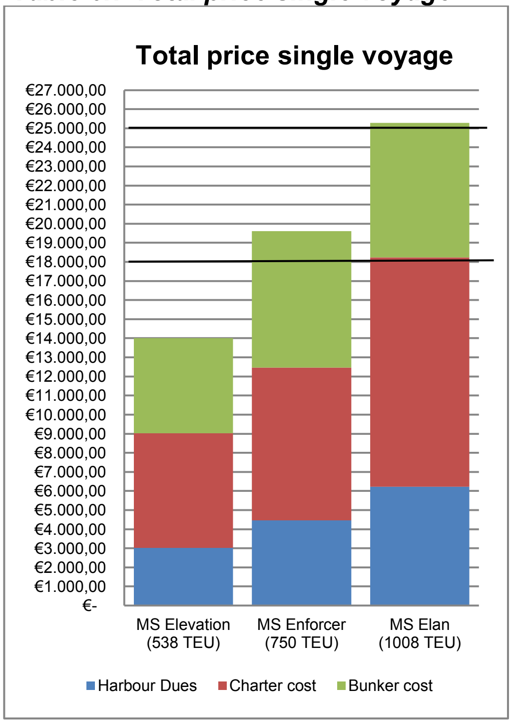


Table 6.5 Price 80 % util. & 150% charter

Table 6.6 Price 80 % util.&200%charter

Table 6.7 Total price single voyage



6.4 Explanation costs short haul feeder shuttle

In general the voyage costs (VC) for a charterer consists of the following elements;

1. FC ~ Bunkering costs
   (fuel consumption, fuel price and speed creating the bunkering costs)
2. PD ~ port costs
3. TP ~ tug boat costs
4. CD ~ pilot costs.

Formula: VC=FC + PD + TP +CD

(Stopford, 2009)

Port dues
The main components determining the harbor dues in both Amsterdam and Rotterdam are: type of vessel, type of cargo, ship's capacity (Gross tonnage) and handled cargo volume in metric tons. Rotterdam can offer a special hinterland rate for its harbor dues, for all seagoing vessels when transfer activities also take place in Rotterdam. (Port of Rotterdam, 2011). The last mentioned hinterland rate is not taken into account with the calculations as in table 6.1.

The Port of Rotterdam, changed its policy regarding quantity reductions for frequent calls. This system has been replaced by the following table:

100 - 500 ton : 5 % discount

500 - 1000 ton: 7,5 % discount

1000 - 1500 ton: 10% discount

1500 – 4000 ton: 18% discount

> 4000 ton: 21 % discount

(Port of Rotterdam, 2011)

This results for the total selection of feeder shuttle vessel types as used for calculations in a discount of 21 %, as all vessel types will generate over 4000 ton at a 80% utilization . This discount is based on the total yearly generated tonnage volume with the conversion of 1 TEU=10 ton.

Discount port dues
In the Port of Amsterdam the frequency discount of 30% has been processed in the calculation.

Green award
Depending on the deployed type of short haul feeder vessel, harbor dues in both ports are applicable for green awards (6% discount on harbor dues)(Port of Amsterdam, 2011) and for the status of the vessel regarding Environmental Shipping Index (ESI). In the calculation as shown these discounts were included(Port of Rotterdam, 2011).

Environmental Shipping Index

An assessment of selected vessels for nomination for green awards and maximum ESI points has not been included. This study assumes that for this specific short haul feeder shuttle, all deployed vessels will meet the optimal requirements in order to obtain maximum discount for the green award program and Environmental Shipping Index.

Tug boat assistance

For the vessel dimensions of selected feeder shuttles, tug boat assistance is not required. It's possible that with exceptional weather circumstances the comfort of tugboat assistance is required or even obliged. It's recommended for the selection of vessel types deployed as feeder shuttle, to take the port regulations into account concerning pilot exemption and tug boat duty.

Pilot

The category of the feeder vessel with frequent calls at both the Port of Rotterdam as well as the Port of Amsterdam can apply for exemption of obliged pilot assistance. Together with the pilot, the master of the vessel need to sail a number of voyages from the pilot station in both Rotterdam and Amsterdam into the ports. After these voyages, the master need to pass an exam, after which he'll become a certified master for the specific voyage. The vessel mastered by the certified captain will receive exemption of pilot duty.

6.5 Bunkering costs

*F = F * (S/S*)a*

F: fuel consumption in tons per day

S: actual speed

F*: design fuel consumption

S*: design speed

Exponent a: varying component for steam or diesel engines (Stopford, 2009)

The 750 TEU feeder vessel used in the standard calculations consumes 29,33 metric tons per day by an average speed at 16 knots/ hour.

For 6,5 hours steaming time, this results in a coefficient of 6,5 / 24 hours = 0,271

0,271 x 29,33= 7,95 metric tons bunker fuel

For the calculation, the bunker rates level of September 7, 2011 as published at www.Bunkerworld.com have been used. The bunker rate used for the calculation is U$ 632,50 per metric ton.

The U$ / Euro conversion rate on sept.7, 2011 was 1 U$ ~Euro 0,71

The mentioned bunker rate, converted in Euro would then be: Euro 449,08 per metric ton.

The bunkering costs for a 6,5 hours single voyage from Rotterdam Maasvlakte 1 or 2 towards Amsterdam- Amerika harbor or visa versa are calculated as follows:

Bunker consumption of 7,95 metric ton bunkering x Euro 449,08,- per metric ton = Euro 3567,25 (excel rounded off)

The bunkering costs represent on average 66% of the voyage costs. (Stopford, 2009). Feeder operator Team lines stated that on average fuel oil determines 33% of the total costs.(Lloyds List, 2011)

Table 6.8 Bunkering prices

	Bunker prices		
	Ø Growth	2010	2000
Bunker prices	8%	453	140

10-year Rotterdam Cst 380 prices (USD/mt)				
Year	Average	Increase	Lowest	Highest
2010	453	27%	402	497
2009	356	-25%	167	493
2008	474	36%	177	715
2007	348	19%	306	505
2006	292	25%	254	338
2005	234	51%	145	292
2004	155	2%	132	179
2003	152	14%	124	197
2002	133	15%	101	167
2001	116	-17%	97	138
2000	140	49%	106	171

Source: Dynamar, 2011

Table 6.9 Fuel costs per TEU in U$

Vessel Size TEU	12,500	8,000	5,000	2,500	1,000
Speed/knots	18	18	18	18	18
Fuel Costs/TEU USD	4.46	6.01	6.58	9.11	15.18

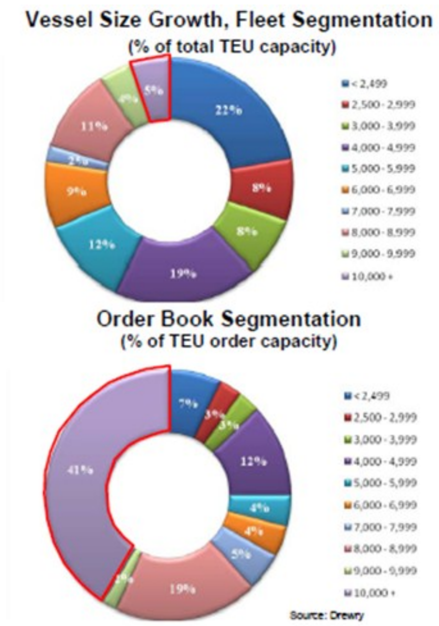
Source: Dynamar, 2011

For the bunkering costs, no details for barge consumption were available. For this reason no sensitivity analysis have been executed. However, it can be assumed that increasing fluctuations in bunker prices have a relatively comparable affect for both barge as feeder vessel.

6.6 Chartering costs

When studying the order book of figure 6.1, the conclusion can be made that with an increasing demand for feeder services as a result of the phasing in of ultra large container vessels, time charter rates for feeder vessels will likely increase followed by the feeder freight rates and an urge to start looking for new efficiencies. This would fuel the acceptance of the described concept of feeder shuttles from port to port, which can positively impact feeder patterns. A smaller feeder shuttle can offer a higher sailing frequency, as the vessel spend more time in port berthing or calling at various terminals. The option of a bigger feeder shuttle will contribute to cost savings as a result of economies of scale. Fluctuations in demand for the feeder shuttle will particularly create diseconomies of scale for bigger size feeder shuttles.The number of vessels under 1000 TEU is expected to decline.

Figure 6.1 Fleet & orderbook segmentation



Source: Drewry,2011

6.7 Comparison barge shuttle extended gate (excl. THC)

Costs
Cost per TEU is **Euro 25**,- for transshipment single voyage. In the competitive barge market for transshipment in between Rotterdam Maasvlakte and Amsterdam America harbor, the range for the freight cost per TEU is between 18 – 25 Euro. This range has been used in the calculations(Port of Amsterdam, 2011) (ECT, 2011).

Transit time
The barge shuttle has an average transit time on the distance Rotterdam/MV1 – Amsterdam/America harbor barge via Amsterdam-Rhine Canal of 12 hours (Port of Amsterdam,2011).

Bunkering costs & Charter rates
For details on bunkering costs and charter rates, the study by Konings is recommended (2010).

6.8 Customs perspective

The Dutch customs office in Amsterdam provided their view on the extended gate concept, comparing an extended gate feedered by a barge with one feedered by a short haul feeder shuttle. According to the customs, there's no significance between the two modes of transport. It's standard practice according to applicable Dutch customs law, articles 512/513. The extended gate supported by feeder shuttle does not involve any additional financial or administrative surcharges.

From the perspective of the Dutch customs authority, in order to launch an optimal format, they prefer a regular feeder shuttle with a fixed service schedule, exclusively executed by feeder operators, main carriers, terminal operators and other involved service providers with Authorized Economic Operators status (AEO).

6.9 Sustainable impact concept feeder shuttle

The feeder shuttle reduces the carbon foot-print of the transported goods considerably, both in comparison with trucking, but also compared with rail and inland shipping. For the greater part can this be explained by the efficiencies of scale. More dense cargo flows to the hinterland generate on average lower CO2 emissions.

Calculation CO2 emissions
The trend of deploying ULCV in deep-sea shipping in order to achieve efficiencies of scale is also applicable for the CO2 emissions. Enlargement of scale leads for deep-sea to lower emissions per slot. The scale of the volume transported is equally important for determining the CO2 emissions as the used mode of transport is. (Den Boer, Stream 2008) For this reason it can be concluded that for the feasibility of the

feeder shuttle, the optimal vessel size to deploy is not only based on economical values, but the sustainable factor should be taken into account as well. Determining the optimal scale is decisive for a successful penetration of this new mode of intermodal transport. The smaller vessels currently used in coastal shipping are not performing better on fuel efficiency than other modes of transport. For comparing the CO2 emissions another related vital element is the deviation-factor. (Den Boer, Stream 2008). A low deviation percentage is in favor of the feeder concept.

Comparison CO2 emissions

In the report “Studie naar Transport Emissies van alle Modaliteiten” (STREAM), a comparison is shown of CO2 emissions in grams/per ton/km by all modes of transport on distances bigger than 150 km. The conclusion of the survey was that trucks bigger than 20 tons and small short sea vessels with a capacity of 150 TEU have the highest CO2 emissions (Den Boer, Stream 2008). As mentioned before, the performance on sustainability level of the various modes of transport depends on energy efficiency and emissions. When assessing the sustainable performance, one should include also other elements as capacity, utilization degree, share of productive mileage, deviation percentage and pre and after transport. The energy efficiency of the various modes of transport are not expected to change considerably. (Den Boer, Stream 2008).

In this survey the emissions of fuel production, construction of infrastructure and production and recycling of transport vehicles are not included.

LNG

The goal for 2050 of the EU is to cut down CO2 emissions from maritime bunker fuels by 40%. (EU, 2011) As from 2015, the ECA provision on sulphur in the emission controlled port regions, only allows emissions below 0.1% of sulphur. It’s expected that low-sulphur fuels will be very costly. This provides opportunities for ships bunkering the low emission fuel LNG. Meech expects a market share of 5% for LNG by 2030. (Lloyds list, 2011)

6.10 Reliability impact concept feeder shuttle

For most shippers, punctual delivery is essential for their supply chain processes. In order to achieve an acceptable service reliability, logistics providers tend to use the intermodal concept, perceived as the most reliable mode of transport. Unfortunately, for “green” logistics, this is often the non-environmentally-friendly mode of trucking(Rodrigue, 2001).

Assuming that, in a densely populated and congested economic activity area, a relatively long haul imbeds more risk in time deviation than a short haul. The level of service reliability introduced by a feeder shuttle covering the first and main part of the long haul of intermodal transport from mother vessel to inland hub can be perceived as reliable when the transit from mother vessel to feeder vessel and from feeder to inland shipping modes is compatible.(Dynamar, 2011)

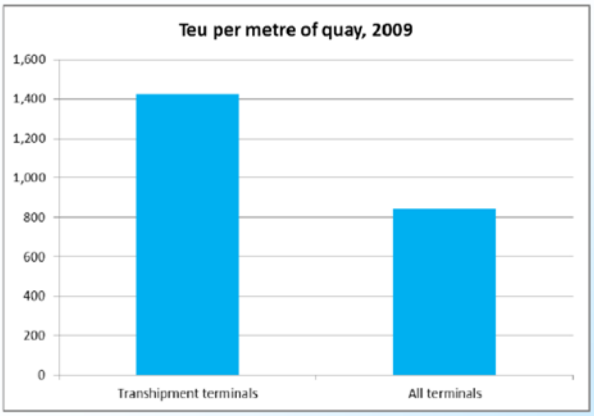
6.11 perspective container terminal operators

The main advantage of deploying ULCV with its substantial efficiencies of scale are for the account of the shipping line. In order to facilitate those big vessels, additional investments have to be made by the terminal operator. A different approach of terminal management is needed to absorb the additional costs. Terminalization might be an answer. In chapter 4, this process of terminalization has been elaborated. The traditional terminal operators are shifting from their classical stevedoring role towards the role of integral logistics service provider.

The trend of shared ownership of container terminals by global terminal operators and global container carrier may create a new approach on data-exchange and a cooperative way of using these data for improving supply chain solutions. In this way a terminal can inter-connect its operation of handling the mother vessel and feeder shuttle simultaneously in order to cut the total transshipment time. Efficient sharing of information and transparency can contribute to a faster supply chain. Without influencing the berthing time of the ULCV, the feeder vessel can at the same time directly get the containers on board destined for inland hub Amsterdam.

The terminal operator in the mega hub port decreases the level of its micro peaks as a result of the extended gate concept. Transshipment terminals as illustrated in table 6.10, in general, realize a higher quay performance.

Table 6.10 Quay performance transshipment terminals



Source: Drewry, 2010

6.12 dwell time

Dwell time is the total time, expressed in days that a container is at the terminal yard, from the moment the container is in the stack until its departure via the consecutive mode of transport.

Dwell time = average number of days a container stays at the terminal

(Time of departure –Time of arrival) / Number of containers handled

The import dwell time in Rotterdam vessel – barge is 4,1 days.(Dekker, 2005)

This means that the yard turns over 365/ 4,1= 89 times

A dwell time of 2 days with the feeder shuttle leads to 365/ 2 = 182,5 times that the yard can turn over in Rotterdam.

These conclusions should be based on a comparison of dwell time data for the specific barge case of a shuttle supporting an extended gate. Unfortunately, as statistics were not available, it has not been possible to generate an accurate statement based on historical data on the difference of dwell time in Rotterdam, comparing barge shuttle with short haul feeder shuttle.

Interviews with terminal experts regarding the topic of dwell time, did result in the following assumptions used for the case study;

The import dwell time in Rotterdam vessel – barge is 4,1 days(Dekker, 2005).

This means that the yard turns over 365/ 4,1= 89 times

A dwell time of 2 days with the feeder shuttle leads to 365/ 2 = 182,5 times that the yard can handle more in Rotterdam.

These conclusions should be based on a comparison of dwell time data for the specific barge case of a shuttle supporting an extended gate. Unfortunately, as statistics were not available, it has not been possible to generate an accurate statement based on historical data on the difference of dwell time in Rotterdam, comparing barge shuttle with short haul feeder shuttle.

Interviews with terminal experts regarding the topic of dwell time, did result in the following assumptions used for the case study;

1. Dwell time for an extended gate barge shuttle can not be equally compared with a regular barge service;
2. Dwell time for an extended gate shuttle, either feeder or barge, depends on: frequency of liner service, carrying capacity of the liner service, container volume;
3. Dwell time for an extended gate barge shuttle will be approximately 1 – 2 days higher than an extended gate feeder shuttle;
4. Dwell time for extended gate barge shuttle will be higher than the feeder shuttle as a result of the more time consuming customs procedures applicable for the barge shuttle than for the feeder shuttle;

5. Dwell time for extended gate feeder shuttle will be lower than the barge shuttle as these containers are controlled by the carrier. The carrier can indicate before arrival, that specific containers from the main liner are destined for the extended gate;
6. Dwell time for extended gate barge shuttle will be higher than the feeder shuttle as 90% of the containers for barging are controlled by the merchants (merchant haulage). The merchants often delay the process by consuming the free storage time at the terminal for supply chain efficiency reasons;
7. Dwell time for extended gate barge shuttle will be higher than the feeder shuttle as the merchants in general decide in a late stage -after arrival of the vessel- about the transport mode and operator for the after transport.

Concept calculation dwell time:

Barge import dwell time vessel – barge: 4,1

Short haul feeder shuttle dwell time: data not available (estimate: 0 – 2 days)

Concept calculation dwell time:

Import containers Port of Rotterdam

1,25 Million containers destined for northern part of the Netherlands

Modal shift: barge 22 %, train 7 %, Truck 37 %

Barge import dwell time vessel – barge: 4,1

Rail import dwell time vessel – train: 6,5

Truck import dwell time vessel – truck: 6,4

Short haul feeder shuttle dwell time: data not available (estimate: 0 – 2 days)

Signal function

The signal function of dwell time as process indicator for terminal management is decreasing. Dwell time used to indicate the level of connectivity, productivity and coordination. This interpretation is diffused by the changing role of the terminal as cost effective storage location. The buffer function of the terminal gradually integrated in the supply chain strategy of the shipper.(Kek Choo Chung, 1993)

The development of a network of inland terminals and satellite ports creates new dynamics for the supply chain. Logistics service providers and shippers strive to make optimal use of the buffer facilities of a terminal. They embedded this aim in their supply chain strategy. In particular those accounts generating high throughput figures for the terminal, often receive additional “red carpet treatment”. In a competitive market, the terminal operators tend to pamper their key-accounts with extra free time, causing higher dwell time for the terminal.

The higher dwell time induces constraints in terms of capacity, efficiency, flexibility and service level. Facilitating ULCV is causing micro-peaks effecting the capacity of a mega hub terminal. In order to stay competitive, terminals need to intensify the use of their site by focusing on the transshipment function and by changing their buffer function. This strategy combined with the previously mentioned marketing tool of offering temporary storage space requires a solution.

The concept of the high capacity corridor of a feeder shuttle, can contribute to a solution. As tool for optimizing the extended gate concept of a mega hub container terminal, the feeder shuttle can lead to considerable savings on dwell time. A focus on the gateway function of a terminal in the mega hub can be realized by transferring the buffer function towards satellite ports or inland terminals. These alternatives should be able to offer sufficient capacity without spatial or environmental contingents.

A hinterland strategy based on minimizing dwell time of a container at a deep sea terminal on Maasvlakte 1 or 2 might lead to a more cost-efficient use of expensive reclaimed land. This can be explained by the total higher average cost of land and opportunity costs.

6.13 perspective deepsea-operators

A fundamental characteristic of the sector is high fixed costs and low variable costs. This is a problem for the sector. Competition forces companies to price according to variable or marginal costs. If you do this in the long-run you're unable to cover your costs and you're out of business. For this reason, the sector adopted the conference system, which has now been forbidden.

Stability of sailing schedules is one of the most important characteristics in liner shipping. Vessel needs to leave port regardless of cargo in order to keep its schedule. The costs of the vessel are tied to how much cargo is carried. The vessel will have to leave even if the vessel is empty. This “variable” cost becomes a “fixed” cost due to the fact that it must keep its schedule. 90% of costs in liner shipping are fixed as a result of this. The only variable part of these costs is cargo handling(Haralambides, 2011).

For the hinterland transport of carrier haulage, carriers can benefit from the extended gate concept by feeder- shuttle as it can provide a cost-effective solution which simplifies the carrier's task of getting the container at its final destination in the hinterland. The dwell-time at the terminal of arrival in Rotterdam will diminish as there's no time wasted for obtaining accurate information when a specific container needs to arrive at the customer's gate. This waiting time for collecting information is effectively used to move the container already to a location closer to the final destination. This service can be arranged under the license of the terminal operator where the container initially arrived by mother vessel.

The extended gate concept can effectively provide a solution for the deep sea carrier dealing with the increasing issue of imbalances and the urge to cut down the repositioning costs.

6.14 Empty depot

The extended gate concept combined with an empty depot can lead to decreasing repositioning costs of empty containers.(Pondman, 2011) The initial phase of hinterland transport is at the deep-sea container terminal. The full boxes leave for the consignee and the empties go to the shipper. The container terminal will ultimately again be the return base for the boxes after the charging/discharging of the cargo. In general, the shipping line calls the container back at a container terminal. This particular terminal necessarily does not always have to be the terminal of origin. Alternative locations as inland terminals often act as collecting point for a container carrier. These empty depots create efficiencies of scale in the repositioning of empty containers, contributing to sustainable container logistics. Various market developments as the consolidation of container liners, cooperation in alliances, slot-charter agreements and terminal joint ventures in between global terminal operators and shipping lines effect the design of empty depot networks. (Pondman, 2011).

In combination with an empty depot function, the feeder shuttle can efficiently return empty containers from inland hub Amsterdam, into the deep-sea terminals at MV1 and MV2. In this way, carriers are able to efficiently organize the repositioning of their empty's.

6.15 perspective shipper

Whether a shipper chooses a certain distribution mode for his containerized cargo flow, depends as described by Kuipers and Eenhuizen(2004) on a variety of factors as e.g. distribution costs, value of the cargo, time sensitivity, destination, production, packaging requirements, geographical and economic factors of both producer as consumer market. With the extended gate closer to the base of the shippers, it's more convenient to obtain an empty container into their load center.

The inland market is a merchant haulage market which is largely under control of the shippers. An improved relation and more intense cooperation in the supply chain between carrier and shipper in combination with improved information exchange will finally result in improved on-time delivery reliability. (Rodrigue,2011)

6.16 perspective port authority

The quality and quantity of hinterland connections is of crucial importance for ports. Container flows for the hinterland are relatively footloose and can shift from one port to the other in an area like the competition range in between Hamburg and Le Havre

In order to absorb the growth figures of container volumes in the coming decade, a more efficient handling is required (Notteboom and Winkelmans,2004).

The use of short haul feeder shuttle as new intermodal mode of transport, provides additional capacity to the hinterland network of a port. It generates more income on harbor dues for feeder vessels than for inland shipping.

Cooperation and connecting to each others network can create joint operational and commercial benefits for ports. The port can take a role in transition management to achieve those benefits. As described by Kemp and Rotmans(2004), “transition management consists of a deliberate attempt to work towards a transition, in what is believed to be a more sustainable direction with also other benefits besides user benefits”. The multi-domain and multi-level approach of the transition management theory can be very useful to adopt into the analyses of the hinterland strategy for both the Port of Amsterdam and the Port of Rotterdam. Thinking out of the box, not limited to one domain, can create new strategic system innovations and solve complex issues in container logistics(Kemp and Rotmans, 2004). By using the transition theory, both port authorities can steer the different players in the supply chain towards a sustainable direction.(Pondman,2011)

In order to stimulate hinterland transport, the innovation theory is applicable. This theory explains that companies cooperate either to cut down their cost-,time or risk factor or to gain access to unexplored markets .

The Port of Amsterdam is planning the construction of a second major sea lock. In 2011 it’s not clear yet, if this would be at the location of the current Middle-lock. If this would not be the case, until 2018 the feeder-shuttle will be able to make use of two locks, being the Northern-lock and the Middle lock. After construction of the new second major sea lock, the feeder-shuttle can choose 3 locks for her passage through the lock complex in IJmuiden.

The optimal vessel-size for the feeder vessel shall for mentioned reason not exceed the limit restrictions of the Middle-lock (Vessel restrictions Middle lock : LOA maximum 180 meter and width maximum 20 meter).

With the optimal vessel-size, a vessel will have more options, therefore less queuing, less congestion. Furthermore the nautical approach for the Middle locks is faster and the passage of the Middle locks takes less time for reasons of no waiting for other vessels to jointly pass and smaller lock, means less water, thus faster passage.(Port of Amsterdam, 2011)

The land costs in the Port of Amsterdam is considerably lower than the reclaimed land used for container logistics at Maasvlakte 1 and 2. This characteristic together with the fact of being already part of a sequence makes the Port of Amsterdam an option to adopt part of the buffer and consolidation function of mega hub Port of

Rotterdam. This adopted intermediate hub function(Rodrigue, Notteboom, 2011) relieve the container terminals in Rotterdam, enabling them to focus more on the transshipment function.

The advantage for Amsterdam is that they participate with this role in container logistics. The role of intermediate hub strongly connected to hinterland regions creates an attractive location for logistics activities. For Amsterdam, with ample space for distribution areas and located close to Amsterdam Airport Schiphol, it would create new opportunities for logistics activities.(Port of Amsterdam, 2011)

6.17 perspective Dutch government / Ministry of Transport

In order to remain its competitiveness, the main challenge for the maritime logistics cluster in the Netherlands is to efficiently organize and process the cargo flows from the Dutch ports to the hinterland. Improving the effective utilization and synergy of the port and transport network is the aim of the Dutch ministry of transport.

Figure 6.2 Logistics Clusters

Source: MTBS, 2011

The platform of the alliance of Dutch seaports published a report “Samenwerking & marktfocus Nederlandse zee havens” (MTBS, 2011) The report explores the potential cooperation between the Dutch seaports. One of the suggestions made by the authors is possible cooperation via improving the hinterland network by providing transport infrastructure and create corridors with an intermodal network of shuttle services.

6.18 Case study conclusions

A successful introduction of the concept of short haul feedering depends on the economic feasibility. The additional cost for transshipment and terminal handlings should be compensated by the economies of scale caused by the corridors and the lower dwell time at the high cost terminals in Rotterdam. However, other aspects such as demand, capacity, sustainability, governmental policies and terminal operating costs also play a role.

Economic feasibility can not be judged without looking at a number of other key variables of the value chain generating cost savings. Like cost savings on a terminal as a result of lower dwell time for a feeder shuttle.

Economic feasibility
The cost per TEU for transshipment single voyage per short haul feeder shuttle in between Rotterdam Maasvlakte and Amsterdam America harbor is only matching the upper range of the barge freight cost per TEU of Euro 25,- in the case of a 100% utilized feeder vessel of 1000 TEU capacity. For all other calculated scenarios with combinations of variances of 80 % utilization, 60 % utilization, charter rates 150% and 200%, the voyage cost element shows a cost increasing impact. It can be concluded that, based on the calculations for the selection of vessel types the costs for a single voyage per TEU is not economically feasible for the feeder shuttle compared with the barge shuttle.

Charter rates
Increasing demand for feeder services as a result of the phasing in of ultra large container vessels, time charter rates for feeder vessels will likely increase followed by the feeder freight rates and an urge to start looking for new efficiencies. This would fuel the acceptance of the described concept of feeder shuttles from port to port, which can positively impact feeder patterns. A smaller feeder shuttle can offer a higher sailing frequency, as the vessel spend less time in port berthing. The option of a bigger feeder shuttle will contribute to cost savings as a result of economies of scale. Fluctuations in demand for the feeder shuttle will particularly create diseconomies of scale for bigger size feeder shuttles. The number of vessels under 1000 TEU is expected to decline.

Market potential
The potential barge volume of the Northern part of the Netherlands is yearly 487.500 TEU. The potential volume per call is 1042 TEU during 52 weeks per year. With the assumption of a successful market penetration of 50% of a feeder shuttle, this means a potential call size of 521 TEU for the extended gate. At a market penetration of 100%, based on 2011 figures, deployment of a 750 TEU, at 80% utilization rate, vessel will be feasible.

Market share per terminal in Rotterdam Maasvlakte 1, for containers import/export Northern part of the Netherlands is approximately 7%. The share of barge transport is assumed to be 39% based on the Port of Rotterdam statistics. The total market potential for the feeder shuttle as alternative for a barge shuttle is therefore in 2011: 240.240 TEU per year.

In 2020, the cumulative market potential of the largest terminals at MV1 and 2, will be approximates 600.000 TEU per year. For the major terminal operators, the market potential per year is 167.328 (ECT Euromax), 171.472 (APM), 148.719 (ECT Delta) and 91.840 (RWG).

After these calculations, it can be concluded that the ideal vessel size is as expected the 750 TEU vessel. For deploying selected vessel size of 750 TEU at a 80 % vessel utilization (Maximum capacity per year MS Enforcer 750 TEU vessel: 280.800 - 351.000 TEU), combinations of 2 terminals need to be made for a feasible short haul feeder concept.

Reliability
For efficiency reasons, the ideal situation for both barge and feeder shuttling to and from extended gate Amsterdam is by providing direct services, exclusively for a specific mega container terminal. A direct shuttle service creates a more reliable hinterland transport product. Multi-terminal calling creates a risk of delays due to waiting hours and should possibly be avoided. The typical trade-off in hinterland transport is between a higher utilization rate of the shuttle and higher voyage costs. A longer transit time impacts the frequency and reliability of the shuttle. For mentioned reasons, it is recommended to exclusively secure an extended gate shuttle service for an individual mega terminal.

The feeder shuttle shows with a total transit time of 6,5 hours, a better performance than the barge shuttle barge, which needs an average transit time on the distance Rotterdam/MV1 – Amsterdam/America harbor/Westhaven via the routing of the Amsterdam-Rhine Canal of 12 hours.

The level of service reliability introduced by a feeder shuttle covering the first and main part of the long haul of intermodal transport from mother vessel to inland hub can be perceived as more reliable than barge shuttling, assuming transshipment feeder vessel will be more efficient and gets in general more priority at the terminal.

Sustainability
The conclusions on the feasibility regarding sustainability are not based on calculations. Enlargement of scale leads for deep-sea to lower emissions per slot. The scale of the volume transported is equally important for determining the CO_2 emissions as the used mode of transport is. The feeder shuttle should reduce the carbon foot-print of the transported goods. The efficiency of scale of the deployed vessel determines its impact. More dense corridors to the hinterland, generate on average lower CO_2 emissions. It can be concluded that for the feasibility of the feeder shuttle, the optimal vessel size to deploy is not only based on economical

values, but the sustainable factor should be taken into account as well. Determining the optimal scale is decisive for a successful penetration of this new mode of intermodal transport. The smaller vessels currently used in coastal shipping are not performing better on fuel efficiency than other modes of transport. New energy fuels like LNG are being researched for application to coastal shipping. For comparing the CO2 emissions another related vital element is the deviation-factor. A low deviation percentage is in favor of the feeder concept. The advice is to implement direct services, without multi-terminal visits in each port, in order to avoid waiting time.

Dwell time

Terminals using the feeder shuttle concept can benefit in terms of customer service; more flexibility on a terminal, less congestion as a result of increasing container yard capacity and lower house keeping costs, that will result in more reliability, less waiting hours and improved service level. This can lead to increased customer loyalty.

Dwell time for an extended gate shuttle, either feeder or barge, depends on: frequency of liner service, carrying capacity of the liner service and container volume. Comparing the modes, result in a dwell time for an extended gate barge shuttle of 1 – 2 days higher than an extended gate feeder shuttle. Partly, this is as a result of more time consuming customs procedures applicable for the barge shuttle than for the feeder shuttle. The dwell time for extended gate feeder shuttle will be lower than the barge shuttle as these containers are controlled by the carrier. The carrier can indicate before arrival, that specific containers from the main liner are destined for the extended gate. From all the barging volumes, 90% are controlled by the merchants (final receiver). The merchants often delay the process by consuming the free storage time at the terminal for supply chain efficiency reasons, therefore, the dwell time for extended gate barge shuttle will be higher than the feeder shuttle as the merchants in general decide in a late stage -after arrival of the vessel- about the transport mode and choice of operator for the after transport.

The higher dwell time induces constraints in terms of capacity, efficiency, flexibility and service level. Facilitating ULCV is causing micro-peaks effecting the capacity of a mega hub terminal. In order to stay competitive, terminals need to intensify the use of their site by focusing on the transshipment function and by changing their buffer function. This strategy combined with the previously mentioned marketing tool of offering temporary storage space requires a solution.

The concept of the high capacity corridor of a feeder shuttle, can contribute to a solution. As tool for optimizing the extended gate concept of a mega hub container terminal, the feeder shuttle can lead to considerable savings on dwell time. A focus on the gateway function of a terminal in the mega hub can be realized by transferring the buffer function towards satellite ports or inland terminals. These alternatives should be able to offer sufficient capacity without spatial or environmental contingents.

A hinterland strategy based on minimizing dwell time of a container at a deep sea terminal on Maasvlakte 1 or 2 might lead to a more cost-efficient use of expensive reclaimed land. This can be explained by the total higher average cost of land and opportunity costs.

Empty depots
Empty depots create efficiencies of scale in the repositioning of empty containers, contributing to sustainable container logistics. Various market developments as the consolidation of container liners, cooperation in alliances, slot-charter agreements and terminal joint ventures in between global terminal operators and shipping lines effect the design of empty depot networks. In combination with an empty depot function, the feeder shuttle can return empty containers from inland hub Amsterdam, into the deep-sea terminals at MV1 and MV2. In this way, carriers are able to cut their costs by efficiently organizing the repositioning of their empties.

Data exchange
The trend of shared ownership of container terminals by global terminal operators and global container carrier create opportunities on data-exchange and a cooperative way of using these data for improving supply chain solutions. In this way a terminal can inter-connect its operation of handling the mother vessel and feeder shuttle simultaneously in order to cut the total transshipment time. Efficient sharing of information and transparency can contribute to a faster supply chain. Without influencing the berthing time of the ULCV, the feeder vessel can at the same time directly get the containers on board destined for inland hub Amsterdam. The terminal operator in the mega hub port decreases the level of its micro peaks as a result of the extended gate concept.

Customs
From Dutch customs perspective, there is no significance between the two modes of transport. It's standard practice according to applicable Dutch customs law, articles 512/513. Their preferred concept would be a regular feeder shuttle with a fixed service schedule, exclusively executed by feeder operators, main carriers, terminal operators and other involved service providers with Authorized Economic Operators status (AEO). The extended gate supported by feeder shuttle does not involve any additional financial or administrative surcharges.

Carrier haulage
For the hinterland transport of carrier haulage, carriers can benefit from the extended gate concept by feeder-shuttle as it can provide a cost-effective solution which simplifies the carrier's task of getting the container at its final destination in the hinterland. The dwell-time at the terminal of arrival in Rotterdam will diminish as there's no time wasted for obtaining accurate information when a specific container needs to arrive at the customer's gate. This waiting time for collecting information is effectively used to move the container already to a location closer to the final destination. An extended gate closely located to the base of the shippers increases the service level and lower costs to position an empty container into the shippers load center. This service can be arranged under the license of the terminal operator where the container initially arrived by mother vessel.

The extended gate concept can effectively provide a solution for the deep sea carrier dealing with the increasing issue of imbalances and the urge to cut down the repositioning costs. The concept of a dedicated feeder operation in combination with a dedicated terminal operation guarantees more flexibility to the mainline container carrier. In order to be economically viable, the dedicated short haul feeder service needs to offer a minimum of 3 strings per week and a critical base volume of 800 TEU per week in combination with a reliable, consistent service.

Merchant haulage
The inland market in the Netherlands is a merchant haulage market which is largely under control of the shippers. An improved relation and more intense cooperation in the supply chain between carrier and shipper in combination with improved information exchange will finally result in improved on-time delivery reliability.

Costs of land
The land costs in the Port of Amsterdam is considerably lower than the reclaimed land used for container logistics at Maasvlakte 1 and 2 in the Port of Rotterdam. This characteristic together with the fact of being already part of a sequence makes the Port of Amsterdam an option to adopt part of the buffer and consolidation function of mega hub Port of Rotterdam. This adopted intermediate hub function relieves the container terminals in Rotterdam, enabling them to focus more on the transshipment function.

Advantages
The use of short haul feeder shuttle as new intermodal mode of transport, provides additional capacity to the hinterland network of a port. It generates more income on harbor dues for feeder vessels than for inland shipping. Cooperation and connecting to each others network can create joint operational and commercial benefits for ports. Amsterdam can act both as buffer as well as gateway for the Northern territories of the Netherlands The advantage for Amsterdam is that they participate with this role indirectly in container logistics. Furthermore, the role of intermediate hub strongly connected to hinterland regions creates an attractive location for logistics activities. For Amsterdam, with ample space for distribution areas and located close to Amsterdam Airport Schiphol, it would create new opportunities for attracting logistics activities.

Corridors
Cooperation via improving the hinterland network by providing transport infrastructure and creating corridors with an intermodal network of shuttle services, is strongly supported by the Dutch government and the Dutch seaports.

Chapter 7- General conclusions & recommendations

The growing numbers of deployed ultra large container vessels is leading towards a future mismatch in container shipping between the sea leg and the land side. Up scaling the capacity of the interface system between the container terminal and the hinterland port networks will be needed in order to avoid an upcoming mismatch in scale. The purpose of this study has been to analyze how short haul feedering can contribute to increasing the capacity and efficiency of the interface between container terminals and port hinterland networks.

7.1. Research questions

"How can short haul feedering, as a result of the increasing deployment of ultra large container vessels, add value to the interface between container terminals and hinterland transport networks?' will be answered via the following 4 research questions and answers;

Research question1;

What is the impact of increasing deployment of ultra large container vessels on container logistics in a port;

The introduction of ultra large container vessels as technical tool for cost saving achievements in the Asia Europe trade leads towards an increased use of hub-and-spoke concepts with increasing transshipment volumes and changing feeder patterns. The drive of container liners to cut down slot costs to achieve the economies of scale at the sea side, will only be functioning, if the scale of terminal operations and hinterland transport systems at the land-side are matching.

The on-going trend of consolidation and rationalization is leading towards a market development in main trades, like Asia-Europe, in which the perception of container shipping is changing. It is increasingly regarded by the shippers as a homogeneous good. This is paving the way for the landside to follow the example of cooperation in container shipping as performed already at the seaside. Increasing cooperation, alliances and vertical integration in container logistics on the land side by shipping lines, terminal operators, intermodal operators and shippers will result in increasing rationalization and consolidation at the land side operations. The reached economies of scale for hinterland transport will contribute to meet the governments and citizens aim of decreasing congestion, pollution and environmental costs. It can therefor be concluded that the pursuing governments are fuelling the optimization of sustainable transport systems. This is ultimately leading towards increasing consolidation of cargo flows.

The conclusions on the feasibility regarding sustainability are not based on calculations. Enlargement of scale leads for deep-sea to lower emissions per slot. The scale of the volume transported is equally important for determining the CO_2

emissions as the used mode of transport is. The feeder shuttle should reduce the carbon foot-print of the transported goods. The efficiency of scale of the deployed vessel determines its impact. More dense corridors to the hinterland, generate on average lower CO2 emissions. It can be concluded that for the feasibility of the feeder shuttle, the optimal vessel size to deploy is not only based on economical values, but the sustainable factor should be taken into account as well. Determining the optimal scale is decisive for a successful penetration of this new mode of intermodal transport. The smaller vessels currently used in coastal shipping are not performing better on fuel efficiency than other modes of transport. New energy fuels like LNG are being researched for application to coastal shipping. For comparing the CO2 emissions another vital element is the deviation-factor. A low deviation percentage is in favor of the feeder concept. Therefore direct services, avoiding multi-terminal visits in each port, improve the reliability of short haul feedering.

The consequence of the deployment of ULCV on slot utilization is the challenge for shipping lines to fill up the number of slots. When slot-occupancy on the ULCV is too low, vessel operators will then face diseconomies of scale, instead of the aimed cost advantages. For this reason ULCV needs, apart from transshipment volumes, also a captive area which is generating sufficient container volumes. Extended gates enlarge the captive area of a mega hub port. The performance of an extended gate has impact on its attractiveness as center for container logistics.

Research question 2;

What is the economic viability of a short haul feeder shuttle supporting an extended gate as alternative for a barge shuttle ?

A successful introduction of the concept of short haul feedering depends on the economic feasibility. It can be concluded that, based on the calculations in the case study as described in section 6.19, the costs for a feeder shuttle are not economically feasible when compared with a barge shuttle. For judging the economic viability, other factors as supply and demand, sustainability, intermodal competition, governmental policies and terminal operating costs should also be considered. Furthermore, the additional cost for the extended gate concept as transshipment costs and terminal handlings charges should ultimately be compensated by the economies of scale created by the corridors and the lower dwell time at high cost terminals in a mega hub.

Comparing the modes, result in a dwell time for an extended gate barge shuttle of 1 – 2 days higher than an extended gate feeder shuttle. Partly, this is as a result of more time consuming customs procedures applicable for the barge shuttle than for the feeder shuttle. The dwell time for extended gate feeder shuttle will be lower than the barge shuttle as these containers are controlled by the carrier. The carrier can indicate before arrival, that specific containers from the main liner are destined for the extended gate. From all the barging volumes, 90% are controlled by the merchants (final receiver). The merchants often delay the process by consuming the free storage time at the terminal for supply chain efficiency reasons, therefore, the dwell time for extended gate barge shuttle will be higher than the feeder shuttle as the merchants in general decide in a late stage -after arrival of the vessel- about the transport mode and choice of operator for the after transport

For the hinterland transport of carrier haulage, carriers can benefit from the extended gate concept by feeder-shuttle as it can provide a cost-effective solution which simplifies the carrier's task of getting the container at its final destination in the hinterland. The dwell-time at the terminal of arrival in Rotterdam will diminish as there's no time wasted for obtaining accurate information when a specific container needs to arrive at the customer's gate. This waiting time for collecting information is effectively used to shuttle the container already to a location closer to its final destination. An extended gate closely located to the base of the shippers increases the service level and decreases the costs to position an empty container into the shippers load center.

A focus on the gateway function of a terminal in the mega hub can be realized by. These alternatives should be able to offer sufficient capacity without spatial or environmental contingents.

A hinterland strategy based on minimizing dwell time of a container in a mega hub by I transferring the buffer function and empty depot function towards satellite ports or inland terminals might lead to a more cost-efficient use of expensive reclaimed land in the mega hub. As a result of imbalance, short haul feedering can contribute to efficiencies of scale for the repositioning of empty containers in a sustainable way.

It can be concluded that the mode of short haul feedering has the potential to contribute to the realization of sustainable, reliable and cost effective corridors, supporting the efficiency and creating more capacity for the interface between the container terminal in the mega hub and its hinterland transport networks. As hinterland costs represent a major cost element in the supply chain, it pays off for all actors in the supply chain to jointly approach the costs of the hinterland transport network

Research question 3;

What are the critical success indicators in the logistics chain for the solution of short haul feedering ?

An increasing size of mainline vessels will create more demand for feeder containers needed to fill up the vessel. The transshipment costs need to be absorbed by innovative and efficient operations and support from terminal operators, charging favorable THC and authorities providing favorable conditions as pilot exemption and harbor dues.

As a result of fragmentized container flows for specific destinations, intermodal operators need to make a milk run in the port area for collecting their containers. The challenge is to organize a sustainable and economical concept of large scale container bundling.

Cooperation, improved information exchange, consolidation of individual volumes and drastic innovation in container management should largely contribute to a the mode of short haul feedering.

Terminals using the feeder shuttle concept can benefit in terms of customer service; more flexibility on a terminal, less congestion as a result of increasing container yard capacity and lower house keeping costs, that will result in more reliability, less waiting hours and improved service level. This ultimately leads to increased customer loyalty.

Minimizing the dwell time for an extended gate shuttle, either feeder or barge, depends on: frequency of liner service, carrying capacity of the liner service and container volumes

A smaller feeder shuttle can offer a higher sailing frequency, as the vessel spend less time in port berthing. The option of a bigger feeder shuttle will contribute to cost savings as a result of economies of scale.

Stability of sailing schedules is one of the most important characteristics in liner shipping. The utilization degree and the imbalance are key determinants for the slot costs. Also the nautical access of a port determines the success.

A hub port which is more centrally located towards its captive area will accomplish decreasing cost of feedering as a result of lower deployment of vessel capacity and bunkering costs.

A direct shuttle service creates a more reliable hinterland transport product. Multi-terminal calling creates a risk of delays due to waiting hours and should possibly be avoided. The typical trade-off in hinterland transport is between a higher utilization rate of the shuttle and higher voyage costs. A longer transit time impacts the frequency and reliability of the shuttle.

The concept of a dedicated feeder operation in combination with a dedicated terminal operation guarantees more flexibility to the mainline container carrier. The concept of a dedicated feeder operation in combination with a dedicated terminal operation guarantees more flexibility to the mainline container carrier. In order to be economically viable, the dedicated short haul feeder service needs to offer a minimum of 3 strings per week and a critical base volume of 800 TEU per week in combination with a reliable, consistent service.

It can be concluded that for the feasibility of the feeder shuttle, the optimal vessel size to deploy is not only based on economical values, but the sustainable factor should be taken into account as well. The smaller vessels currently used in coastal shipping are not performing better on fuel efficiency than other modes of transport. New energy fuels like LNG are being researched for application to coastal shipping. For comparing the CO2 emissions another related vital element is the deviation-factor. A low deviation percentage is in favor of the feeder concept.

The conclusion can be made that with an increasing demand for feeder services as a result of the phasing in of ultra large container vessels, time charter rates for feeder vessels will likely increase followed by the feeder freight rates and an urge to start looking for new efficiencies. This would fuel the acceptance of the described concept of feeder shuttles from port to port, which can positively impact feeder patterns. A smaller feeder shuttle can offer a higher sailing frequency, as the vessel spend more time in port berthing or calling at various terminals. The option of a bigger feeder shuttle will contribute to cost savings as a result of economies of scale. Fluctuations in demand for the feeder shuttle will particularly create diseconomies of scale for bigger size feeder shuttles.

The drive and or the need of the terminal operator to optimize and intensify the use of scarce port infrastructure will impact the feasibility of short haul feedering.

An intensive relation between the terminal operator, the main line carrier or alliance of shipping lines and the feeder operator will positively impact the concept of short haul feedering.

Cooperation via improving the hinterland network by providing transport infrastructure and creating corridors with an intermodal network of shuttle services, is strongly supported by the Dutch government and the Dutch seaports.

The level of service reliability introduced by a feeder shuttle covering the first and main part of the long haul of intermodal transport from mother vessel to inland hub can be perceived as more reliable than barge shuttling, assuming transshipment feeder vessel will be more efficient and gets in general more priority at the terminal.

In order to stay competitive, terminals in a mega hub need to intensify the use of their site by focusing on the transshipment function and by changing their buffer function. This strategy combined with the previously mentioned marketing tool of offering temporary storage space requires a solution.

Custom clearance of containers exclusively executed by feeder operators, main carriers, terminal operators and other involved service providers with Authorized Economic Operators status (AEO)

The trend of shared ownership of container terminals by global terminal operators and global container carrier create opportunities on data-exchange and a cooperative way of using these data for improving supply chain solutions.

Efficient sharing of information and transparency can contribute to a faster supply chain.

The inland market in the Netherlands is a merchant haulage market which is largely under control of the shippers. An improved relation and more intense cooperation in the supply chain between carrier and shipper in combination with improved information exchange will finally result in improved on-time delivery reliability.

Research question 4

What can be the contribution of short haul feedering on sustainable hinterland logistics for the Northern part of the Netherlands ?

Increasing public pressure on expenditure of tax payers' money on infrastructure will result in changing systems for funding and pricing. These new systems will drastically change existing feeder patterns and will consequently acquire the ideal efficiencies of scale, for the operation of corridors. Optimization of sustainable transport systems should therefor lead to increasing consolidation of cargo flows.

In the optimization process of container logistics in the Netherlands, the seaside development and terminal development will not create bottlenecks. The challenge is to get the containers in a cost efficient and sustainable way to its final destination in the hinterland. All capacity of hinterland transport will be badly needed to absorb the future container flows. The port of Amsterdam can offer available capacity and can act as satellite for Rotterdam without additional infrastructural investments. In this way Amsterdam can benefit from the growth in container volumes handled in Rotterdam and is anticipating on changes in modal shift.

The nautical restrictions of the inland waterway corridor Rotterdam – Amsterdam restrict the carrying capacity to a maximum of 500.

Various market developments as the consolidation of container liners, cooperation in alliances, slot-charter agreements and terminal joint ventures in between global terminal operators and shipping lines effect the design of empty depot networks. In combination with an empty depot function, the feeder shuttle can return empty containers from inland hub Amsterdam, into the deep-sea terminals at MV1 and MV2. In this way, carriers are able to cut their costs by efficiently organizing the repositioning of their empties.

The use of short haul feeder shuttle as new intermodal mode of transport, provides additional capacity to the hinterland network of a port.

Cooperation and connecting to each others network can create joint operational and commercial benefits for ports. Amsterdam can act both as buffer as well as gateway for the Northern territories of the Netherlands The advantage for Amsterdam is that they participate with this role indirectly in container logistics. Furthermore, the role of intermediate hub strongly connected to hinterland regions creates an attractive location for logistics activities. For Amsterdam, with ample space for distribution areas and located close to Amsterdam Airport Schiphol, it would create new opportunities for attracting logistics activities.

Market share per terminal in Rotterdam Maasvlakte 1, for containers import/export Northern part of the Netherlands is approximately 7%. The share of barge transport is assumed to be 39% based on the Port of Rotterdam statistics. The total market potential for the feeder shuttle as alternative for a barge shuttle is therefore in 2011: 240.240 TEU per year.

Adding up the largest terminals at MV1 and 2, the market potential approximates 600.000 TEU per year in 2020. For the major terminal operators, the market potential is 167.328 (ECT Euromax), 171.472 (APM), 148.719 (ECT Delta) and 91.840 (RWG);

Resume:

After answering the research questions, the main research question can be answered as follows;

The feeder shuttle, as sustainable high capacity corridor, can contribute to the efficiency and capacity of the interface between the container terminals and hinterland networks. The feasibility depends for the greater part on the captive service area and its market potential. The bigger the container volumes, the more efficient the service network can operate. Consolidation of extended gate volumes will result in efficiencies of scale, with the deployment of bigger size feeder shuttles. These up scaled feeder shuttles will result in increasing competitiveness of both the mega hub as well as the feeder hub.

7.2. Implications for policy and recommendations

Improving procedures application certificate for pilot exemption;

Extend program green incentives for early adaptors deploying cleaner vessels;

Conclude bilateral agreements with operators creating sustainable high capacity corridors;

Value creation is only possible if terminals and shipping companies cooperate when implementing a short haul feeder shuttle in their hinterland transport networks.

Promotion by governments and port authorities for sustainable transport towards merchants in order to improve the modal split.

Task for port authority to initiate actions in order to accomplish more cooperation and collaboration among actors in the supply chain.

7.3. Directions for further research

Simulation or queuing model to research quantitative impact of short haul feeder shuttle on efficiency terminal operations;

Quantitative research to determine optimal size of feeder vessel capacity;

Quantitative and qualitative research comparing the mode of rail transport as feedering mode for an extended gate with the alternatives short haul feeder shuttle and barge shuttle;

Further research of the so-called Estuary barge (in Dutch: “kruip-coaster”) as vessel type and mixed mode for hinterland transport;

Validation study of shippers potential in Northern part of the Netherlands;

Validation study long term capacity barge corridor Amsterdam – Rotterdam;

Study for improving Information exchange within the supply chain; bench study container shipping with the aviation sector.

Research for identifying other geographic areas or port regions in Europe, which are suitable for an introduction of short haul feeder shuttle concept as mode for hinterland transport.

Research the potential of a short haul feeder network of environmental friendly feeder vessels feedering the ULCV in mega ports.(e.g. LNG)

Reliability and structure of the inland waterway shipping sector should be further researched in order to conclude the competence of barge shipping to absorb future hinterland transport volumes

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Shortsea Promotion Centre Holland – www.shortsea.nl

NDL / HIDC – www.hidc.com

UNCTAD – www.unctad.org

ECT- www.ect.nl

EGS - www.europeangatewayservices.nl

Seago - www.seagoshipping.nl

JR Shipping - www.jrshipping.nl

Bunkerworld - www.Bunkerworld.com

Appendices

Appendix 1 Definitions

Charterer: “Individual or company who hires a ship” (Stopford, 2009)

Time charter: “The shipowner retains possession and mans and operates ship under instructions from charterer who pays for the voyage costs”. The charter hire is specified as a fixed daily or monthly payment for the hire of the vessel. The owner takes the operational risk and the charterer takes the market risks, paying the agreed daily hire regardless of market conditions. The charterer pays fuel, port charges, stevedoring and other cargo related costs.” (Stopford, 2009)

Voyage costs: “Port costs (port charges, stevedoring charges, cleaning holds, cargo claims), canal transit dues and bunker fuel”. (Stopford, 2009)

Demurrage: “The money payable to the shipowner for delay for which he’s not responsible in loading and/ or discharging beyond the lay time” (Stopford, 2009)

Despatch: “Means the money in which the owner agreed to repay the ship if the ship is loaded or discharged in less than the lay time allowed in the charter-party (customarily demurrage)”.(Stopford, 2009)

Cost Insurance Freight (C.I.F): The purchase price of the goods (by importer) includes payment of insurance and freight which is arranged by the exporter. (Stopford, 2009)

Free on Board (F.O.B).: “Goods and purchased at cost and the importer makes his own arrangement for insurance and freight”. (Stopford, 2009)

Freight charges: The costs to transport a container from A - B

Ultra Large Container Vessels: Container vessels with a capacity more than 10.000 TEU.

Malacca-max vessel: A container vessel design of over 18.000 TEU. The design was based and named after the design parameter of the Strait of Malacca with a draught of maximum 21 meters. (Wijnolst, 1999)

Hub-and spoke: “The hub and spoke system is in fact an system that allows shipping lines to efficiently serve smaller markets by using a combination of very large mother vessels (>10.000 TEU), that call only at a big hub port and smaller feeder ships. By including transshipment in the operation of shipping companies, they're able to achieve considerable economies of scale. Smaller ships then provide faster feeder services on inter-regional short routes or other low volume routes. Transhipment offers an efficient way of serving smaller ports and countries and provide many more port-to-port connections to shippers than direct services (Damas, 2001) In fact, with the hub and spoke system, carriers can provide shipping services virtually between any two ports not connected by a direct service". (Vroegop, 2010)

Feedering: "Transhipment from mainline carrier onto a sea-going feeder vessel and vice versa, for short haul distribution to ports which are too small or lack sufficient volmes to be served by a mainline carrier. Feedering can be regarded as an extension of the deep sea operation".(Vroegop, 2008)

Terminal Handling Charges(THC) : costs per handling of a container in a port

Shipper: "Individual or company with cargo to transport" (Stopford, 2009)

S-curve: "The relationship between effort and performance taking the shape of the letter "S". The "S" curve is useful for understanding and even predicting innovation." (Wijnolst, 2009)

Appendix 2 Quantitative & qualitative research

Quantitative research

The following quantitative data were collected, researched and analysed;

Analysis forecast deep sea container trade
Forecast Asia- Europe trade; 2010 – 2020 / 2020 – 2030 / 2030 - 2040

Market analysis container supply/demand Port of Rotterdam
period 2010 – 2020; period 2020 – 2030; period 2030 - 2040

Cost analysis transhipment by feeder shuttle

Qualitative research

Semi-structured in depth qualitative open ended face-to-face interviews;
Deep-sea-ports;
Port of Amsterdam; Port of Rotterdam.

Intermodal offices & others
Short Sea Promotion Centre Holland; Bureau Rijn & Binnenvaart; EVO.

Container Carriers (Deep-sea) ;
CMA-CGM; ; APL; COSCO; Hanjin.

Container Carriers (feeder operators) ;
SeaGo, Teamlines

Terminal Operators;
Hutchison Port Holding-ECT ; Hutchison Port Holding-ACT; Ter Haak/USA Terminals.

Collecting qualitative documents;
During the whole process of research, the author collected qualitative documents related to the topic, like official reports, public documents and company documents.

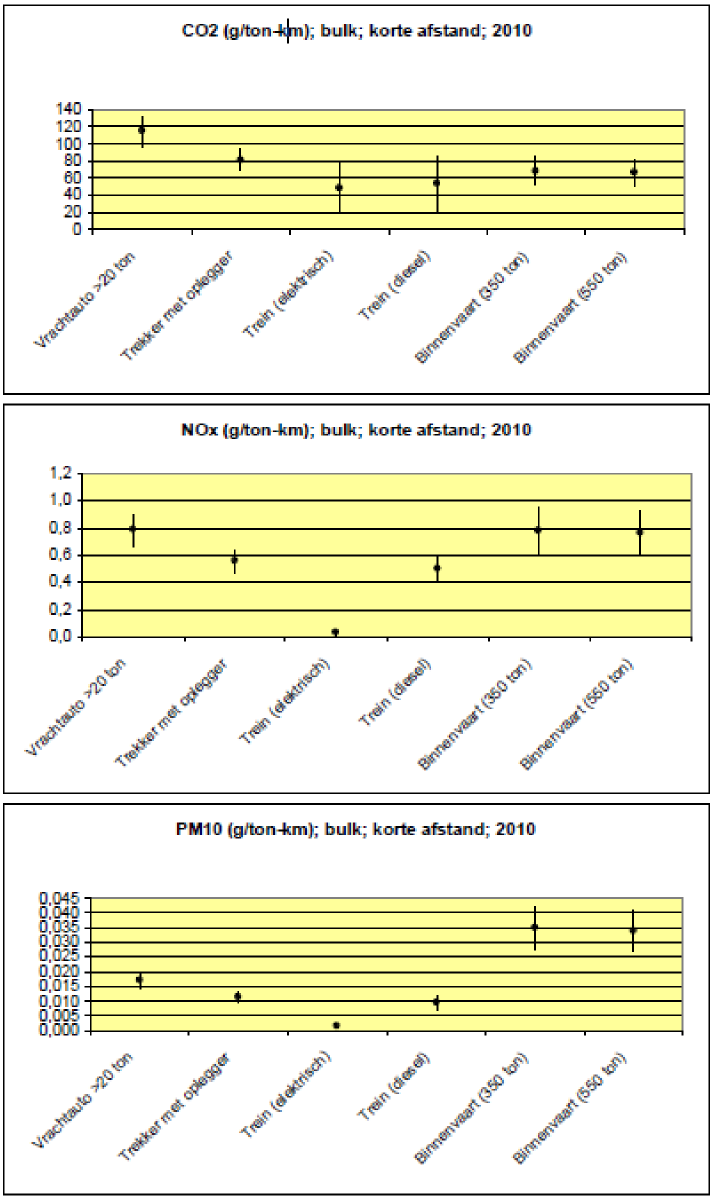
Appendix 3 Emissions

Binnenvaart		Best case								Worst case							
		Omweg-percentage	Voor- en natransport	Productieve km's	Belading	CO_2	NO_x	PM_{10}	SO_2	Omweg-percentage	Voor- en na-transport	Productieve km's	Belading	CO_2	NO_x	PM_{10}	SO_2
		%	%	%	ton	g/ton-km	g/ton-km	g/ton-km	g/ton-km	%	%	%		g/ton-km	g/ton-km	g/ton-km	g/ton-km
2005	Bulk																
	Spits	0%	0%	78%	265	62	0,77	0,036	0,073	20%	10%	78%	196	99	1,21	0,055	0,112
	Kempenaar				416	62	0,77	0,036	0,073				307	99	1,21	0,055	0,112
	Rhine Herne Canal ship				1.021	58	0,73	0,034	0,069				754	94	1,15	0,052	0,106
	Koppelverband				4.158	23	0,28	0,013	0,027				3.073	42	0,50	0,022	0,045
	Four barges convoy set				9.071	15	0,19	0,009	0,018				6.705	31	0,37	0,016	0,032
	Container																
	Neo Kemp	0%	0%	98%	24	57	0,71	0,033	0,067	20%	10%	98%	18	129	1,50	0,064	0,127
	Rhine Herne Canal ship				72	46	0,58	0,027	0,054				53	113	1,31	0,065	0,109
	Container ship (Rhine)				150	35	0,43	0,020	0,041				111	97	1,10	0,045	0,090
	Container ship (JOWI class)				351	27	0,34	0,016	0,032				260	85	0,96	0,039	0,076
2010	Bulk																
	Spits	0%	0%	78%	265	52	0,61	0,028	0,033	20%	10%	78%	196	85	0,96	0,042	0,053
	Kempenaar				416	50	0,59	0,027	0,031				307	82	0,93	0,041	0,052
	Rhine Herne Canal ship				1.021	43	0,51	0,023	0,027				754	72	0,81	0,035	0,045
	Koppelverband				4.158	22	0,26	0,012	0,014				3.073	41	0,44	0,019	0,026
	Four barges convoy set				9.071	15	0,18	0,008	0,009				6.705	30	0,32	0,013	0,019
	Container																
	Neo Kemp	0%	0%	98%	24	36	0,43	0,020	0,023	20%	10%	98%	18	99	0,64	0,030	0,061
	Rhine Herne Canal ship				72	44	0,52	0,024	0,028				53	111	0,78	0,036	0,069
	Container ship (Rhine)				150	33	0,40	0,018	0,021				111	95	0,59	0,027	0,059
	Container ship (JOWI class)				351	26	0,31	0,014	0,016				260	84	0,46	0,022	0,052
2020	Bulk																
	Spits	0%	0%	78%	265	49	0,46	0,019	0,029	20%	10%	78%	196	81	0,70	0,029	0,047
	Kempenaar				416	48	0,45	0,019	0,028				307	78	0,68	0,028	0,046
	Rhine Herne Canal ship				1.021	41	0,39	0,016	0,024				754	69	0,59	0,024	0,040
	Koppelverband				4.158	21	0,20	0,006	0,012				3.073	39	0,31	0,012	0,023
	Four barges convoy set				9.071	14	0,13	0,006	0,008				6.705	29	0,22	0,009	0,017
	Container																
	Neo Kemp	0%	0%	98%	24	34	0,32	0,013	0,020	20%	10%	98%	18	96	0,48	0,021	0,055
	Rhine Herne Canal ship				72	42	0,39	0,016	0,024				53	107	0,59	0,025	0,062
	Container ship (Rhine)	0%	0%		150	32	0,30	0,012	0,018				111	92	0,44	0,019	0,063
	Container ship (JOWI class)				351	25	0,23	0,010	0,014				260	82	0,35	0,015	0,047

Emissies zijn inclusief emissies tijdens raffinage en elektriciteitsproductie.

Zeescheepvaart		Best case								Worst case							
		Omweg-percentage	Voor- en nat-ransport	Productieve km's	Belading	CO_2	NO_x	PM_{10}	SO_2	Omweg-percentage	Voor- en na-transport	Productieve km's	Belading	CO_2	NO_x	PM_{10}	SO_2
		%	%	%	ton	g/ton-km	g/ton-km	g/ton-km	g/ton-km	%	%	%		g/ton-km	g/ton-km	g/ton-km	g/ton-km
2005	Droge bulk																
	1300 GT	-40%	0%	50%	1.044	37	0,70	0,053	0,40	40%	10%	50%	772	111	2,1	0,15	1,1
	5800 GT				4.562	13	0,30	0,027	0,19				3.372	45	0,9	0,078	0,55
	20000 GT				17.262	6,0	0,15	0,012	0,083				12.759	24	0,50	0,036	0,24
	45000 GT				45.475	2,9	0,19	0,014	0,037				33.612	15	0,61	0,041	0,11
	80000 GT				84.341	2,3	0,28	0,022	0,032				62.339	13	0,86	0,065	0,09
	Containers																
	1300 GT	-40%	0%	98%	987	43	0,74	0,039	0,32	40%	10%	98%	729	132	2,2	0,11	0,93
	5800 GT				3.961	21	0,36	0,016	0,14				2.928	70	1,1	0,047	0,40
	20000 GT				13.009	11	0,28	0,018	0,13				9.615	43	0,90	0,053	0,37
	45000 GT				28.025	9	0,23	0,018	0,12				20.714	37	0,76	0,054	0,36
	80000 GT				47.510	9	0,20	0,011	0,081				35.116	35	0,67	0,033	0,24
2010	Droge bulk																
	1300 GT	-40%	0%	50%	1.044	37	0,68	0,032	0,19	40%	10%	50%	772	111	2,0	0,093	0,54
	5800 GT				4.562	13	0,29	0,012	0,089				3.372	45	0,88	0,035	0,26
	20000 GT				17.262	6,0	0,15	0,012	0,083				12.759	24	0,46	0,035	0,24
	45000 GT				45.475	2,9	0,07	0,005	0,037				33.612	15	0,25	0,016	0,11
	80000 GT				84.341	2,3	0,06	0,005	0,032				62.339	13	0,20	0,014	0,09
	Containers																
	1300 GT	-40%	0%	98%	987	41	0,72	0,055	0,15	40%	10%	98%	729	128	2,1	0,16	0,44
	5800 GT				3.961	20	0,35	0,014	0,066				2.928	68	1,1	0,041	0,19
	20000 GT				13.009	11,1	0,27	0,017	0,12				9.615	42	0,84	0,050	0,36
	45000 GT				28.025	8,9	0,22	0,017	0,12				20.714	36	0,70	0,051	0,35
	80000 GT				47.510	8,4	0,19	0,010	0,079				35.116	34	0,62	0,031	0,23
2020	Droge bulk																
	1300 GT	-40%	0%	50%	1.044		0,51	0,047	0,19	40%	10%	50%	772	111	1,5	0,14	0,54
	5800 GT				4.562		0,22	0,024	0,088				3.372	45	0,65	0,069	0,26
	20000 GT				17.262		0,11	0,011	0,039				12.759	24	0,33	0,031	0,11
	45000 GT				45.475		0,05	0,005	0,017				33.612	15	0,17	0,014	0,05
	80000 GT				84.341		0,04	0,004	0,015				62.339	13	0,14	0,012	0,05
	Containers																
	1300 GT	-40%	0%	98%	987		0,53	0,034	0,15	40%	10%	98%	729	128	1,5	0,096	0,43
	5800 GT				3.961		0,26	0,014	0,065				2.928	68	0,75	0,039	0,19
	20000 GT				13.009		0,20	0,015	0,058				9.615	42	0,59	0,044	0,17
	45000 GT				28.025		0,16	0,016	0,056				20.714	36	0,49	0,045	0,16
	80000 GT				47.510		0,14	0,009	0,037				35.116	34	0,43	0,027	0,11

Case 1: Korte afstand, bulk voor CO_2, NO_x en PM_{10} voor 2010



Appendix 4 Global ranking of sea ports –trend 2011

Rank	Port	Country	2008 TEU m	2009 TEU m	2010 TEU m		Change 2009-2008	Change 2010-2009	Change yoy 2011-2010
1	Shanghai	China	27.98	25.00	29.07		-10.6%	16.3%	12.1%
2	Singapore	Singapore	29.97	25.87	28.43		-13.7%	9.9%	3.6%
3	Hong Kong	China	24.25	20.98	23.53		-13.5%	12.1%	3.0%
4	Shenzhen	China	21.40	18.25	22.51		-14.7%	23.3%	2.6%
5	Pusan	South Korea	13.45	11.98	14.21		-10.9%	18.6%	
6	Ningbo	China	10.80	10.50	13.14		-2.8%	25.1%	21.1%
7	Guangzhou	China	11.00	11.19	12.55		1.7%	12.2%	2.1%
8	Qingdao	China	10.32	10.26	12.01		-0.6%	17.1%	17.6%
9	Dubai	UAE	11.80	11.12	11.60		-5.7%	4.3%	
10	Rotterdam	Netherlands	10.78	9.74	11.14		-9.6%	14.3%	11.9%
11	Tianjin	China	8.50	8.70	10.08		2.4%	15.9%	21.7%
12	Kaohsiung	Taiwan	9.68	8.58	9.18		-11.4%	7.0%	
13	Port Klang	Malaysia	7.80	7.30	8.87		-6.4%	21.5%	11.6%
14	Antwerp	Belgium	8.66	7.31	8.48		-15.6%	16.0%	7.9%
15	Hamburg	Germany	9.70	7.06	7.94		-27.2%	12.4%	18.0%
16	Los Angeles	US	7.85	6.75	7.80		-14.0%	15.6%	10.2%
17	Tanjung Pelepas	Malaysia	5.60	6.02	6.53		7.5%	8.5%	18.0%
18	Long Beach	US	6.49	5.07	6.26		-21.9%	23.5%	7.2%
19	Xiamen	China	5.04	4.68	5.82		-7.1%	24.4%	5.1%
20	Dalian	China	4.50	4.55	5.24		1.1%	15.2%	12.7%
21	Laem Chabang	Thailand	5.24	4.62	5.19		-11.8%	12.3%	
22	Bremerhaven	Germany	5.50	4.55	4.90		-17.2%	7.6%	24.9%
			256.31	230.09	264.48		-10.2%	14.9%	
28	Valencia	Spain	3.60	3.65	4.20		1.3%	15.1%	8.6%
33	Felixstowe	UK	3.13	3.02	3.40		-3.5%	12.6%	
45	Zeebrugge	Belgium	2.21	2.33	2.50		5.4%	7.3%	-2.9%
49	Le Havre	France	2.49	2.23	2.40		-10.4%	7.6%	-14.5%

Source: BNP Paribas, 2011

Appendix 5 Voyage costs

	Rotterdam	Amsterdam	Green Award		ESI Discount		Roundtrip	% of total c	Slotcost single voyage per TEU						
			Discount 6%		20 pt	40 pt			Utilization	Utilization	Utilization				
Harbour Dues			R'dam	A'dam					100,00%	80,00%	60,00%				
MS Elevation (538 TEU)	€ 2.496,72	€ 1.222,38	€ 134,80	€ 58,34	€ 100,00	€ 250,00	€ 3.026,28	21,60%	€ 5,63	€ 5,63	€ 5,63				
MS Enforcer (750 TEU)	€ 3.681,81	€ 1.699,11	€ 205,91	€ 86,95	€ 100,00	€ 250,00	€ 4.469,89	22,80%	€ 5,96	€ 5,96	€ 5,96				
MS Elan (1008 TEU)	€ 5.353,53	€ 2.265,10	€ 294,21	€ 108,91	€ 180,00	€ 450,00	€ 6.230,16	24,64%	€ 6,18	€ 6,18	€ 6,18				
												Rotterdam	Amsterdam	Rotterdam	Amsterdam
Charter cost				R'dam ESI								Charter cost			
				Discount 10%								150%		200%	
MS Elevation (538 TEU)	€ 3.000,00	€ 3.000,00		€ 249,67			€ 6.000,00	42,82%	€ 11,15	€ 13,38	€ 15,61	€ 4.500,00	€ 4.500,00	€ 6.000,00	€ 6.000,00
MS Enforcer (750 TEU)	€ 4.000,00	€ 4.000,00		€ 368,18			€ 8.000,00	40,81%	€ 10,67	€ 12,80	€ 14,93	€ 6.000,00	€ 6.000,00	€ 8.000,00	€ 8.000,00
MS Elan (1008 TEU)	€ 6.000,00	€ 6.000,00		€ 535,35			€ 12.000,00	47,46%	€ 11,90	€ 14,29	€ 16,67	€ 9.000,00	€ 9.000,00	€ 12.000,00	€ 12.000,00
												€ 20,07		€ 26,77	
Bunker cost												€ 19,20		€ 25,60	
												€ 21,43		€ 28,57	
MS Elevation (538 TEU)	€ 2.493,30	€ 2.493,30					€ 4.986,60	35,59%	€ 9,27	€ 11,12	€ 12,98				
MS Enforcer (750 TEU)	€ 3.567,25	€ 3.567,25					€ 7.134,49	36,39%	€ 9,51	€ 11,42	€ 13,32	Barge	€ 18,00		
MS Elan (1008 TEU)	€ 3.528,33	€ 3.528,33					€ 7.056,65	27,91%	€ 7,00	€ 8,40	€ 9,80	Barge	€ 25,00		
Total cost												total	Per TEU	total	per TEU
MS Elevation (538 TEU)	€ 7.605,21	€ 6.407,67					€ 14.012,88	100,00%	€ 26,05	€ 30,13	€ 34,21	€ 3.000,00	€ 6,69	€ 6.000,00	€ 13,38
MS Enforcer (750 TEU)	€ 10.793,15	€ 8.811,23					€ 19.604,38	100,00%	€ 26,14	€ 30,18	€ 34,21	€ 4.000,00	€ 6,40	€ 8.000,00	€ 12,80
MS Elan (1008 TEU)	€ 14.137,64	€ 11.149,17					€ 25.286,81	100,00%	€ 25,09	€ 28,87	€ 32,65	€ 6.000,00	€ 7,14	€ 12.000,00	€ 14,29

The harbour Dues are the same at 100%, 80%, 60% because they all are the A-tariff

	Rotterdam	Amsterdam	Roundtrip	% of total cost		Slotcost single voyage per TEU		
						Utilization	Utilization	Utilization
Harbor Dues						100,00%	80,00%	60,00%
MS Elevation (538 TEU)	€ 3.160,40	€ 1.222,38	€ 4.382,78	28,52%	per TEU	€ 8,15	€ 9,78	€ 11,41
MS Enforcer (750 TEU)	€ 4.660,52	€ 1.699,11	€ 6.359,63	29,59%	per TEU	€ 8,48	€ 10,18	€ 11,87
MS Elan (1008 TEU)	€ 6.776,62	€ 2.265,10	€ 9.041,72	32,18%	per TEU	€ 8,97	€ 10,76	€ 12,56
Charter cost								
MS Elevation (538 TEU)	€ 3.000,00	€ 3.000,00	€ 6.000,00	39,04%	per TEU	€ 11,15	€ 13,38	€ 15,61
MS Enforcer (750 TEU)	€ 4.000,00	€ 4.000,00	€ 8.000,00	37,22%	per TEU	€ 10,67	€ 12,80	€ 14,93
MS Elan (1008 TEU)	€ 6.000,00	€ 6.000,00	€ 12.000,00	42,71%	per TEU	€ 11,90	€ 14,29	€ 16,67
Bunker cost								
MS Elevation (538 TEU)	€ 2.493,30	€ 2.493,30	€ 4.986,60	32,45%	per TEU	€ 9,27	€ 11,12	€ 12,98
MS Enforcer (750 TEU)	€ 3.567,25	€ 3.567,25	€ 7.134,49	33,19%	per TEU	€ 9,51	€ 11,42	€ 13,32
MS Elan (1008 TEU)	€ 3.528,33	€ 3.528,33	€ 7.056,65	25,11%	per TEU	€ 7,00	€ 8,40	€ 9,80
Total cost								
MS Elevation (538 TEU)	€ 8.653,70	€ 6.715,68	€ 15.369,38	100,00%	per TEU	€ 28,57	€ 34,28	€ 39,99
MS Enforcer (750 TEU)	€ 12.227,77	€ 9.266,36	€ 21.494,12	100,00%	per TEU	€ 28,66	€ 34,39	€ 40,12
MS Elan (1008 TEU)	€ 16.304,95	€ 11.793,43	€ 28.098,37	100,00%	per TEU	€ 27,88	€ 33,45	€ 39,03